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Beyond Todaro: A Re-Consideration of Comparative Macroeconomic Relevance between Unemployment and Migration in Developing Countries

超越托达罗：失业和农业劳动力转移在发展中国家宏观经济中相对重要性的再研究

Jenseits von Todaro: Wiederueberlegung ueber die relative makrooekonomische Relevanz zwischen Arbeitslosigkeit und Migration in den Entwicklungslaendern

Jingbei HU (胡景北)

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by

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Beyond Todaro: A Re-Consideration of Comparative Macroeconomic Relevance between Unemployment and Migration in the Developing Countries

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English Abstract

This paper investigates comparative relevance of intersectoral migration of agricultural labor and change in unemployment for short-run macroeconomic performance. Migration of this kind and change in unemployment occur simultaneously in every country all over the world. Data reveal that quantity of the former exceeds that of the latter many times and that the former links economic growth and inflation much more closely than the latter does in some developing countries, which is inconsistent with Todaro model making migration induced by changes in unemployment and negating immediate relations between migration and macroeconomic performance. This paper set up a criterion composed of both rates between change in unemployment and migration and between marginal products of agricultural and nonagricultural labor to determine which of both migration and unemployment may have greater output effects. With it the data of the United States and China are analyzed. It is found that the output effects of change in unemployment should be greater in the United States during the post-war era, while migration could affect aggregate output far more strongly in China since 1978. Therefore, a short-run macroeconomic framework for China and similar developing countries should replace unemployment with migration as one of core variables to analyze the relationships among migration, economic growth and inflation.

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中文摘要

本文研究农业劳动力的部门转移和失业变化的在短期宏观经济运行中的相对作用。农业劳动力转移和失业变化发生在世界每个国家。托达罗模型认为前者是由后者引致的并且否定前者和宏观经济运行的直接联系。本文的资料说明在某些发展中国家中，前者不但在数量上数倍地超过后者，而且与经济增长和通货膨胀的关系也比后者与它们的关系更为紧密。这些经验事实显然和托达罗模型不相容。本文提出一个标准以检验农业劳动力转移和失业变化对总产出的相对影响。该标准由失业和转移两者的数量比与农业和非农劳动的边际产出比构成。本文并用这个标准研究了美国和中国的数据，发现失业变化的总产出效应在战后的美国经济中比较大，而农业劳动力转移在 1978 年以后的中国经济中的总产出效应大。因此，以中国和类似的发展中国家为背景的短期宏观经济学应当用农业劳动力转移代替失业作为自己的核心变量来分析转移和经济增长/通货膨胀的关系。

In his seminal work (Todaro, 1969; Harris and Todaro, 1970; Todaro, 1976), Todaro argued that migration of rural labor forces into urban areas is dependent on urban unemployment. Since rural wage level is much lower than the urban ones, rural labor has incentives to migrate out into cities. But urban unemployment means the migrants may not find jobs there. Therefore, changes in unemployment will negatively affect the migration decisions made by rural labor forces and the less unemployment there is in the urban areas, the more rural-urban migration may be and verse visa.[1] In this sense migration is regarded by Todaro as what is induced by changes in unemployment.[2] Todaro model then becomes a paradigm in the research of internal or intersectoral migration of rural or agricultural labor in the developing countries (Banerjee and Kanbur, 1981; Ghatak, Levine and Price, 1996).[3] The present paper will first point out that Todaro model is irrelevant to some developing countries with massive migration of labor force out of agriculture because the magnitude of migration there is far beyond the frame of Todaro model. Furthermore, it will show that migration may have immediate and clear effects on economic growth and inflation. Those phenomena seem to be inconsistent with Todaro model as well as the prevalent mainstream short-run macroeconomics where intersectoral migration of labor does not have macroeconomic effects without through the channel of its correlations with changes in unemployment.

This paper will then detailedly examine the comparative importance of migration of agricultural labor and change in unemployment for the short-run macroeconomic performance or, exactly speaking, for aggregate output. Output effects of unemployment are well known, especially through the so-called Okun's Law (Okun, 1962; Knotek, 2007). Mechanisms of these effects are somewhat straightforward since changes in unemployment indicate changes in labor employed in the production of the output in the short run when other variables are held constant. Output effects of intersectoral reallocation or migration of labor are, on the contrary, more complicated to understand. It presupposes gaps of marginal products of labor among sectors. Although this presupposition corresponds to the reality since there are sectoral productivity differences within every economy we know about and the intersectoral reallocation of labor is routine, the net and aggregated quantity of labor reallocated into sectors of higher productivity in a certain period of time is essentially difficult to deal with statistically, not to say of its effects on aggregate output. It is perhaps a practical ground why labor reallocation is not considered explicitly in the mainstream short-run macroeconomics. Nevertheless, reallocation of labor between agricultural and nonagricultural sectors makes an exception. Firstly, labor forces in these two

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[1] Negative relations between migration and unemployment are known to economists much earlier. Johnson (1948: 153), e.g. already pointed "perhaps the most significant of the generalizations explaining migration has been that net off-farm migration is closely related to the availability of job opportunities in nonfarm sectors of the economy. People leave farming communities when unemployment is of modest proportions; when unemployment is high the migration is small." But Todaro first set up a model to investigate the relations analytically.

[2] Bartlett (1983: 85) saw the "induced migration" unemployment equilibrium is "a key proposition" of Todaro model and subsequent literature.

[3] Todaro model is sometimes named the HT model in the literature according to a paper written by Harris and Todaro (1970). Blomqvist (1978) analyzed distinctions between the model Todaro (1969) put forward and the HT model. Regarding the induced migration both the models are consistent.

sectors are clearly defined in the regular statistical publications of most countries of the world and the net quantity of labor reallocation can be made known through some well-defined procedures. Secondly, there is a noticeable gap in labor productivity between both the sectors. According to different studies (Maddison, 1970; Restuccia, Yang and Zhu, 2008), labor productivity in agriculture is far lower than in nonagriculture in all countries including today's most developed ones. Thirdly, countries all over the world including the developed and developing ones nowadays are experiencing labor reallocation between the two sectors, particularly migration of agricultural labor out into nonagricultural sectors, as our Tables below suggest. Fourthly, labor transferred out of agriculture is of special scientific importance since the transfer is one of the most important aspects of the transition of the mankind from the agricultural to post-agricultural societies after it passed through the transition from gathering and hunting economy to agriculture. Hence the inclusion of migration of agricultural labor into the macroeconomic framework is practically feasible and theoretically necessary. With the productivity gap, a worker transferred from agriculture into nonagriculture will reduce output of the former, but raise that of the latter far more and lead aggregate output to rise if other conditions remain unchanged. Hence migration has macroeconomic relevance. Questions posed here are how great the output effects of migration can be and if these effects are greater than that of changes in unemployment. This paper tries to deal with these questions. To address them formally, the following second section will propose a criterion to determine which of the both migration and unemployment has stronger output effects. The criterion lies in the comparisons of the sums of three quantities. The first quantity is output that workers out of agriculture will produce in nonagriculture and the second one is the loss in output that out-migration of these workers may cause in agriculture, while the third quantity refers to decrease in nonagricultural output resulted from unemployment increments. Changes in aggregate output depend on the sum of these three quantities. Impact of change in unemployment on aggregate output will be greater than labor migration if the sum is negative, that it, the first quantity can not offset the sub-sum of the last two quantities; and migration has greater output effects if the first one is larger than that only for offsetting the last two ones together. The criterion will be applied to the United States and China in the third and fourth sections of this paper, respectively, where it is found that migration of agricultural labor might have less output effects than change in unemployment did in the United States during the post-war period, while migration impacted on China's aggregate output clearly more strongly than unemployment since 1978 when China began its far-reaching reforms in the direction to market economy. Accordingly, macroeconomic research on economies of China or similar developing countries should necessarily consider, instead of unemployment, migration as its core variable, which, however, may lead to a new macroeconomic framework particularly adequate for the developing countries. [4]

[4] An effort in this direction is in Hu (2009).

1. Irrelevance of Todaro Model

To make macroeconomic irrelevance of Todaro model clear, we first collect data of some important phenomena in Table 1.1 and 1.2 below. There are four stocks of the labor market which are of importance for macroeconomic performance: total amount of labor (L), agricultural and nonagricultural labor (L_1 and L_2), and unemployment (U). Derived from them, we get five flows of ΔL, ΔL_1, ΔL_2, ΔU and M, where M is used to describe labor transfer between agriculture and nonagriculture. For the year of 2008, we find the following relations for the five selected economies of the United States, Germany, China, Sub-Saharan Africa and the world as a whole in Table 1.1 and 1.2:

(1.1) $U > L_1$ and $|\Delta U| > |M|$

for US and Germany and

(1.2) $L_1 > U$ and $|M| > \Delta U$

for China, Sub-Saharan Africa and the world.

Table 1.1 States of Labor Markets: US, Germany, China, Sub-Saharan Africa and the World, 2008

	Unit	US	Germany	China	Sub-Saharan Africa	World
Total labor (L)	m	154	43	784	316	3212
Agricultural labor (L_1)	m	2	1	307	171	1061
Nonagricultural labor (L_2)	m	143	39	468	120	1968
Unemployment (U)	m	9	3	9	25	183
l_1 (=L_1/L)	%	1.4	2.0	39.1	54.2	33.0
U (=U/L)	%	5.8	7.3	1.1	7.9	5.7
L_1/U (=l_1/u)	%	24.3	27.4	3459	687	580

Sources: US: ERP, 2010, Table B35. Germany: Statistisches Jahrbuch fuer die Bundesrepublik Deutschland 2010, Table 3.1, 3.2. China: NBSC, ed., 2010, Table 1-4. Sub-Saharan Africa and the world: ILO, 2011, Table A2, A4, A10, A11.

Note: m stands for million. The numbers are round in Table 5.1, but the computations of l, u and L_1/U were done with original data.

The quantitative relations between two stocks of U and L_1 are well known and even belong to the characteristics used to divide developed and developing countries from each other, while that between two flows, M and ΔU, has got little attention, although flows have more to do with short-run macroeconomics. A first glance at Relation (1.1) and (1.2) may hint that Todaro model can well apply to US and Germany, but, ironically, not to

Table 1.2 Changes of Labor Markets: US, Germany, China, Sub-Saharan Africa and the World, 2008

	Unit	US	Germany	China	Sub-Saharan Africa	World
Change in total Labor (ΔL)	m	1.2	0.1	5.5	9.2	50.9
Change in agricultural labor (ΔL_1)	m	0.07	0.01	-7.9	3.7	4.4
Change in nonagricultural labor (ΔL_2)	m	-0.8	0.6	12.8	4.8	40.9
Change in unemployment (ΔU)	m	1.9	-0.5	0.6	0.7	5.6
Migration from agriculture into nonagriculture (M)	m	-0.06	-0.01	10.1	1.5	12.6
Δl_1	%	0.04	0.02	-1.3	-0.5	-0.4
Δu	%	1.2	-1.1	0.1	0.0	0.1
$\|M/\Delta L\|$	%	4.9	9.3	185.1	15.8	24.8
$\|M/\Delta L_2\|$	%	7.6	11.3	79.0	30.3	30.9
$\|M/\Delta U\|$	%	3.1	-1.9	1805	199	225
Growth rate of GDP	%	0.4	1.3	9.0	5.5	2.8

Sources: Labor data: as of Table 5.1. GDP data: US: ERP, 2010, Table B4. Germany: Statistisches Jahrbuch fuer die Bundesrepublik Deutschland 2010, Table 24-2. China: NBSC, 2009, Table 2-4. Sub-Saharan Africa and the world: ILO, 2011, Table A1.

China and Africa as well as the whole world, because migrations are much smaller than changes in unemployment in US and Germany and migration may depend on unemployment change in both the countries. For example, labor migrated back to agriculture in US in 2008 as depicted in Table 1.2 when the severe economic downturn brought about a strong increase in unemployment in nonagriculture. In fact, one of the events Todaro (1969) mentioned to support his arguments is the return migration of agricultural labor during the Great Depression in the United States.[5] However, in China and the whole world in 2008 there were increases in unemployment and a huge migration from agriculture to nonagriculture at the same time, while agriculture labor migrated out without changes in unemployment rate in Sub-Saharan Africa. It shows that growing unemployment did not seem to hinder the mass outflow of agriculture labor.

Todaro was conscious to the phenomena of concurrence of migration and unemployment growth, as shown for China and the World in 2008 and explained it with the argument that a creation of new jobs in modern sector can induce more migrants from agricultural sectors and thus exacerbate the unemployment. But the way he dealt with the phenomena is much more of analysis for certain job-creation policy than for general macroeconomic running. The question Todaro tried to answer with his model is, in his own word (1976: 216), "will 500 more urban jobs induce *more* than 500 rural workers who may have been on the margin of migrating to actually migrate to the city?" (italic in original). When the answer is positive, he is not for the policy which plans to create 500 more urban jobs. What we are facing is, however, not the magnitude of 500 new jobs, but of 50 000 in a small country as Kenya Todaro originally analyzed and 5 million in a big one as China, as Table 1.2 shows. New jobs of 50 000 in Kenya and 5 million in China cannot be brought about by a certain policy. To deal with job-creations of such large magnitudes we need short-run macroeconomic analysis, but not policy analysis. For example, a creation of 500 new jobs in Kenya and of 50 000 in China may not cause the urban wage level to rise, but that of several hundred thousands or even millions must have wage effects if without agricultural labor migrating into urban areas since otherwise labor shortage should be unavoidable for the modern sector. In the case of Sub-Saharan Africa there were nearly 5 million new jobs created in nonagriculture in 2008 and labor market would become tight if 1.5 million of agricultural labor forces would not have migrated into cities.[6] In China's case, nonagricultural jobs increased in 2008 nearly 13 million, of that more than 11 million were taken by migrants in that year. If all new jobs would be assigned to urban unemployed ones, there would be, on the one side, still vacancies because total urban unemployment plus natural growth in urban labor was less than the new jobs created. On the other and more important side, the urban wage level must have risen enormously, which would reduce the creation of new nonagricultural jobs greatly. Obviously, the creation of one or more million new jobs in nonagriculture in Sub-Saharan Africa and China as well as in the whole world in 2008 would not be possible if there would not be massive migration out of agriculture. In other words, it was the flows of migrants out of agriculture that support the rapid expansion of nonagricultural production and hence economic growth, although to different extent, in Africa and China. If migration was induced, then it was induced by the expansions of nonagricultural activity and rapid economic growth with somewhat

[5] Todaro failed to mention that the total amount of agricultural labor was less than the unemployment in US in e.g. 1933 (ERP, 2010, Table B35), a context which was tremendously different from most developing countries he tried to deal with 40 years ago and even today.

[6] It should be kept in mind that M is computed based on the assumption that natural growth rates of agricultural and nonagricultural labor are equal. M should be higher in Sub-Saharan Africa since the natural growth rate of the former is higher than that of the latter there.

stable wage levels, not by changes in unemployment. To such macroeconomic relations of migration Todaro model is apparently irrelevant. [7]

Relation (1.2) of |M|>|ΔU| does not exist only in 2008 or a few special years for at least some developing countries, but are their general experiences. Take China as an example. Firstly, we use the definition of the migration rate, *m*, made by Hu (2009) as follows

(1.3) $m_t = M_t/L_t$

where M stands for migration of labor force out of agriculture and t for time period, and

(1.4) $M_t = (L_{1,\,t-1} + n_t L_{1,\,t-1}) - L_{1,\,t}$

and

(1.5) $n_t = \Delta L_t/L_{t-1}$

Note that the labor migration out of agriculture is held positive in this definition. Furthermore, we combine unemployment increment proportionally with total labor and get a rate of unemployment increment or new unemployment, u^*, as follows

(1.6) $u^*_t = \Delta U_t/L_t$

It is obvious that u^* is comparable to *m* because their numerators are flows and their denominators are the same. China's data of *m* and u^* from 1979 to 2008 are depicted in Fig. 1.1 where the growth rate of China's GDP, *g*, is illustrated as well. It is shown clearly that fluctuations of *g* with *m* were far more closely linked than that of *g* with u^* did during the period under review. This is first of all because of quantitative domination of *m* over u^* or M over ΔU. In consideration of the familiar concept of unemployment rate, *u*, we add the Fig. 1.2 for another comparison of unemployment with migration. Fig. 1.2 again demonstrates *u* should be much less correlated with *g* than *m* did in the same period. There may be two reasons for the insignificance of *u* for *g*. Firstly, even *u* was often less or much less than *m*, which indicates that U must also be less or much less than M although U is a stock. Secondly, *u* did not change as frequently and strongly, based on small ΔU, at least to some extent as *g* and *m* did. Both of *g* and *m* fluctuated strikingly in the short as well as long term. Fig. 1.3 further displays relations of unemployment and migration with inflation which is represented by changes in the Consumer's Price Index (CPI). It points much closer links of *m* with CPI than that of *u*. Observed from the angle of effects of variables of labor markets on aggregate output and overall price level, it is apparent that migration has immediate relations to general macroeconomic performance and is macroeconomically even more relevant than unemployment in China during the

[7] The implication of Todaro model that urban unemployment can increase along with, because of rural–urban migration, growth in urban employment is valid in China and the world as depicted in Table 1.2. But his suggestions for policy-making, to improve rural economy and let rural labor remain there, must be in doubt because economic growth of the developing countries may depend on out-migration of rural labor, which Todaro did not seem to recognize.

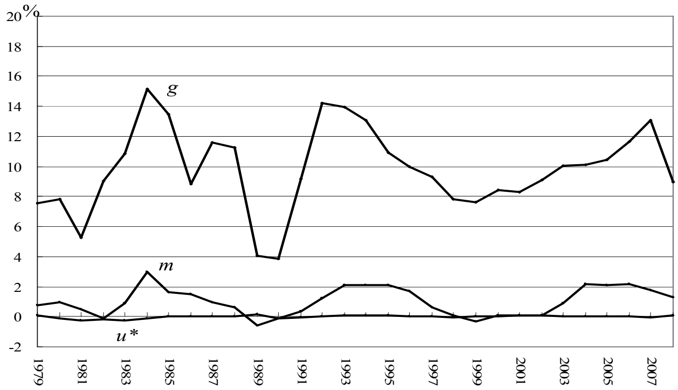

Fig. 1.1 Growth rate of GDP (g), migration rate (m) and rate of new unemployment (u*) in China, 1979 to 2008

Sources and note: NBSC, ed., 2010, Table 1-4, 1-9. g is of constant price.

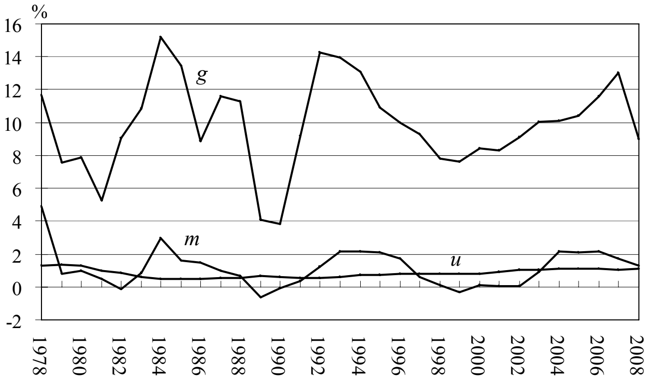

Fig. 1.2 Growth rate of GDP (g), migration rate (m) and unemployment rate (u) in China, 1979 to 2008

Sources and note: As of Fig. 1.1.

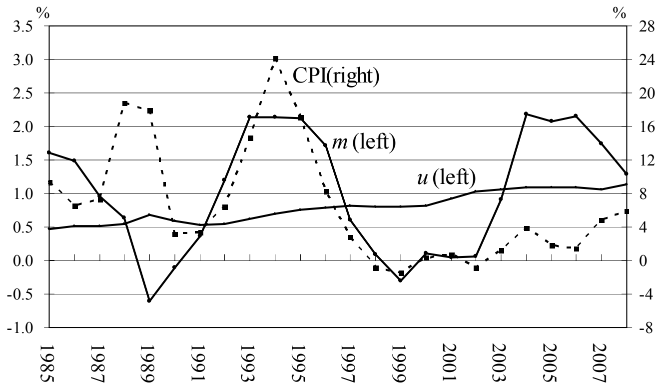

Fig. 1.3 Inflation rate (CPI), migration rate (m) and unemployment rate (u) in China, 1985 to 2008

Sources: As of Fig. 1.1 for m and u and Table 1-21 for CPI.

period of 30 years we are looking at. The data on the world as a whole in Table 1.1 and 1.2 hints that migration has immediate relations to general macroeconomic performance and is macroeconomically even more relevant than unemployment in

China during the period of 30 years we are looking at. The data on the world as a whole in Table 1.1 and 1.2 hints China may not be an extreme case because of its particular size, history or institutions, but has something common with or similar to many other developing countries regarding the quantitative relations between migration and unemployment represented by Relation (1.2).

A massive migration of agricultural labor which supports the economic growth in developing countries is beyond Todaro's imagination. To investigate migration of this kind we have to go away from Todaro. But going away from Todaro means to leave the prevalent mainstream framework of short-run macroeconomic analysis since Todaro model is only an extension of this framework to take migration of labor out of agriculture into account. At the core of the mainstream macroeconomic framework there are three variables of the first rank. They are national income, unemployment and inflation, represented by rate of economic growth, unemployment rate and rate of change in general level of price or inflation rate, respectively. All other real or monetary variables are of the second or still lower ranks. Other variables of labor markets as labor participation, women labor, intersectoral reallocation and international migration of labor do not play roles immediately related to economic growth and inflation, but through their correlations with unemployment, that is, changes in these variables must be seen theoretically as induced by changes in unemployment. As for labor reallocation among the sectors within an economy, the mainstream macroeconomics assumes, according to Barro (1997, Chapter 5), that marginal products of labor are same large among all sectors and intersectoral reallocation of labor can not affect the aggregate output and overall price level, although it changes the sectoral outputs and then the structure of aggregate one. Hence labor transfer between economic sectors will not be taken into account for the macroeconomic analysis. What Todaro does is to give up this equal-productivity assumption and lets intersectoral migrations of labor change the aggregate output. However, he, either, does not allow migration to relate with output and inflation immediately, but still through unemployment, the way the participation of women in labor markets, e.g., is also dealt with. Therefore, Todaro model is more adequate to analyze labor migration essentially induced by changes in unemployment, but it is not able to study migration of agricultural labor in some typical developing countries as China. For short-run analysis of those developing countries unemployment is not qualified as a core variable of the first ranks to interact immediately with aggregate output and inflation. In its place there should be migration of agricultural labor. Therefore, irrelevance of Todaro model leads to irrelevance of mainstream macroeconomic framework, which is designed for the developed countries, for some developing countries.[8] More than 20 Years ago, Chenery (1989) pointed in editing the "Handbook of Development Economics" that the short-run macroeconomic analysis for the developing countries still lacked theoretical frameworks at that time, but

[8] Hu (2010) argued that replacing unemployment with migration of agricultural labor has an implication of social welfare for the developing countries because agricultural workers and their families in these countries are the most populous, but the poorest and politically weakest social group, often poorer and politically weaker than the group of urban unemployed persons. One of the reasons for this implication is that the most effective and sustainable way to ease the plight of the agricultural population may be the transfer of agricultural labor forces into nonagriculture activities. Putting unemployment as one of the core variables for the mainstream macroeconomics is of similar importance for social welfare in the developed countries since the group of the unemployed and their families is the most populous and one of the poorest social groups there, see. e.g. Keynes (1936), Samuelson (1948).

expected researches in this field would become the frontier of development economics. However, only after many years of labor migrations out of agriculture in such a magnitude which has been distinctly surpassing the scale of changes in unemployment are the basic features of the needed theoretical frameworks recognizable.[9]

2. Model

As usually in short-run macroeconomic research, the total amounts of labor and capital as well as the sectoral allocation of capital are assumed given and institutions and technology constant. We divide the economy into two sectors of agriculture and nonagriculture and assume higher labor productivity in nonagriculture than in agriculture. Furthermore, we suppose that labor forces are homogeneous and their migrations between both the sectors do not take time, and a worker cannot have jobs in both sectors at the same time. Short-run changes in labor markets will affect aggregate output. The pathways by which labor has effects on growth and fluctuations of aggregate output are changes in employment (or unemployment) or intersectoral migration (sectoral reallocation) or both together. Assuming an aggregate production function for the two-sector economy in the short-run in the period t as follows

$$(2.1) \quad Y_t = p_t f_{1,t}(l_{1,t}) + f_{2,t}(l_{2,t}) \qquad (l_{1,t} + l_{2,t} + u_t = 1)$$

where Y stands for aggregate output or income and f_i (i=1, 2) for sectoral outputs in kind, while subscripts 1, 2 and t denote agriculture, nonagriculture and time, respectively. We let nonagricultural product be the numeraire and p represents the relative price of agricultural product, $p_t>0$. f_1 and f_2 are continuous and differentiable at least two times, and satisfy the Inada conditions. The fixed total amount of labor, L_t, allocates in the two sectors as $L_{1,t}$ and $L_{2,t}$. We normalize L_t to unity for Equa. (2.1) and express its allocations with $l_{1,t}$ and $l_{2,t}$, $1>l_{1,t}>0$, $1>l_{2,t}>0$, where l denotes sectoral share of labor. We also assume there is unemployment of U_t in the economy, $U_t>0$, and let $u_t=U_t/L_t$ be unemployment rate, $1>u_t>0$. In addition, we set $u_t=u_{t-1}$. A note of $l_{1,t} + l_{2,t} + u_t = 1$ to Equa. (2.1) describes the complete allocations of L_t. Because the sectoral allocations of capital are assumed to be invariable, capital shares do not appear in Equa. (2.1).

As a general practice in many developing countries, unemployment usually refers to workers who are out of work but are searching for jobs in the nonagricultural sector. Therefore, we suppose that unemployment is a subtraction of labor inputted in the nonagriculture. No unemployment would exist in agriculture. We also do not take hidden unemployment and underemployment in agriculture into account. Furthermore, we assume unemployment is independent of workers' intersectoral migrations and vice versa. There are labor forces who transfer out of or into agriculture and who get laid-off or employed newly in the period t. Net migration out of agriculture in this

[9] Chenery (1989: 853) thought, however, in another direction of short-run macroeconomic researches for the developing countries as he said "a more adequate framework … may involve formal modeling of the political economy of policy choice. This may turn out to be one of the features that distinguish the analysis of developing countries from comparable studies of advanced countries". Two representative and voluminous textbooks in the field, Ray's Development Economics (1998) and Agenor and Montiel's Development Macroeconomics (1999), do not deal with intersectoral migration of agricultural labor explicitly.

period is symbolled by M_t and net new unemployment by ΔU_t, $L_{1,t} > M_t \geq 0$, $L_{2,t} > \Delta U_t \geq 0$. If $\Delta U_t \neq 0$, then $u_t \neq u_{t-1}$. Let $u^*_t = \Delta U_t / L_t$ stand for new-unemployment rate and $m_t = M_t / L_t$ for migration rate of agricultural labor force during the period t, respectively, $1 > m_t \geq 0$, $1 > u^*_t \geq 0$, $u_t = u_{t-1} + u^*_t$. Note all of l_1, l_2, u, u^* and m are fractions of L. Introducing u^*_t and m_t into Equa. (2.1) at the same time, we have

$$\text{(2.2)}\quad Y_t^* = p_t f_{1,t}(l_{1,t}^*) + f_{2,t}(l_{2,t}^*)$$
$$= p_t f_{1,t}(l_{1,t} - m_t) + f_{2,t}(l_{2,t} + m_t - u^*_t) \qquad (l_{1,t}^* + l_{2,t}^* + u_{t-1} + u^*_t = 1)$$

We look for the conditions under which $Y_t^* = Y_t$ exists with concurrence of both u^*_t and m_t. Without regard to changes in p, we differentiate Equa. (2.1) with respect to $l_{1,t}$ and $l_{2,t}$ and get [10]

$$dY_t = p_t f'_{1,t}(l_{1,t}) \cdot dl_{1,t} + f'_{2,t}(l_{2,t}) \cdot dl_{2,t}$$

Let $dY_t = 0$, indicating Y will not vary despite changes in both $l_{1,t}$ and $l_{2,t}$ which result immediately from new unemployment (or changes in total employment) and sectoral reallocations of labor, respectively. We replace $dl_{1,t}$ and $dl_{2,t}$ with $-m_t$ and $(m_t - u^*_t)$ under the assumption that each of m_t, u^*_t and $(m_t - u^*_t)$ is sufficiently small and get

$$p_t f'_{1,t}(l_{1,t}) \cdot (-m_t) + f'_{2,t}(l_{2,t}) \cdot (m_t - u^*_t) = 0$$

That is

$$\text{(2.3)}\quad [m f'_2(l_2) - mp f'_1(l_1)] - u^* f'_2(l_2) = 0$$

Equa. (2.3) drops the subscripts for time to simplify the notations. In the first term on the left-hand side of Equa. (2.3), there are positive output in nonagriculture and negative one in agriculture, both of which are brought about by the labor migration from agricultural to nonagriculture. Thus, the first term itself denotes the net contribution of the migration of agricultural labor to aggregate output. The second term stands for a negative increment in nonagricultural as well as aggregate output caused by new unemployment. It shows that both changes in aggregate output resulting from labor migration and new unemployment respectively must offset to each other wholly if aggregate output remains constant. A trivial solution to Equa. (2.3) is $u^*_t = m_t = 0$. It does not have economic sense. We will search solutions with $u^*_t > 0$ and $m_t > 0$. Firstly, let

$$\text{(2.4)}\quad r = \frac{p f'_1(l_1)}{f'_2(l_2)}$$

be the ratio of the marginal products between the agricultural and nonagricultural sectors when the changes in employment are equal great in both sectors. According to the Inada conditions, $f'_1(l_1) > 0$, $f'_2(l_2) > 0$, there must be $r > 0$. We introduce r into Equa. (2.3) by dividing it by $f'_2(l_2)$ and obtain

$$\text{(2.5)}\quad (m - mr) - u^* = 0$$

[10] To differentiate (2.1) with respect to u^*_t and m_t will get similar results, but their economic meanings are difficult to be explained. If considering p_t, we get in Equa. (2.3) two additional terms of $(\partial p_t / \partial l_{1,t}) f_{1,t} \cdot dl_{1,t}$ and $(\partial p_t / \partial l_{2,t}) f_{1,t} \cdot dl_{2,t}$. The sum of the both terms may be very small because $\partial p_t / \partial l_{1,t} < 0$ and $\partial p_t / \partial l_{2,t} > 0$. It is not taken into account further in order to make economic meanings of Equa. (2.3) clearer. But the both terms indicate that migration has effects on overall price level because, with nonagricultural product as the invariable numeraire, changes in p in Equa. (2.1), $Y = pf_1(l_1) + f_2(l_2)$, will necessarily lead to that of Y and also of the price level, which is a topic for further researches.

Since the second term on the left-hand side of Equa. (2.5) is negative in the case of $u^*>0$, Equa. (2.5) will not hold if $r\geq 1$ because it will lead that the first term becomes negative or zero. Therefore, the first necessary condition for Equa. (2.5) is $1>r>0$, that is, $f'_2(l_2)>pf'_1(l_1)>0$. In accordance with the findings by Restuccia, Yang and Zhu (2008) that agricultural labor productivity in all countries under their review are significantly lower than nonagricultural one, the condition may be met in the empirical research.

We rewrite (2.5) to get

$$(2.6)\quad (m - u^*) - mr = 0$$

Because the second term on the left-hand side of Equa. (2.6) is obviously negative, Equa. (2.6) will not hold either if the first term becomes zero or negative with $m \leq u^*$. Hence, the second necessary condition for Equa. (2.6) is $m>u^*$ to ensure that the first term is positive. We look for the sufficient conditions for Equa. (2.6). Dividing Equa. (2.6) by m and transposing the terms to get

$$(2.7)\quad 1=\frac{u^*}{m}+r \qquad\qquad (m>0)$$

where u^*/m is ratio of new-unemployment and migration rates. Because of $u^*>0$ and $m>0$, it holds $(u^*/m)>0$. According to the definitions of u^* and m, we have

$$(2.8)\quad \frac{u^*}{m}=\frac{\Delta U/L}{M/L}=\frac{\Delta U}{M}$$

The ratio of new-unemployment and migration rates is equivalent to the ratio of new-unemployment and migration themselves. The main messages conveyed by Equa. (2.7) are that the sum of both the ratio of new-unemployment and migration rates and the ratio of marginal products between the two sectors must be unity if aggregate output remains constant in spite of the concurrence of new unemployment and intersectoral migration of labor. Equa. (2.7) is the sufficient condition for Equa. (2.3) and indicate that both new unemployment and migration of agricultural workers have the equal output effects since the effects of simultaneous changes in both variables on aggregate output exactly counteract each other. If Equa. (2.7) is not satisfied and there is

$$(2.9)\quad 1>\frac{u^*}{m}+r,$$

the output effects of labor migration will exceed those of growth in unemployment. What (2.9) expresses is that the extra product produced by the in-migrated workers in nonagricultural activity surpasses what is needed to compensate for both the reductions in agricultural production caused by these workers' out-migration and in nonagricultural production affected by new unemployment. Thus, the aggregate output must rise. A necessary condition for (2.9) being valid is $(u^*/m)<1$ when $r<1$ is already given. That means $u^*<m$ and $\Delta U<M$, that is, the size of new unemployment is smaller than that of labor migration.

In contrast to Equa. (2.9), growth in unemployment will exert larger macroeconomic effects when

$$(2.10)\quad 1<\frac{u^*}{m}+r$$

happens. The expression (2.10) implies that the negative output effect of new unemployment could not be offset by the positive effect of labor migration out of agriculture and, therefore, growth in unemployment must lead to a fall in aggregate output. Obviously, (2.10) is valid if and only if $(u^*/m)\geq 1$ or $u^*\geq m$ because of $r>0$.

The above analysis also applies to the cases of $-1<u^*<0$ and $-1<m<0$. Suppose $|\Delta U_t|<U_{t-1}$. $u^*<0$ means total amount of unemployment reduces from the previous level and $m<0$ implies the migration of labor forces from the high-productive sector to the low-productive ones. $-u^*$ will increase and $-m$ decrease aggregate output. Equa. (2.7), (2.9) and (2.10) are still able to determine which of both return migration of agricultural labor and declines in unemployment has stronger output effects because $(-u^*/-m)$ is equal to (u^*/m) in these equations. [11]

However, if u^* and m change in opposite directions, the analysis will become more complicated. Assuming $u^*<0$ and $m>0$. Both unemployment reduction as well as migration of labor to higher productive sectors will raise aggregate output at the same time and Equa. (2.3) should be rewritten correspondingly as follows:

$$(2.11)\quad [mf'_2(l_2)-mpf'_1(l_1)]+|-u^*|f'_2(l_2)=\Delta Y>0$$

Dividing it by $|-u^*|f'_2(l_2)$ to obtain

$$\frac{f'_2(l_2)-pf'_1(l_1)}{f'_2(l_2)}\,\frac{m}{|-u^*|}+1=\frac{\Delta Y}{|-u^*|\,f'_2(l_2)}=\frac{1}{s_u}\qquad (u^*\neq 0)$$

Introducing r and arranging the equation to

$$(2.12)\quad (1-r)\frac{m}{|-u^*|}=\frac{1}{s_u}-1=\frac{1-s_u}{s_u}=\frac{s_m}{s_u}$$

where s_m and s_u stand for shares of output increments, brought about respectively by m and $-u^*$, in total increment of output. It is clear if

$$(2.13)\quad (1-r)\frac{m}{|-u^*|}=1$$

we have $s_m=s_u$ and migration of agricultural labor will contribute the same to increases in aggregate output as does the reduction in unemployment. But if

$$(2.14)\quad (1-r)\frac{m}{|-u^*|}>1$$

there must exit $s_m>s_u$ and migration will have stronger output effects, Conversely, if

$$(2.15)\quad (1-r)\frac{m}{|-u^*|}<1$$

we get $s_m<s_u$, a reduction in unemployment will make more contributions to output growth than migration of agricultural labor does. Clearly, Equa. (2.15) holds as long

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[11] Introducing $-u^*$ and $-m$ into Equa. (2.3) will get $[(-m)f'_2(l_2)-(-m)pf'_1(l_1)]-(-u^*)f'_2(l_2)=0$. Replacing derivatives with r and transposing the terms will result in Equa. (2.7) with the same extensions as Equa. (2.9) and (2.10).

as $|-u^*|\geq m$ because of $1>r>0$. Equa. (2.13) to (2.15) also apply to the case of $u^*>0$ and $m<0$ where growth in unemployment on the one hand and labor migration into the lower productive agriculture on the other will reduce aggregate output simultaneously.[12] The three equations will determine which of the both factors may cause more losses in aggregate output.

Obviously, all forms of u^*/m in the above equations can be replaced with $|u^*|/|m|$, which will be very helpful in the empirical research since it is no longer needed to distinguish cases of u^* or m in different parts of their ranges of (-1, 1). Particularly for Equa. (2.10) and (2.15), it reduces the comparisons of output effects of both labor migration and changes in unemployment to that of absolute sizes of the both because the two equations are valid as soon as $|u^*|/|m|\geq 1$ or $|u^*|\geq|m|$. That means the dominance of $|u^*|$ over $|m|$ or the same absolute size of u^* and m already indicate that changes in unemployment has stronger output effects. But the relations of $|u^*|<|m|$ do not have prediction power of this kind. Let explain it with an example. Assuming r=20%, L=10 million, ΔU=0.1 million in an economy in a certain period of time, there must be M=0.125 million to keep the aggregate output unchanged under the simultaneous influences of ΔU (>0) and M (>0). Of those 0.125 million migrant labor out of agriculture, 0.1 million will compensate for newly laid-off nonagricultural workers, while the output that the residual 0.025 million migrant workers in nonagriculture produce is used to offset the decline in agricultural output the out-migration of the whole 0.125 million workers may cause. If u^* and m change in different directions and -ΔU=0.1 million, for example, there must still be M=0.125 million to ensure that contributions of both unemployment reduction and labor migration to growth in output are same great. The example makes clear that $|u^*|\geq|m|$ can predict that changes in unemployment must have stronger output effects than labor migration out of agriculture, while $|u^*|<|m|$ cannot play the corresponding role without prior knowledge on r.

3. United States

Labor migration out of agriculture and changes in unemployment appear in all economies around the world we observe in reality. Their comparative importance for short-run macroeconomic performance in a certain economy is hence an empirical question. We select two countries to investigate the question. They are the United States, the world's most developed nation, and China, a nation with the world's most labor force. This section will deal with the US in the post-war era. One reason for the period we select to study lies in that US heightened in 1947 its standard for statistics of labor forces from the age of 14 to 16. It reduced agricultural labor at nearly 5% at once in 1947, while nonagricultural labor decreased only nearly 1% through it (ERP, 2010, Table B35). We shall use the US labor statistics from 1947 to 2009. It is known that (1) agricultural labor (L_1) and its share in total amount of labor (l_1) still keep their long-run declining trends in the US after the World War II, as described in Fig. 3.1. It shows L_1 and l_1 declined from 7.9 million to 2.1 million and 13.3% to 1.4% during the post-war era of 62 years, respectively. Therefore, there was clearly net migration of

[12] It was similar to what happened in the US economy in 2008 as shown in Table 5.2.

labor out of agriculture in the post-war economic history of the US. (2) Agriculture in US as a whole remains the sector essentially composed of family farms with labor forces mainly from within the family of the farm owners or managers who have rented in farm from the owners, although there is a small fraction of farms which are very big according to land size or farm output [13]

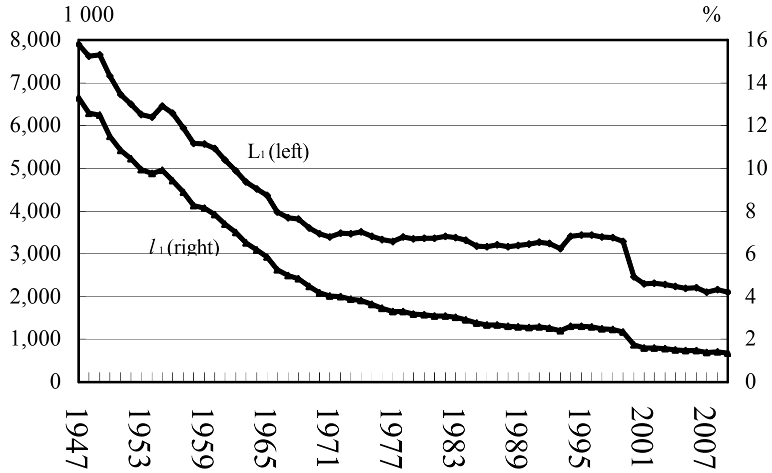


Fig. 3.1 L_1 and l_1 in US, 1947-2009

Source: ERP, 2010, Table B35.

(Suits, 1995; Allen and Lueck, 2003). (3) Marginal productivity of labor even in US agriculture, the world's most advanced one, is not high enough to support the annual labor income as high as, or similar to, that in other economic sectors. This is mainly because of the seasonality of farm work, so that hiring wage labor all the year is reasonable neither to job-searchers who look for permanent employment nor to farmers who cannot pay competitive wages for the whole calendar year (Friedmann, 1978). (4) At least until the middle of 1960s, many economists found there might still be excessive labor force in US agriculture that should be transferred into nonagricultural sectors (Johnson, 1960; Denison, 1962).

We can compute M, m and u^* by the means of equations (1.3), (1.4) and (1.6), respectively. In order to simplify our computations, however, we, following Hu (2009), use the identity

(3.1) $m_t = (l_{1,t-1} - l_{1,t}) = -(l_{1,t} - l_{1,t-1}) = -\Delta l_1$

and the equation

(3.2) $M_t = m_t L_t$

[13] According to Suits (1995) based on US Department of Agriculture (1992), there were 2.1 million farms and 2.9 million farm employment in the United States in 1990. The average acreage per farm amounted to 461. Although only about 5% of all farms contained 1 000 or more acres each, they used more than 40% of all farm acreage. And only 2% of all farms were incorporated, but they owned 12% of all land in farms and marketed 22% of the total value of all farm crops (Suits, 1995: 5-6). The similar structure is found in Europe as well. Hill (1993) finds from agricultural statistics of the European Union that farms in which more than half labor was done by non-family members amounted to only less than 7% of all farms in 1989. Alone in UK and Spain, such farms reached more than 15%.

to compute both m and M for the United States from 1948 to 2009. US' u^* and m are depicted in Fig. 3.2 where there were 58 of total 62 years with $m>0$ and only 4 years witnessed $m<0$ with very small size, which highlights again the fact of net outmigration of agricultural labor in the recent economic history of the US. However, m does not seem to compete with u^* quantitatively. As illustrated in Figure 3.2, fluctuations of u^* are clearly stronger and more frequent than m. In particular, the amplitude of fluctuations in u^* is much wider than that of m, since u^*, with its maximum of 3.5% during the period under the review, frequently exceeds the benchmark of 1% in the both directions. But m does not reach it at all in the whole period. The interval of fluctuations in u^* is (-2.0%, 3.5%) and the difference between its largest and smallest values amounts to 5.5 percentage points, while the corresponding quantities for m reach only (-0.2%, 1.0%) and 1.2 percentage points, respectively, far below that of u^*. Furthermore, there are 47 years when there is $|u^*|>|m|$, amounting to 76% of total years concerned, and the mean of $|u^*|/|m|$ is 4.41, meaning that the size of changes in unemployment may be more than four times larger than that of migration of labor out of agriculture in an average year during the post-war era. We transfer the data on $|u^*|/|m|$ into natural logarithms for the T-test with the requirement of normal distribution. The results of the T-tests lead to accept the hypothesis of $|u^*|/|m|>1$ with the T-statistic being 5.842242. Since u^* and m are the representations of $\Delta U/L$ and M/L, respectively, $|u^*|>|m|$ implies $|\Delta U|>|M|$, that is, the absolute size of changes in unemployment, no matter they are positive or negative, probably are much bigger than that of labor migration in US in most of years under the review. That means changes in unemployment should have stronger effects on aggregate output in US from 1948 to 2009 than migration of agricultural labor did.

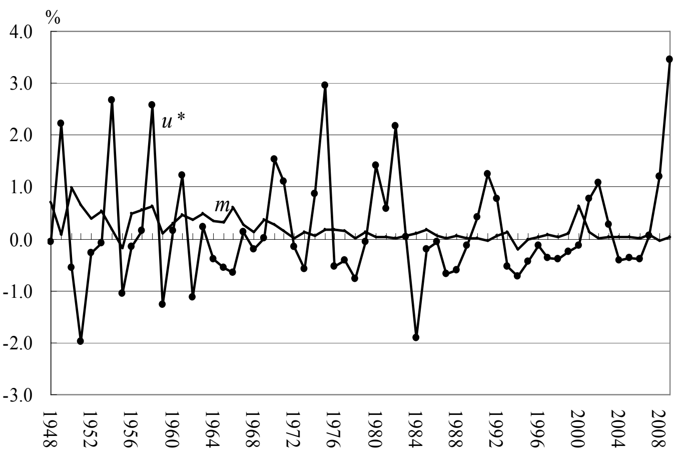


Fig. 3.2 u^* and m in US, 1948-2009

Source: As of Fig. 3.1.

We further compare the graphs on $|u^*|/|m|$ and u/l_1 in Figure 3.3. In order to depict small values of both the data series more clearly, the logarithmic scale is utilized in Fig. 3.3. It shows that the relations of $|u^*|/|m|$ could be divided clearly in two phases. The first phase lasts from 1948 to 1969 when $u<l_1$ or $U<L_1$ and the second one from 1970 to 2009 when $u>l_1$ (or $U>L_1$). We do the descriptive statistics and the T-test for the two phases separately and collect the results with that for the whole post-war era in Table 3.1. It is shown that $|u^*|<|m|$ happened in 15 years during the whole period, of which two third of them, that is, 10 years, were in the first phase of total 22 years, while only 5 years occurred in the second phase of 40 years. The frequency of occurrence of $|u^*|<|m|$ in the first phase exceeds that of the second phase nearly 4 times. That means almost an half of the years in the first phase experienced $|u^*|<|m|$. But only nearly one tenth of the years in the second phase were the cases. The T-tests even does not accept the hypothesis of $|u^*|>|m|$ for the first phase, while accepting it for the whole period and particularly for the second phase. It implies that one cannot assert surely that the absolute sizes of changes in unemployment be larger than that of migration of agricultural labor, and cannot either say which of both was more important for output growth and fluctuations in US even in more than 20 years after the WW II without the knowledge on concrete values of r. It also implies that the relation between total unemployment and agricultural labor may be of some relevance for the predictions of the range of quantitative relations between unemployment changes and migration of agricultural labor.

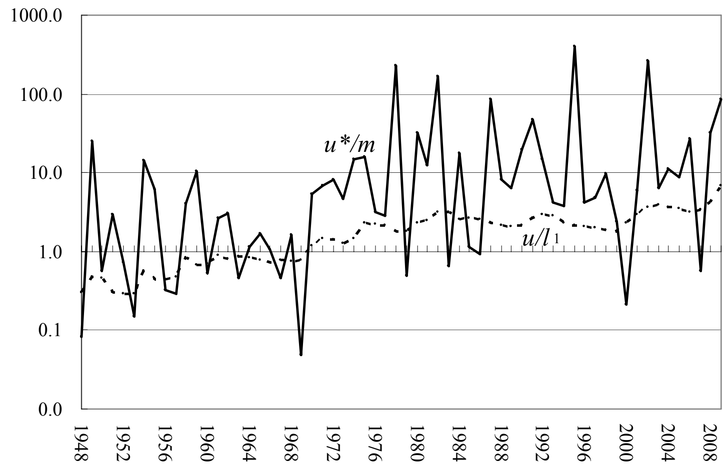


Fig. 3.3 $|u^*|/|m|$ and u/l_1 in US, 1948-2009

Source: As of Fig. 3.1, logarithmic scale of the vertical axis.

Table 3.1 Frequency of Occurrence of $|u^*|<|m|$ in US, 1948-2009

Period	1948-2007	1948-1969	1970-2009
	Whole period	First phase	Second phase
		$u<l_1$	$u>l_1$
Total years	62	22	40
Years of $|u^*|<|m|$	15	10	5
Frequency of the year with $|u^*|<|m|$, (%)	24.2	45.5	12.5
Means of $|u^*|/|m|$	4.41	1.15	9.23
T statistic	5.9422	0.3957	8.0808
Hypothesis of $|u^*|>|m|$	accepted	not accepted	accepted
Confident interval of $|u^*|/|m|$	(2.90, 6.68)	(0.63, 2.09)	(5.81, 14.68)

Source: As of Figure 3.1. α=0.05 for the T-tests.

4 China

4.1 Values of $\frac{u^*}{m}$

Turning now to values of $u^*/m + r$ in China, we note that, different from in the United States, the value of $|u^*|/|m|$ or r alone does not seem to be able to determine the comparative macroeconomic importance of unemployment changes or migration of agricultural labor in China. We shall discuss $|u^*|/|m|$ first. China has published its official unemployment statistics only from 1978, that is, the initial year of its on-going economic reforms,[14] while there are not any estimates found in the literature on China's unemployment in the earlier years up to 1977. Moreover, the Chinese labor

[14] China's unemployment statistics encompass only unemployed persons in urban areas who are assigned urban residence status. Assignment of this prestige status in China depends mainly on the status of parents or earlier ancestors. The status was assigned in the first years after the communists came to power in 1949 and established the status system, known as the Hukou system in the Western literature. Even a farmer who has worked and lived in urban areas for more than 10 years cannot change his status to that of urban resident and must remain a farmer. Therefore he does not qualify to register as unemployed if he lost his job, e.g., due to effects of a macroeconomic recession on the factory where he has been working in for many years. In recent years, this rigid and apartheid-like system has become looser to some extent in different regions, but remains essentially in place for the China as a whole. This particular institutional arrangement should be kept in mind when dealing with China's economic statistics, especially on labor and unemployment. Naughton (2007: 113) names this Hukou system "two different form of *citizenship*: one rural and one urban" (italic in original). See also Fan (2008).

statistics collects only urban unemployed persons who have registered, which corresponds more to the conception of nonagricultural unemployment used in the second section of the present paper. Rural labor forces in China were assigned a plot of land for cultivation. Hence, they are not qualified to be registered as unemployed if they lost their rural nonfarm jobs or urban jobs after they had gone there and got employed. Making use of those unemployment statistics, we produce data series of ΔU, *u* and *u** for China from 1979 to 2008. At the same time, we compute China's *m* and M for the same period of time by means of Equa. (3.1) and (3.2). The data on China's agricultural labor force, L_1, and its share in total labor, l_1, are depicted in Fig. 4.1 where L_1 increases first from 283 million in 1978 to 391 million in 1991 and then decreases to 307 million in 2008. It may be alleged that China has come into the phase of the absolute decline in agricultural labor force since the beginning of 1990s. In contrast, China's l_1 always shows the robust declining trend during the whole period of 31 years. More significant is that l_1 declined very quickly during the period: from 70% in 1978 to 39% in 2008, a percentage point each year on the average. If we imagine that a country's l_1 were 80% before the era of modern economic growth and 10% when it accomplishes the mission of transferring most of agricultural labor force into nonagricultural activity, it would take 70 years to reach this target if l_1 declines a percentage point a year. But in the world economic history of last 300 years, no major countries reached the speed. All developed countries nowadays took much more than 100 years to complete this process. China itself began the modern economic growth at least in 1870s and staggered along until the end of 1970s when its l_1 still remained around 70%. Therefore, the speed of the decline in l_1 in China during last 31 years must be a very striking event in the economic development for China as well for the whole world.

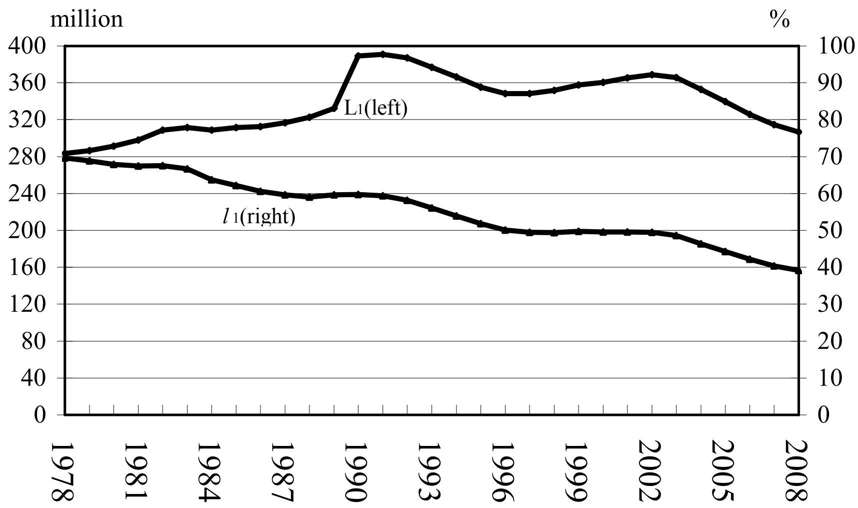


Fig. 4.1 L_1 and l_1 in China, 1978-2008

Source: NBSC, 2010, Table 1-4.

We illustrate China's U, ΔU and M in Fig. 4.2. The first look at it already hints that the size of labor migration out of agriculture may surpass that of changes in unemployment or even total unemployment itself to an essential extent in China from 1979 to 2008. Annual migration in China often exceeded the mark of 10 million, while China's total unemployment reached this mark in no years during the same period, although it tended higher in an almost continuous mode. The annual growth in unemployment, ΔU, even did not reach 1 million in almost all years under the review. The amplitude of fluctuations in M is clearly much wider than U or ΔU in Fig. 4.2. The same relations stand for between *u* or *u** and *m* displayed in Fig. 1.1 and 1.2 above since *u*, *u** and *m* are only the expressions of U, ΔU and M with reference to total labor, L. On the other hand, it should be emphasized that l_1 has been much larger than *u* in China during the period of its economic reforms, and will remain so in decades to come, too.

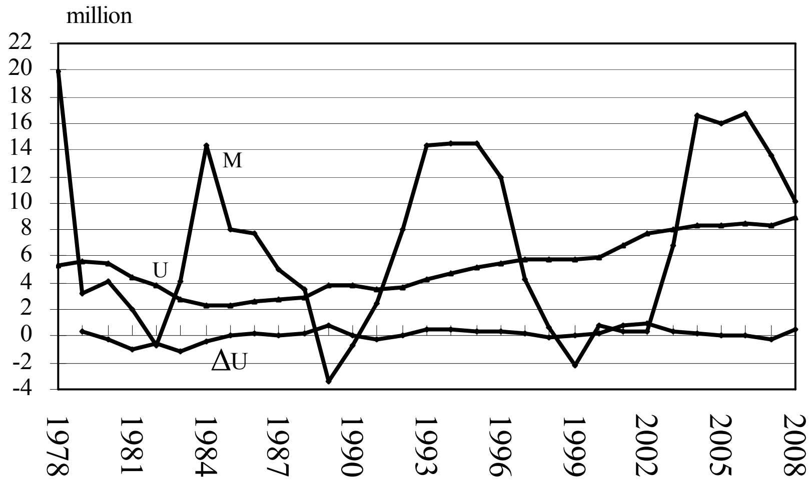
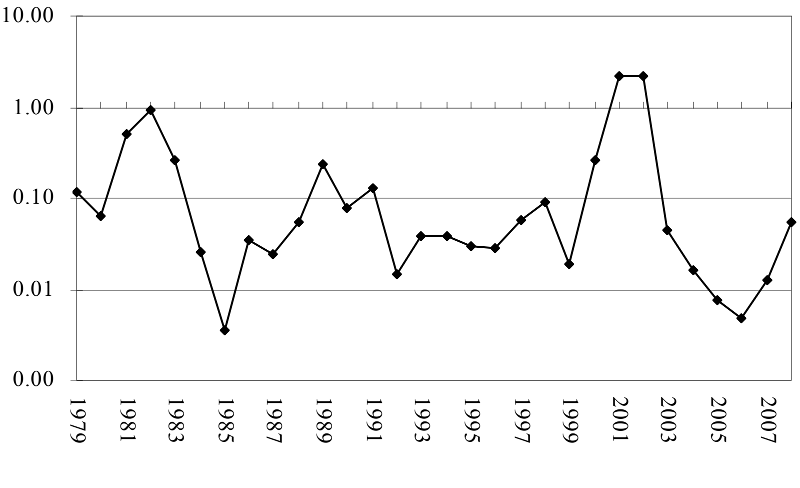


Fig. 4.2 U, ΔU and M in China, 1979-2008

Source: As of Fig. 4.1.

The graph of the ratio of $|u^*|/|m|$ in Fig. 4.3 shows that of the total 30 years under review there were only two years with $|u^*|>|m|$, while all other 28 years witnessed $|u^*|<|m|$, and the scale of dominance of *m* over *u** is essentially much larger than that of *u** over *m*. A T-test with logarithmic values of $|u^*|/|m|$ accepts the hypothesis of $|u^*|>|m|$ in China for the whole period of the 30 years.[15]



[15] The T-statistic is -9.512482 with α=0.05.

Fig. 4.3 $|u^*|/|m|$ in China, 1979-2008

Source: As of Fig. 4.1. Logarithmic scale of the vertical axis.

However, the knowledge of $|u^*|<|m|$ alone is not enough to determine the comparative output effects between u^* and m, as proved above. For the combined comparisons with another factor, r, we have to find concrete values of $|u^*|/|m|$ in the range of $0< |u^*|/|m| <1$. Let α be the level of confidence and assign α=0.05, our T-test results in a confident interval for the mean of the data series on $|u^*|/|m|$ as (3.7%, 10%). It implies the true mean of $|u^*|/|m|$ may be very probable to lie between 0.037 and 0.100. In order to reinforce the robustness of our possible conclusions, we take the maximal value from the interval, that is, $|u^*|/|m| =10\%$, for our references later.

4.2 Value of r

Since $|u^*|/|m|=0.10<1$, the value of $|u^*|/|m|$ is unable to determine comparative importance between unemployment changes and migration of agricultural labor in China. We have to investigate the other factor, r, ratio between marginal products of agricultural and nonagricultural labors. Our strategy to investigate r in this subsection consists of two steps. Firstly, we will show there exist certain relations between marginal and average products of labor in a sector and the ratio between two sectors' marginal products should not be greater than that between their average products. Secondly, we shall check average products of labor in the two sectors in China and compare its ratio, based on which we may find a probable range of values of r. To simplify the notions, we let MP and AP represent marginal and average product, respectively, and $s=\frac{AP_1}{AP_2}$ stand for ratio of average product of agricultural labor to that of nonagricultural one, $s>0$ because of $AP_1>0$, $AP_2>0$ according to Inada conditions. The relation between r and s can be set up as follows [16]

$$\text{(4.1)} \quad \frac{r}{s}=\frac{\beta_1}{\beta_2}$$

where β stands for rate of marginal and average products within a same sector, β=MP/AP, $\beta>0$ because MP >0, AP>0. It is easy to get from Equa. (4.1) that

$$\text{(4.2)} \quad r>s \text{ if and only if } \beta_1>\beta_2$$

Equa. (4.2) shows that the rate of marginal product of agriculture to that of nonagriculture will be greater than that of their average products only when the rate between marginal and average products in agriculture is greater than that in

[16] It can be proved as $r=\frac{MP_1}{MP_2}=\frac{\frac{MP_1 AP_1}{AP_1}}{\frac{MP_2 AP_2}{AP_2}}=\frac{\frac{MP_1}{AP_1}}{\frac{MP_2}{AP_2}}\frac{AP_1}{AP_2}=\frac{\beta_1}{\beta_2}s$. Rearranging it will obtain Equa. (4.1)

nonagriculture. But the case of $\beta_1 > \beta_2$ may not be probable to happen. For a production function as f_1 and f_2 in Equa. (2.1) satisfying the Inada conditions and with constant capital input, it can be proved that:

$$(4.3) \quad \frac{d\beta}{dL} < 0$$

The proof is in Appendix of this paper. Equa. (4.3) shows that changes in β and L may go in opposite directions. It implies that the more labor is employed in a sector with constant capital input, the smaller the sector's β will be (Hu, 2008). Equa. (4.3) can be transformed into a form with the explicit introduction of capital, K, as follows

$$(4.4) \quad \frac{d\beta}{d\frac{K}{L}} = \frac{d\beta}{dk} > 0 \qquad \text{(K is constant)}$$

where k denotes the well-known capital-labor ratio, $k>0$ since K>0, L>0. While Equa. (4.4) maintains the original negative relations between β and L, it further tells that β will still go greater when variable labor to constant capital becomes smaller. In other words, the greater capital a labor force is equipped with in a sector, the greater the sector's β will be. For an economy with two sectors, we have

$$(4.5) \quad \beta_1 > \beta > \beta_2, \text{ if } k_1 > k > k_2$$

It means a sector with higher capital-labor ratio relative to that of the other sector will have higher β than the other sector does. Combining Equa. (4.2) and (4.5) to get

$$(4.6) \quad r > s \text{ if and only if } k_1 > k_2$$

In Lewis' economy with exact two sectors of agriculture and nonagriculture (Lewis, 1954), for example, there are too many labor forces compared to capital available in agriculture, which results in such a low marginal product of labor that approaches to zero or even becomes negative, while the average product is still positive and high enough to ensure the subsistence for the population. Therefore, β_1 must be very small, approaching to zero or negative in the Lewis' agriculture. At the same time, labor is equipped with much capital enough to produce profits in Lewis's capitalist nonagricultural sector, in which marginal product of labor is equal to the level of wage which is not only positive, but also at least as high as the subsistence level in Lewis's agriculture. Obviously, there must be $k_1<k_2$ and hence $\beta_1<\beta_2$ in Lewis's economy, which results in $r<s$ there. Although there are not statistics or estimates on capital per labor force in China's agriculture and nonagriculture and the Chinese economy may go beyond the Lewis's subsistence level nowadays, there is still too much labor in the Chinese agriculture which should be transferred into nonagricultural activity in the future decades. And the capital per worker in China's agriculture should be distinctly less than that in its nonagriculture. There is almost unimaginable to allege $k_1>k_2$ for the Chinese economy during the period from 1978 to 2008. The case of $k_1<k_2$, as in Lewis' economy, should be more plausible for China even today and we assume, therefore, that $\beta_1 \leq \beta_2$ and then $r \leq s$ for the Chinese economy in the period under review. [17]

[17] A descriptive statistical research by Li, Liu and Wang (2009) shows that more developed provinces in China had higher β than less developed ones did. That is, the provinces with lower l_1 are more possible to have higher β, while provinces with higher l_1 have lower β in general. It

Now we are make the second step to check China's s quantitatively. In China's statistics, the Chinese economy is divided into three sectors of the primary, secondary and tertiary one, of which the primary one contains only agriculture without the subsector of mining which is categorized under the secondary sector in China. We combine the secondary and tertiary sectors for nonagriculture and compute the sectoral average product of labor with the Gross Domestic Product (GDP) divided by labor employed in the sector, that is, $AP_i = \frac{GDP_i}{L_i}$, i=1, 2. The data on sectoral GDP and employment in China from 1978 to 2008 are used to compute the sectoral AP. In order to avoid possible distortions resulted from the price developments, we deflate the GDP date with the constant price of the year of 2005 which can be worked out from China's statistics available. The results of computations of AP_1, AP_2 and their ratio, s, are shown in Figure 4.4. It reveals that AP_1 and AP_2 rose quickly and almost continuously since 1978 and AP_1 grew almost 4 times and AP_2 6 times. As a result of these unequal growths, s experienced continual changes or fluctuations on the one hand and a clearly decreasing trend on the other. For the whole period, both of the mean and median of s are around 0.24 and its standard deviation amounts to 0.03. It implies the value of 0.24 may be a good representative of the true mean of s. In fact, this value seems to be in line with Maddison's findings (1970). He compares average productivity of labor in agriculture and nonagriculture in two years of 1950 and 1965 for 22 countries, all of which were less developed at that time, and finds the ratios of the productivity between the two sectors be around 0.2 for the most countries in each of the two years, although productivity in each of the both sectors rose for the most countries from 1950 to 1965. Restuccia, Yang and Zhu (2008) also find $s<0.2$ in almost all developing countries in 1985. Our T-tests with $\alpha=0.05$ for the data on s from 1979 to 2008 show that the confident interval for the mean of s should be (0.219, 0.251). For robustness of the results we are searching for, we take $s=0.25$ for further studies.[18] $s=0.25$ implies that, when still remaining in term of average product and highlighting with an example, out of 4 million farmers who have transferred into nonagricultural activity in a certain year, merely 1 million are needed to produce nonagricultural output for the compensation of the loss in agricultural production made by out-migration of these 4 million farmers. Labor migration out of agriculture should be more important for aggregate output than changes in unemployment if there would be less than 3 million new unemployment occurring in that year. What happened in China from 1979 to 2008 was even far more over this example: The

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probably implies that the case of $\beta_1>\beta_2$ could not be somewhat possible for the Chinese provinces. In contrast, $\beta_1 \leq \beta_2$ and thus $r \leq s$ may be much more plausible.

[18] Regarding empirical studies, there are few researches on China's sectoral MP in the literature. Chow (1993) estimates values of MP in different sectors in China in 1978. His results are RMB Yuan 63 for agriculture, Yuan 1027 for manufacturing, Yuan 452 for construction, Yuan 739 for transportation and Yuan 1809 for trade. The estimations by Wang (1997) on the ratio of MPs between China's nonfarm and farm sectors are 2.55 for the year of 1980, 2.29 for 1988 and 3.68 for 1992. Yang and Zhou (1999) divide the Chinese economy into three sectors of agriculture, rural and state-owned industries. They find that MP is among Yuan 450 to 600 in Chinese agriculture from 1987 to 1992, among Yuan 600 to 900 in the rural industries from 1987 to 1991 and Yuan 9300 in 1992, and among Yuan 7700 to 9300 in the state-owned industries from 1987 to 1992. Comparing with $s=0.25$, most of these findings support $r \leq s$, while some support $r>s$. The biggest value of r from these findings is $r = 1/2.29 = 0.44 > 0.25$, which is found by Wang (1997) only for the year of 1988. Nevertheless, all these estimations are very rudimentary and could not be taken seriously.

relative quantity of labor migrated out of agriculture to changes in unemployment exceeded several times the proportion of 4:3 of this example.

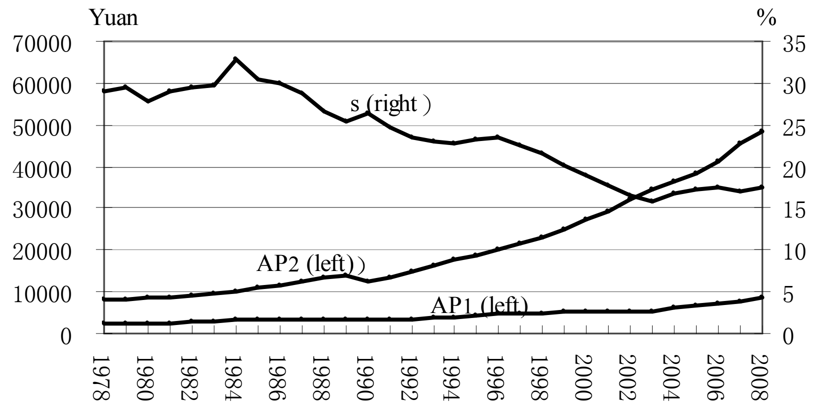

Figure 4.4 Average product of labor in China, 1978-2008

Sources: NBSC, 2009, Table 2.3, 2.5 and 4.3.

Note: Sectoral GDPs are of price of the year 2005.

Making a summary of the results about $|u^*|/|m|$ and r we got above. Since $|u^*|/|m|$ was estimated as 0.10 and r as 0.25, we have for the Chinese economy in the period from 1979 to 2008 that

(4.7) $|u^*|/|m| + r = 0.10 + 0.25 = 0.35<1$

When the means of $|u^*|/|m|$ and r are taken into account, then $|u^*|/|m|=0.25$, $r=0.24$, we will get

(4.8) $|u^*|/|m| + r = 0.25 + 0.24 = 0.49<1$

It can be concluded from (4.7) and (4.8) that the Chinese economy in the last 30 years may satisfy the conditions of Equa. (2.9) and (2.14) and its labor migration out of agriculture should have larger output effects than changes in unemployment could do. [19] Therefore, it is necessary for understanding the Chinese and some other similar developing economies to study immediate relations between intersectoral migrations of agriculture labor force on the one hand and growth and fluctuations of aggregate output on the other, which demands, however, to leave Todaro and to set up another framework for short-run macroeconomics for these economies.

[19] Zhang (2010) made an econometrical study of many factors including unemployment which may have influences on the growth rate of GDP in China from 1979 to 2008. He found that only two from them, investment rate and migration rate, are significant.

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Appendix: Proof of Equation (4.3)

Assuming a production function $f(x, y)$ where x (≥ 0) stands for labor and y (>0) for capital. Supposing y is constant and can be dropped from $f(x, y)$. $f(x)$ is continuous and differentiable at least two times and satisfies the Inada conditions, particularly following ones

$$\text{(A1)}\quad f(0)=0,\ f'(x)>0,\ f''(x)<0,\ \frac{f(x)}{x}>0,\ [\frac{f(x)}{x}]'<0$$

Let $AP(x)$ and $MP(x)$ be average and marginal product of labor, respectively. $\beta(x)$ is defined as

$$\text{(A2)}\quad \beta(x)=\frac{MP(x)}{AP(x)}$$

In fact, $\beta(x)$ is the elasticity of output with respect to labor regarding $f(x)$. Note

$$\text{(A3)}\quad MP(x)=f'(x)>0$$

$$\text{(A4)}\quad MP'(x)=f''(x)<0$$

$$\text{(A5)}\quad AP(x)=\frac{f(x)}{x}>0$$

$$\text{(A6)}\quad AP'(x)=[\frac{f(x)}{x}]'=\frac{f(x)}{x^2}[(\beta(x)-1]<0$$

therefore

$$\text{(A7)}\quad \beta(x)<1$$

$$\text{(A8)}\quad MP(x)<AP(x)$$

Differentiate (A2) with respect to x to get

$$\text{(A9)}\quad \beta'(x)=\frac{1}{[AP(x)]^2}[MP'(x)AP(x)-MP(x)AP'(x)]$$

We observe (A9) in three cases as follows:

(I) $MP'(x)<AP'(x)$

In this case we have

$$\begin{aligned} \beta'(x) &= \frac{1}{AP^2}[MP'(x)AP(x)-MP(x)AP'(x)] \\ \text{(A10)}\qquad &< \frac{1}{AP^2}[AP'(x)AP(x)-MP(x)AP'(x)] \\ &= \frac{1}{AP^2}AP'(x)[AP(x)-MP(x)]<0 \end{aligned}$$

based on (A6) and (A8).

(II) $MP'(x)=AP'(x)$

Both (A8) and $MP'(x) = AP'(x)$ together determine that $MP(x)$ and $AP(x)$ are not identical, but parallel curves in a coordinate plane, that means

(A11) $AP(x) - MP(x) = \mathrm{C}$ (C is a constant, C>0)

Introducing (A11) into (A2) to get

(A12) $\beta(x) = \dfrac{AP(x) - C}{AP(x)} = 1 - \dfrac{C}{AP(x)}$

We differentiate (A12) with respect to x and obtain

(A13) $\beta'(x) = \dfrac{\mathrm{C}}{AP^2} AP'(x) < 0$

based on (A6).

(III) $MP'(x) > AP'(x)$

Assume $MP(x) < AP(x)$ and $MP'(x) > AP'(x)$ at the same time, that is

(A14) $MP(x) - AP(x) < 0$

(A15) $MP'(x) - AP'(x) = [MP(x) - AP(x)]' > 0$

hold at the same time. Let

(A16) $h(x) = MP(x) - AP(x)$

According to l'Hôpital's rule, $h(0) = 0$. It is known that $h'(x) > 0$ from (A15), that is, $h(x)$ increases monotonously. Hence we have

(A17) $h(x) = MP(x) - AP(x) > 0$

But (A17) is inconsistent with (A14). Hence (A14) and (A15) can not hold at the same time and the case (III) must be excluded.

Summarizing the analysis above, we get

(A18) $\beta'(x) < 0$.

(A18) is also the Equation (4.3) in the texts.

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