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Chinese Rural to Urban Migration:
The Role of Non-Pecuniary Benefits in Migration Decisions

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ABSTRACT

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by

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Since the 1978 opening of the Chinese economy, increased rural to urban migration has both fueled economic growth and strained existing urban infrastructure. Although the Chinese government has attempted to slow this migration (through restrictive household registration programs,) it has continued on a massive scale. Many traditional models of migration in developing countries predict wage equalization and zero net migration at equilibrium, but there are no indicators that either of these outcomes will be observed in China. This paper considers the role of non-pecuniary benefits in migration decisions in China, identifies migration-inducing policies and suggests potential remedies. A set theoretic model of the decision-making process is approximated using a time series regression to analyze the migration decision process, comparing non-pecuniary wages in provinces over the five-year period from 2002 to 2006 to predict migration. The conclusions from this model are then compared with the findings of a Markov chain analysis of current Chinese employment trends.

I. INTRODUCTION AND HISTORY:

Since the 1978 opening of the Chinese economy, increased rural to urban migration has both fueled economic growth and strained existing urban infrastructure. Chinese collectivization under Mao Zedong and the Chinese Communist Party (CCP) generated a unique foundation of the Chinese labor market and a distinctive set of concerns for Chinese labor and population as a result of China's unprecedented growth. The current influx of migrants to urban areas can be seen as an outgrowth of this unique foundation, while creating an even more unique set of requirements on potential courses of action for addressing the problem.

China's transition to Socialism under Mao Zedong and the CCP was built on a tenant of government central planning, with an early objective of establishing a modern industrial sector.[1] The CCP closely modeled the Soviet system in its industrial development, especially at the beginning in 1953, with a narrow focus on heavy industry.[2] The reforms benefitted from knowledge generated by the Soviet experience and were implemented gradually with private enterprises slowly being taken over by the state.[3] Agricultural collectivization was also modeled after the Soviet plan, but the deviations were much more pronounced in these reforms, mainly that the CCP chose to implement piecewise centralization of agriculture culminating in the collective farming system.[4] The Chinese Communist system had successes and failures in the years that followed, but overall the Communist agricultural system was not as productive as

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[1] Michael G. Kort, China Under Communism (Brookfield: The Millbrook Press, 1994) 77.
[2] Kort 78.
[3] Fredrick C. Teiwes, "The Establishment and Consolidation of the New Regime, 1949-1957," The Politics of China 1949-1989, ed. Roderick MacFarquhar (Cambridge: Cambridge University Press, 1993) 41.
[4] Teiwes 59.

China's immense population necessitated, resulting in widespread inefficiencies and the largest recorded famine in history (30 million deaths).[5]

During Deng Xiaoping's famous "opening-up" reforms, starting in 1978, most of the collective structure was dismantled. Specifically, the government tried to back out of enterprises,[6] but whether this process was ever fully completed is not totally clear, as special government committees continue to regulate many of the most critical and productive industries in China.[7] Rural reform, which occurred in two stages, was also a significant part of the Deng reforms. The first stage was not quite privatization, but adjustment to the existing system.[8] Initially, agricultural reforms were implemented with the goal to "reform producer incentives"[9] alleviating issues of worker motivation created by collectivization and increasing productivity. As Justin Yifu Lin describes in his "Collectivization and China's Agricultural Crisis in 1959-1962," forced collectivization creates serious incentive distortions for work productivity. Remuneration systems based on need, and not performance, such as those in Communist China, create a classic prisoners dilemma. The added constraint of a non-voluntary one-time game (a situation created by the imposition of forced collectivization) increases the incentive for underperformance by removing the opportunity for the other player(s) to opt out after they conclude that they would gain a greater payoff by not playing the game at all.[10] This perverse system of agricultural organization would severely stunt agricultural production

[5] R. Keith Schoppa, Revolution and Its Past, 2nd Edition (Upper Saddle River: Prentice, 2005).
[6] Xiaobo Hu, ""The State, Enterprises, and Society in Post-Deng China: Impact of the New Round of SOE Reform," Asian Survey 40.4 (2000).
[7] Hu 642.
[8] Kathleen Hartford, "No Way Out?," The Reform Decade in China, ed. Marta Dassu and Tony Saich (London: Kegan Paul International, 1992) 85.
[9] Hartford 85.
[10] Justin Yifu Lin, "Collectivization and China's Agricultural Crisis in 1959-1961," The Journal of Policial Economy 98.6 (1990): 1241.

and development. The effects of inhibited agricultural development are still observed in China's relatively low labor productivity in agriculture (which will be discussed in greater detail later in the paper). The second part of the reforms was centered on decreasing the dominance of agriculture in rural areas through the sponsorship of "specialized households" and township and village enterprises (TVEs).[11] These reforms succeeded in lowering the percent of rural dwellers employed in agriculture from ninety percent to only eighty percent,[12] but this percentage is still relatively high, particularly in comparison with China's development goals.

During the creation and tear-down of the communist system in China, economic and social disparity between rural and urban areas was amplified. The roots of this divide can be traced to the early "globalization" of colonialism and the influence of Western forces.[13] Under the Canton System and in the wake of the Opium War, Western traders helped usher in an early heyday of capitalism and prosperity in the coastal cities, while other parts of the country did not have the benefits of this interaction. The institutionalization of the Chinese household registration system, called hukou, tied Chinese citizens to either rural or urban areas during the Great Leap Forward, exaggerating this disparity.[14] Once the hukou system was relaxed later, the disparity between employment in urban and rural areas encouraged rural to urban migration. However, the urban economy could not accommodate the excess labor, creating both a formal and informal economy. Such a dual economy is characterized by a multi-sector

[11] Hartford 92.
[12] Hartford 94.
[13] Timothy Cheek, Living with Reform: China since 1989 (London: Zed Books Ltd, 2006) 78.
[14] Cheek 78.

urban economy and a bifurcated social order with a high degree of wage and quality of life disparity.[15]

China's dual economy has been further aggravated by the Chinese government's export-oriented economic focus. Keeping the Chinese official currency, the Renminbi, artificially low, compared to other internationally important currencies, has given support to the Chinese manufacturing industry. Supporting the already advanced Chinese manufacturing sector by introducing international trade under artificially ideal conditions inflated urban wages. Introducing international trade into a market with labor distortions across sectors can prevent the wage equilibrium suggested by Harris and Todaro's seminal paper on migration and wage disparity in less developed countries "Migration, Unemployment and Development: A Two Sector Analysis."[16]

Rural and urban labor disparity was further amplified by continued labor market intervention by the Chinese government. This intervention is manifested mostly in two ways: government influence in business and government restrictions on population. Continued involvement in the operation of Chinese businesses is a study in official government ideology in comparison to government's actual policies.[17] Citing the government's plans to create separation of state and its continued control of state-operated enterprises (SOEs), Xiaobo Hu explains in his paper "The State, Enterprises and Society in Post-Deng China: Impact of the New Round of SOE Reforms" that the

[15] Tiejun Cheng and Mark Selden, ""The Origins and Social Consequences of China's Hukou System"," The China Quarterly 139 (1994): 644.
[16] Bharati Basu, "Rural-urban migration, urban unemployment, and the structural transformation of a dual economy," Journal of International Trade and Economic Development 9.2 (2000): 145.
[17] Hu 642

Chinese government feels that large and even medium size SOE's are critical to remain in government control, although 41.5% of SOE's were "in the red" as of 1998.[18]

Government control of population in China has taken many forms since the 1978 reforms including the "one child policy," household registration systems, and a variety of social programs. The primary method by which the Chinese government has attempted to control migration into urban areas is through the hukou system, a household registration system by which residents are officially classified as either urban or rural residents and either agricultural or non-agricultural workers, which was started under Mao Zedong's Great Leap Forward.[19] While the hukou system has become less stringent in recent years, it is still a factor affecting migration decisions. The hukou system restricts access to many public goods, including healthcare, affordable housing and unemployment benefits, in urban areas to only those with official urban permits. An article recently published in *China Daily* profiles the plight of a "rural" family that has lived in Beijing for ten years, but still struggles as social outsiders. The family has been faced with housing and healthcare problems due to their rural hukous, and worry for the future of a young daughter.[20] Because Chinese media are often biased, journalism that focuses on the misfortune of Chinese citizens is rather uncommon and may be a signal of the severity of the problem.

Another urban labor issue created by the dismantling of the Communist system in China is the existence of a group of citizens known as xiagang, workers laid-off from SOEs, most of whom are unskilled, older, and unemployed for long periods, draining resources in China. These workers are unqualified for many of the new jobs being created

[18] Hu 644-645.
[19] Cheek 78.
[20] Jiaojiao Rong, "Hukou an obstacle to market economy"

by Chinese growth, and government-sponsored retraining programs do not provide adequate training. Because they are undereducated for participation in the modern Chinese economy, many xiagang rely on government resources via the Chinese welfare system. These lay-offs have caused a certain amount of instability "manifested in demonstrations, strikes, and petitioning," which should be a critical concern of the Chinese government.[21]

One of the greatest dangers of a dual economy and the severity of Chinese inequality is that they contribute to social unrest. Because China's reforms were completely economic in nature and not also political (in contrast to the USSR), the tenants of Communism still define the expectations of the population. When Chinese citizens, both rural and urban, do not receive the benefits they expect from the government, tension and anti-government sentiment can cause serious economic and political instability, inhibiting China's continued growth. It is critical that the Chinese government addresses issues of inequality and urban poor in order to maintain a society that is suited for continued economic growth. Factors contributing to this destabilizing migration are considered in the model in the following section.

[21] Hong Yung Lee, "Xiagang, the Chinese Style of Laying Off Workers," Asian Survey 40.6 (2000): 919.

II. MIGRATION MODEL:

A migration model based on the classic Harris and Todaro Model is used to analyze the impetus for migration in China. Its setting is in line with their model's backdrop: a less developed country with urban and rural sectors for labor, specializing in manufacturing and agriculture, respectively. Harris and Todaro developed a set of equations for analyzing migration decisions as follows:

$$E(w_U) = P_F w_F + P_I w_I$$
$$P_F + P_I = 1$$

$E(w_U)$= expected urban wage
w_F = wage in formal sector
P_F = probability of obtaining work in the formal sector
w_I = wage in informal sector
P_I = probability of obtaining work in the informal sector[22]

A base assumption of the model is in the rationality of the potential migratory population, and given this assumption the model suggests "that rural-urban migration will continue so long as the expected urban real income at the margin exceeds real agricultural product."[23] The real agricultural product is determined by the output in the agricultural sector, but the urban manufacturing wage is a set minimum wage. The expected urban wage is then the probability that a migrant finds employment in the urban area times the urban minimum wage. (In China, a migrant's estimate of his or her likelihood of finding a job is usually determined by experiences of other family or community members.) For simplicity, Harris and Todaro assumed a random job selection process and a constant urban wage (equal to the government-mandated minimum). China's urban centers face a variety of wage-inflating influences such as international pressures and overseas corporate policies,

[22] John R. Harris and Michael P. Todaro, "Migration, Unemployment and Development: A Two-Sector Analysis," The American Economic Review 60.1 (1970): 127
[23] Harris and Todaro 127.

guaranteeing that urban wages remain above marginal productivity, as suggested by Harris and Todaro, thereby inducing surplus labor supply from migration.

Harris and Todaro suggest that an informal sector will take in the excess urban labor, creating three separate employment outcomes for migrants: formal employment, informal employment and unemployment. There is a corresponding probability of finding employment in each of these fashions based on employment availability. Given the nature of informal employment in Chinese urban areas, the probability of obtaining informal employment is essentially one hundred percent, making the probability of being completely unemployed effectively zero. For example, many urban employment-seekers find aluminum can and cardboard collecting to be an alternative to formal employment, although the wage that they can receive is significantly lower. Although there are many opportunities for additional informal employment, the model assumes that the worker will not hold both formal and informal employment. For the purposes of the model, workers with formal employment are designated as formal employees because the majority of their wages will come from the formal sector.

In their 1998 paper "The new rural-urban labor mobility in China: Causes and implications," Seeborg, Jin and Zhu further specify the Harris and Todaro model to better reflect the dual nature of state and non-state employment in Chinese urban centers. They break down formal labor into two sectors: the SOE sector and the non-SOE contract wage sector.[24] Because SOE reform has resulted in a significant reduction in the amount of Chinese employed in SOEs, Seeborg et al's segmented formal sector will be revised to fit the more overarching division of state and non-state employment. Revising the above

[24] Michael C. Seeborg, Zhenhu Jin and Yiping Zhu, "The new rural-urban labor mobility in China: Causes and Implications," The Journal of Socioeconomics 29 (2000): 39-56.

system of equations to reflect Seeborg et al's revisions, the following system is developed:

$$E(w_u) = P_{FS}w_{FS} + P_{FN}w_{FN} + P_I w_I$$
$$P_{FS} + P_{FN} + P_I = 1$$

$E(w_U)$= expected urban wage
w_{FS} = wage in state formal sector
P_{FS} = probability of obtaining work in the state formal sector
w_{FN} = wage in non-state formal sector
P_{FN} = probability of obtaining work in the non-state formal sector
w_I = wage in informal sector
P_I = probability of obtaining work in the informal sector

Harris and Todaro's expectation that the method employed by migrants of selecting a location is based on their expected returns on migration, given their limited information, is also supported by Seeborg et al. Harris and Todaro conclude that the expected urban wage defined above is the most influential condition considered in migration decisions. Comparing this wage to the real wage in agriculture (marginal product of labor in agriculture), is the method by which the potential migrant makes a final location decision. Migration will continue until equilibrium is reached between the rural and urban populations. As migration to urban areas creates labor surpluses, lowering the probability of employment and therefore the expected urban wage, it increases the agricultural marginal product of labor (MPL) due to diminishing marginal returns (observed in reverse as labor is removed).

Marginal productivity of labor and its effect on rural to urban migration are the focus of Fei and Ranis' "A Theory of Economic Development."[25] Simultaneously articulated by Lewis, the Lewis Fei-Ranis Model considers the effect of surplus rural

[25] Gustav Ranis and John C. H. Fei, "A Theory of Economic Development," Development Economics 1 (1992): 170-202.

agricultural labor on migration to urban areas. Postulating that the marginal product of labor in agriculture is zero, given excess labor, the model implies that migration is important for reaching higher total output by reallocating labor to urban industry. Once the excess labor in agriculture has migrated, further migration removes productive workers from the agricultural sector. Each successive agricultural participant removed from the agricultural sector has a higher productivity because agricultural production is assumed to have diminishing marginal returns. For China, excess labor in agriculture has been estimated at between 150 and 200 million workers.[26]

In the case of China, wage equalization may never occur. There are two main factors preventing equalization: the multitude of informal employment opportunities in Chinese urban centers and the role of non-pecuniary wages in migration decisions. The latter will be the main focus of the empirical portion of this paper.

While the Harris-Todaro Model is not described in the literature as such, it implies set theory-based decision processes, in which the migrant makes a choice between two potential outcomes based on a potential pay-off. Kennan and Walker use a very complex model and United States data to generate an econometric model of migration as a job search problem, with wage as the main determinant of the final migration decision in their 2005 paper entitled "The Effect of Expected Income on Individual Migration Decisions." They approximate a vector of "amenity variables" in order to account for non-pecuniary benefits that are location specific, along with considering expected wage, age, a native location preference, and moving costs.[27]

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[26] Zhongmin Wu and Shujie Yao, "On Unemployment Inflow and Outflow in Urban China," Regional Studies 40.8 (2006): 812.

[27] John Kennan and James R. Walker, ""Geographical Wage Differentials, Welfare Benefits and Migration"," (2000): 1-23.

Initially, Kennan and Walker approximated these migration decisions using the Gittins Index, which gained popularity as a solution to the multiarmed bandit problem, in the late 1970's.[28] The function of the Gittins index is as a tool to compare the expected payoff of the projects available for pursuit at a given time period and select the project with the highest potential return.

Understandably, the Gittins Index is an appealing model for migration because of the ease with which each possible location could be considered a "project" to be considered using the model. McCall and McCall employed the Gittins Index in their 1987 paper "A Sequential Study of Migration and Job Search."[29] Banks and Sundaram's 1994 paper "Switching Costs and the Gittins Index," details the main shortcoming of the Gittins Index - its inability to accommodate remigration costs to a previous location.[30] While McCall and McCall only cite this general weakness, Kennan and Walker completely abandon the usage of the Gittins index solution of the multiarmed bandit problem because of it. These relocation costs are critical to their model, given the nature of migration in the United States. Comparatively, Chinese migration processes are simplified by the negligible costs of returning to a migrant's original location. Additionally, McCall and McCall empirically show that switching costs are not significant in determining the outcome of the model through the consistency of their results in comparison with general migration literature.

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[28] P. Whittle, "Multi-armed Bandits and the Gittins Index," Journal of the Royal Statistics Society 42.2 (1980): 143.
[29] B. P. McCall and J. J. McCall, "A Sequential Study of Migration and Job Search," Journal of Labor Economics 5.4 (1987): 452-476.
[30] Jeffrey S. Banks and Rangarajan K. Sundaram, ""Switching Costs in the Gittins Index"," Econometrica 62.3 (1994): 687-694.

In the case of China, remigration usually only occurs to the migrant's original rural location where, presumably, they still have relatives and old family friends. Due to the cultural significance of ancestral hometowns, it is common for a Chinese rural community to be home to multiple generations of families and include entire family lines. Because this is usually the case in Chinese remigration, the cost is usually just that of a bus or train ticket to that location. General migration costs, (such as housing costs), opportunity costs of lost wages while the migrant finds housing and employment, and costs of social establishment in a new community, are not as prevalent in migrants' decision processes to return to their hometowns as in more mobile countries, such as the United States. This phenomenon of remigration is currently being observed in China. Due to the international economic downturn, Chinese urban industries have begun to shed workers. In the January 31, 2009 *Economist*, an article titled "A Great Migration into the Unknown," details the effects of the recession on Chinese employment. Citing Zhang Jianmin, a university professor in Beijing, the article approximates that about 10 percent of migrant workers from the countryside - approximately 15 million people - will lose their jobs this year.[31]

As described by Whittle in his 1979 proof of the Gittins index "Mutli-armed Bandits and the Gittins Index," the Gittins Index is a framework for evaluating a multi-armed bandit problem with i indexed potential projects, of which only one can be selected to work at a given time. The player (in this case the migrant), selects the project with the highest discounted perceived outcome minus a moving cost. So, for each project $i = (1, 2, \ldots, N)$ such that N is finite and time is discrete, there exists a function:

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[31] "A great migration into the unknown," The Economist 29 January 2009.

$$Y_i = \beta y_i - M_i$$

Y_i = expected net payoff from project i
β = discount factor
y_i = expected real payoff from project i
M_i = moving cost associated with project i

The player then selects the project that he will pursue from the set of all Y's, so the player's final payoff is defined as[32]:

$$Y = \max (Y_1, Y_2, \ldots, Y_N)$$

In order to assess the role of non-pecuniary benefits in migration decisions, location-specific attributes can be added to the expected payoff (y_N in the above model). McCall and McCall created a simple random variable in their model, with equal likelihood of being positive or negative, and they added this value to the expected wage in the given location in order to account for whether the migrant's overall payoff from relocation is increased or decreased by quality of life in the given location.

[32] P. Whittle 146.

III. DATA

Ideally, the determination of individual-level migration decisions would be performed with individual-level survey data. While those data do exist and are used by Yaohui Zhao in his "Labor Migration and Earnings Differences: The Case of Rural China,"[33] obtaining this type of data is problematic because it is prohibitively costly, often reported in Chinese and of questionable accuracy. Because the aim of this paper is to determine which non-pecuniary factors influence an individual's migration decision, the influences of benefits on net migration are modeled by performing an Ordinary Least Squares (OLS) regression on province-level panel data.

The province-level data set was obtained from the *China Statistical Yearbook* from the years of 2003 to 2007, so the data actually refer to the five-year period of 2002 to 2006. The selected provinces were all of the mainland provinces, (which excludes Taiwan, "the rogue province," Hong Kong and Macao). A set of variables was selected to address demographic, economic and quality of life attributes in each province. The changing nature of the Chinese data caused much difficulty in variable selection, as many tables were added to the *China Statistical Yearbook* or discontinued in that period, so proxy variables were used in a few situations and will be explained individually in the results section.

[33] Yaohui Zhao, "Labor Migration and Earnings Differences: The Case of Rural China," American Journal of Agricultural Economics 80.2 (1999): 767-782.

IV. RESULTS

A random effects panel regression is approximated for 31 provinces, over the five year period, as described above. In order for a model to be appropriately specified as a random effects model, the individual-level effect component of the function must be uncorrelated with the regressors. For a model that hopes to assess the migration decisions made by individual residents in certain provinces, such a correlation would be theoretically difficult to justify due to variation in the motivation to migrate of individual migrants. For example, proximity to family members is an attribute of varying importance to migrants, along with other characteristics such as weather and even wage. Because the data used measure net migration, they reflect the province-level aggregation of a multitude of distinct and unrelated motives for migration. Specifying random effects for the model most accurately reflects the varying nature of the reasons for which migrants decide to relocate.

Multiple aspects of development were selected for the model to ascertain their importance in migration decisions: geography, education, healthcare and regional economic characteristic variables. Variables were selected for the regression that most represent characteristics of development in those areas (summarized in Appendix A). Endogeneity was a perceived issue in the model, and lags of one year were included for some variables to take this into account. All GRP variables were lagged along with variables that were compositions of variables including GRP.

Various aspects of development and basic demography are described below including reasons for variable inclusion and an explanation of the results from the regression (summarized in Table 1 below).

Table 1: Panel Regression for Percent Migration (5 years, 31 Provinces)

	Variable	Coefficient	Z-score	P>|z|
+	urban total income per capita lagged	-0.0001	-0.63	0.529
+	rural net income per capita lagged	-0.0002	-0.25	0.803
**+	patents per capita	8.0952	2.54	0.011
	city province	1.1817	.88	0.379
*	life expectancy	0.3880	1.73	0.084
	hospital beds per capita	518.7654	0.91	0.363
**	illiteracy rate	-0.1032	-2.04	0.042
	educational funding per capita	0.1402	0.14	0.892
+	% employment in urban private sector	-34.3898	-1.49	0.136
+	% employment in rural private sector	30.2395	1.08	0.281
*	constant term	-31.4570	-1.95	0.051

** Significant on 95% confidence interval
* Significant on 90% confidence interval
+ Jointly Significant on 90% confidence interval

R^2: within = .0800
between= .7450
overall = .6100

Geography:

The main geographic issue addressed in the model is the issue of "city-provinces." Beijing, Shanghai, Tianjin and Chongqing are all classified as both cities and provinces, and they all also happen to be magnets for migration. A dummy variable is used in the model to designate these provinces. The effect of this variable is statistically insignificant, but this result is encouraging for the selection of the other variables. A main difference for these provinces is population size, so the fact that it is insignificant signals that variables were appropriately controlled for population size. Also, other urban

attributes were articulated separately, so this variable is not taking on any statistical significance due to omitted variable bias.

Tibet is an outlier in both the measures of development and in the actual amount of migration, in that it is both the least developed province in most measures and experienced largest decrease in population (controlled for natural growth rate). In order to determine whether Tibet was driving any of the results in the model, the regression was run again after removing Tibet from the dataset. Only the significance of life expectancy was diminished, which will be discussed in the later section on healthcare. The full results for the regression excluding Tibet are included in Appendix C. Because many attributes of underdevelopment, along with having a large minority population, are also characteristic of Xinjiang, in Northwest China, and other neighboring provinces, a binary variable was added to the model denoting provinces that the Chinese government officially designates as "Western Provinces," but it was statistically insignificant. Additionally, a variable was created to denote provinces bordering other countries in order to capture distance from Beijing and the presence of a significant minority population. This variable was also statistically insignificant in all of the regressions and left out of all final models.

Education:

Education is another major aspect of development, but it proved to be a more complicated one due to the issue of variation in population density, which heavily influences institution size. Initially, the numbers of educational institutions of varying types were considered for the model, but these differences in population density between more urban-oriented provinces and more rural-oriented ones made the measures not

particularly telling. In some less developed provinces, usually highly rural, inhabitants live in small, spread out communities, so more institutions are required in order to geographically accommodate the population. Because these institutions are serving more spread out communities, they are likely to be smaller and often have fewer resources. Comparatively, in the city-provinces, institutions are generally rather large and academically rigorous with a sizeable student body.

Not only do many rural institutions lack resources and ability, but sometimes curricular inappropriateness is also a problem in rural schools. For example, students in Western provinces are often instructed in Mandarin, although many students exclusively speak local dialects at home and are unfamiliar with the language. Initially, number of educational institutions per capita seems like it may be an appropriate measure of educational access, but in the end it is misleading and inconclusive because of the inability to measure quality differences.

Educational funding per capita was also considered as an explanatory variable to account for available educational resources in each province. Availability of funding is only helpful if it is used efficiently, which is not necessarily an appropriate assumption for any public education system. To the extent that local political and institutional corruption is a factor, the misallocation of educational funding becomes a more serious concern in provinces farther from Beijing as the government's ability to closely monitor local authorities is diminished.

To deal with such issues, an output-oriented approach was considered and illiteracy rates were selected as a measure of academic attainment. While a gender breakdown of illiteracy rates was also tested, the overall rate was included in the final

model. The adult illiteracy rate over age 15 was the only education variable deemed significant in the model, on the 95% level, but as the only educational variable that accurately measured educational effectiveness, this is not surprising. The effect of increasing illiteracy by one percent is only a .1 % decrease in population. Because of the high variance (standard deviation is 8%) of illiteracy rates between provinces, this effect is reasonable. For example, Tibet in 2004 had the highest illiteracy rate in the sample at 54.86%. That rate was decreased by 10% in a three year period, which would lead to a 1% decrease in the magnitude of the population outflow in Tibet.

Healthcare:

Issues of health are often cited as one of the most significant urban/rural discrepancies. Again measures of things like "hospitals per capita," sound like promising measures, but are in the end misleading of the Chinese medical system. Because seeking healthcare in underdeveloped provinces can actually lead to greater risk for complications due to poor sanitation, the availability of medical facilities does not necessarily convey the quality of healthcare. The number of medical technical personnel was also included in the model, but it was insignificant. Medical educational standards may vary across provinces, making this an inaccurate measure of healthcare quality, or poor medical resources may render effective medical personnel inept by no fault of their own.

Life expectancy was the best measure of quality and availability of healthcare in each province. As an outcome of these attributes it is a more accurate measurement than any of the inputs, namely facilities and staff. For every one-year increase in the life expectancy in a province, there is an expected .388 increase in the population, controlled for natural growth rates. For an area experiencing a large amount of emigration,

(presumably with low life expectancy), increasing life expectancy by 3 years, which is about one standard deviation, could retain another 1.164% of the population. This is the only result that Tibet is driving, as the variable is not statistically significant in the regression excluding Tibet (see Appendix C). The general healthcare in Tibet is behind the majority of other provinces. For example, Tibet has the highest maternal mortality rates for both permanent residents and the floating population in addition to the lowest percent of women receiving prenatal care and the highest percent of at-home births.[34] The combination of Tibet's underdeveloped healthcare sector and its large migration outflows contribute to Tibet's influence on the significance of this variable.

Regional Economy:

Lastly, economic variables were added to the model to account for the varying economic activities and situations across provinces. Measures of institutional development are generally highly correlated, so multicollinearity was an issue in determining the statistical significance of these variables. A test for joint significance confirmed that urban total income per capita, rural net income per capita, patents granted per capita, percent population employed in urban private enterprises and percent population employed in rural private enterprises were jointly significant on the 90% level. A table of correlations is included in Appendix B.

Most obviously, per capita gross regional product was considered as a measure of relative wealth of the province. Breaking this down into urban and rural wages was more meaningful, as it indicated not only the overall production in a province, but also the development of the rural sector in comparison to the urban sector and to other provinces.

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[34] Access for All: Basic Public Services for 1.3 Billion People, Human Development Report, UN Development Program (Beijing: China Publishing Group Corporation, 2008).

The most important local economic condition considered was the growing prevalence of the private sector (in contrast to the state sector). The percent of the total provincial population employed in the private sector, delineated by urban and rural residence, was used to measure this.

Understandably, there is a probable causal link between these variables with entrepreneurship providing a potential link. Patents, and what they imply about intellectual property rights, give an indication of the entrepreneurial environment in a province and quantify the link between type of enterprise ownership and the actual effect that it can have on GRP (as shown by the urban total income per capita and rural net income per capita).

II. MARKOV MODEL:

In the panel regression of regional attributes, it was demonstrated that the sector of employment of the population is significant for both economic growth and migration. A Markov analysis, as described below in detail, was performed on the percent of the population employed in three sectors of interest: foreign-funded institutions, state-controlled institutions and private institutions. These three sectors are not representative of all employment sectors, but they make up a significant amount of the labor market. Analyzing patterns in employment trends by sector and predicting equilibria, when possible, creates a more comprehensive foundation from which to make policy suggestions.

Because Markov Processes are stochastic processes for which changes of state rely only on the previous state, population models are quite appropriate for this type of mathematical modeling.[35] They look to establish a relationship that holds across time steps between these states dictating the probabilities of state change, and to generate equilibrium once these transitional probabilities have been established.

Markov Models are centered on a decision-making unit (DMU hereafter), and the process by which the DMU transitions between parallel states within the parameters of a stochastic process. For explanative purposes, let there be n states, and let the current state (at time t) be indexed as i. Usually, Markov Chains are discussed in terms of discrete time steps, from t to $t+1$. [36]

Ideally, using rural and urban populations by province would be most beneficial for the scope of this paper, letting the migrant act as a DMU and considering there to be

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[35] Allen C. Kelley and Leonard W. Weiss, "Markov Processes and Economic Analysis: The Case of Migration," Econometrica 37.2 (1969): 280-297.
[36] Emanuel Parzen, Stochastic Processes (Oakland: Holden Day, 1962) 188.

62 states (for urban and rural residence in each of the 31 provinces), in an attempt to predict an equilibrium (again, if one were to exist), between rural and urban populations within the provinces. Due to data availability, this is not possible to approximate. An array of variables relating to labor force ownership characteristics are instead modeled by this method to establish an equilibrium landscape of conditions for the Chinese labor force from which to make policy suggestions.

In order to determine the appropriateness of the process as a Markov chain, both the state space and the nature of the time parameter must be considered. The data are organized by discrete time steps and limited by yearly census data. Assuming China's continued status as a sovereign country, time should be considered to be infinite, though discretely delineated by yearly time steps.

As described by Emanuel Parzen in *Stochastic Processes*, the state space of the data is critical in Markov analysis because it determines whether the Markov process can officially be classified as a Markov chain. In each of the situations modeled for this paper, a particular sector of the labor market is sectioned off for specific analysis, so there are only two states: in the state 'x' in question, or not in the state 'x' in question. Because it meets the condition of being either countable or finite, then the process can be classified as a chain and allows the use of a Markov Chain.[37]

For simplicity, individual sectors are isolated for analysis in this way, such that each DMU is designated as being in a particular state or in the composite state that is the compliment of the state in question. In the later model of percent labor in foreign-funded enterprises, the state other than the one in question includes employment in all firms not designated as foreign-funded enterprises. This assumption simplifies the implementation

[37] Parzen188.

of the model, such that each DMU has only two options to consider: continue in the current state(S) or not(N). The probabilities of these two options are the relationship used to predict the distribution of the population into the states at time t and they can be used to predict equilibrium. The following is a generalization of the process by which the transition matrix describing the process is applied to a certain population at a given time to predict the population in the next period and then generalized in the final equation such that it can describe the process by which the transition matrix can be applied to the initial data to predict a future population using the number of time steps. The data used in each of the models comes from the China Statistical Yearbook, so it is reported not in probabilities, but in values at a variety of time periods, which were converted to percentages for the computational component of the model. In the equations below, this is important because for all i, $u_{si} = s_{ni}$.

$$P = \begin{bmatrix} p & 1-p \\ 1-q & q \end{bmatrix} = transition\ matrix$$

$$p = probability\ of\ \ remaining\ in\ state\ S$$

$$q = probability\ of\ \ remaining\ in\ state\ N$$

$$v_0 = \begin{bmatrix} u_{s0} \\ u_{n0} \end{bmatrix} = vector\ of\ \ initial\ distribution\ (t=0)$$

$$v_i = \begin{bmatrix} u_{si} \\ u_{ni} \end{bmatrix} = vector\ \ distribution\ at\ t = i$$

$$v_i = P^i v_0$$

Parzen explains that by mathematical induction, the above process can be show to generalize to the form:

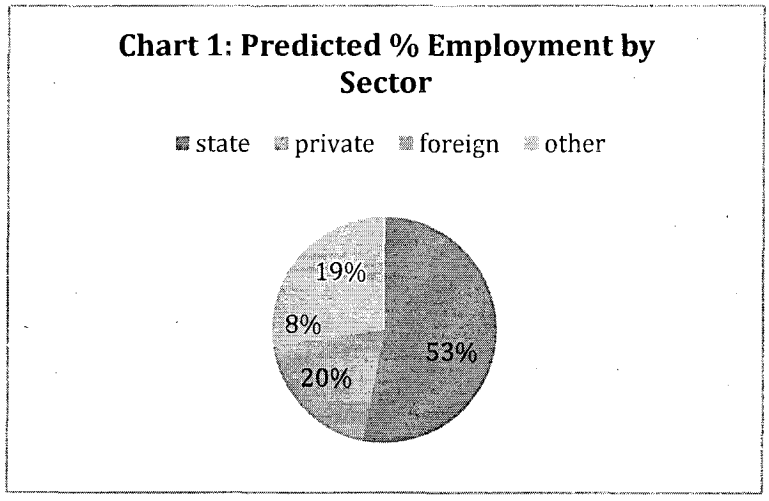
$$P(n) = \frac{1}{2-p-q}\begin{bmatrix}1-p & 1-q\\ 1-p & 1-q\end{bmatrix} + \frac{(p+q-1)^n}{2-p-q}\begin{bmatrix}1-p & -(1-p)\\ -(1-q) & 1-q\end{bmatrix}$$

From the above it can then be determined that:

$$\lim_{n\to\infty} p(n) = \frac{1-p}{2-p-q} \; and \; \lim_{n\to\infty} q(n) = \frac{1-q}{2-p-q}$$

In order to determine the transitional probabilities, a program was created to approximate them by finding the values that minimize the sum of the squared deviations of the actual observed values, and the predicted values in terms of the initial values and the probabilities p and q.

The process approximated that the equilibrium percent of employment in foreign-funded firms should approach 8.3% over time. For the state sector, it approximated 53% and for the private sector, 19.7%. These percentages don't add up to 100 because the Chinese Statistical Yearbook's sector divisions include a few other smaller, less influential and hybrid divisions. These percentages are displayed in Chart1:



IV. CONCLUSIONS

Internal migration in China has resulted in social problems and has been addressed by Chinese policy-makers in the implementation of the household registration system. Despite barriers to migration, it continues to occur, further amplifying the social unrest of migrant workers. Given the increasing current strain on the world economy, retaining high levels of growth and economic satisfaction amongst Chinese citizens will be critical for continuing political stability in China. To prevent anti-government protesting and other actions, it is in the Chinese government's interest to work towards any means that may be capable of increasing overall satisfaction for the Chinese people, and alleviating tensions over internal migration would be in line with that goal. From the models discussed in this paper, certain recommendations can be made to help slow migration.

As shown in the panel regression, the causes of migration are gaps in both pecuniary income and non-pecuniary benefits, so working to decrease inequality both of those areas is a starting point in the attempt to slow migration. One way in which to decrease this inequality is the overall improvement of the economic environmental factors, as demonstrated by the panel model. Economic environmental factors were so highly correlated with development that multicollinearity issues were even encountered. In order to increase pecuniary benefits, output in rural and agricultural areas needs to be increased. The panel regression showed that an increase in per capita wages was highly correlated with private employment in both the rural and urban sectors and the number of patents granted in a region (used as an indicator for entrepreneurship). The predicted division of employment by sector, determined in the previous section, shows a continued

dominance of the state sector, and this discrepancy is worrisome given the regression result. The overall suggestion to rise out of this section of the paper is that in order to secure the necessary economic growth in rural and agricultural areas, China needs to reduce restrictions on the economy in these areas, allowing for the increased entrepreneurship to generate increased wealth.

In order to increase non-pecuniary income in rural areas, the most important thing that China can do is to focus on the quality of its resources (including human resources), that are employed in those areas. Incentive programs to attract well-trained doctors from other provinces might be a way to change not only the quality of healthcare in rural China, but to also improve the public's perceptions of healthcare. Rural teaching programs of a similar nature could also be implemented, even within provinces. (This may even be more effective, as somewhat local, well-trained teachers would have a better idea of what would constitute an appropriate curriculum.) These tangible changes in the quality of services provided by the government could change the perceptions of the rural population and would decrease the incentive to migrate to urban areas, ideally decreasing overall migration.

While the idea of deregulating both of these services sounds appealing from a free market standpoint, the reality of China's Communist framework must be recognized. One of the aspects of migration that has caused considerable strife is the exclusion of the floating population from many public services due to the Chinese concept of the role of government as a provider. The reality that China needs to institute change to help alleviate social stresses caused by internal migration is undeniable, but the task of recommending policies is particularly difficult in a Communist framework.

Appendix A: Summary of Panel Regression Variables

Summary of Panel Regression Variables

Variable	Mean	Std. Dev.	Min.	Max.
percent migrate	-4.9365	3.6007	-13.3780	6.6423
urban total income per capita	9499.7850	3354.4970	5292.0900	22808.5700
rural net income per capita	3211.9760	1507.4000	1462.2700	9138.6500
patents per 1000	0.1244	0.1779	0.0026	0.9743
city province	0.1290	0.3360	0.0000	1.0000
life expectancy	71.2439	3.1495	64.3700	78.1400
hospital beds per capita	.0028	.0009	.0015	.0053
illiteracy rate	12.0087	8.2084	3.8500	54.8600
educational funding per capita	0.0757	0.1864	0.0175	2.2482
% Rural Employment in private sector	0.0175	0.0227	0.0007	0.1176
% Urban Employment in private sector	0.0276	0.0263	0.0036	0.1444

Appendix B: Correlation Table for Collinear Variables

	patents per 1000	urban total income pc	rural net income pc	% rural employment in private sector	% urban employment in private sector
patents per 1000	1				
urban total income pc	0.8851	1			
rural net income pc	0.9039	0.9206	1		
% rural employment in private sector	0.8699	0.8081	0.8714	1	
% urban employment in private sector	0.8943	0.8229	0.8535	0.8715	1

Appendix C: Regression Results Excluding Tibet

Table 1: Panel Regression for Percent Migration (5 years, 30 Provinces)

	Variable	Coefficient	Z-score	P>|z|
+	urban total income per capita lagged	-0.0002	-1.21	0.225
+	rural net income per capita lagged	-0.00005	0.06	0.956
**+	patents per capita	7.7962	2.44	0.015
	city province	1.2530	0.91	0.363
	life expectancy	.2735	1.16	0.245
	hospital beds per capita	103.7291	0.17	0.864
***	illiteracy rate	-.2349	-3.04	0.002
	educational funding per capita	.2150	0.21	0.835
+	% employment in urban private sector	-28.6613	-1.24	0.217
+	% employment in rural private sector	39.2103	1.37	0.170
	constant term	-20.6182	-1.20	0.229

*** Significant on 99% confidence interval
** Significant on 95% confidence interval
* Significant on 90% confidence interval
+ Jointly Significant on 90% confidence interval

R^2: within = .1337
between= .7022
overall = .5775

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