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Abstract. An integrative analysis of several regional economic outcome variables in China for the period of 1995-2013 reveal the major sources of regional growth differences in China. Patterns of growth in population, per capita income, gross regional product, housing prices and changes in unemployment rates are identified using principal components analysis. Regression analysis of principal component scores is applied to identify geographic patterns in the sources of the growth. The analysis suggests that shifts in labor supply largely were responsible for the regional growth differences over the period, though shifts in labor demand were nearly equally as important. The results have implications for evaluating the success of regional development policies such as the Western Development Strategy.

Keywords: China; Regional growth; Western Development Strategy

JEL Codes: R11; R12; R23; R58

Introduction

Implementation of market-based reforms that began in 1978 and integration into the global economy transformed the Chinese economy and grew it to the second largest in the world (Chow, 2004; Dreger and Zhang, 2014). The banking and housing sectors were reformed, while stock markets were created (Chow, 2004; Ye et al., 2010; Man et al., 2011). Privately-owned businesses increasingly replaced state-owned enterprises, foreign direct investment increased, and exports increased, notably with the accession of China into WTO membership (Tung, 2005; Wu, 2007). However, growth across regions of China has been uneven during the post-reform period (Wei, 2002; Fan and Sun, 2008; Hao and Wei, 2010; Lin et al., 2013).

Studies of regional growth in China have focused separately on agglomeration economies (e.g., Fan and Scott, 2003; Lu and Tao, 2009; Ke, 2010), exports and foreign direct investment (Wu, 2007; Hao and Wei, 2010; Dreger and Zhang, 2014), household amenity attractiveness (e.g., Liu and Shen, 2014), and housing supply (e.g., Wang and Zhang, 2014; Yuan and Hamori, 2014). Yet, there have not been any studies that have compared the relative importance of labor demand, labor supply and housing supply as sources of regional growth in China using multiple economic indicators as has been done for the US (Partridge and Rickman, 1999; 2003; 2006; Glaeser and Tobio, 2008; and Rickman and Wang, forthcoming).[1] Therefore, this study assesses the relative roles of firm productivity/labor demand, household amenity attractiveness/labor supply and housing supply in explaining growth differences across the provinces and municipalities under central government control of China. We examine the period of 1995 to 2013 because of the number of reforms undertaken in the 1990s, particularly the late 1990s. The study formulates an integrative empirical approach in examining the patterns of growth in per capita income, housing prices, gross regional product, unemployment rates, and population.

[1] Chen (2016) constructs a multiple factor panel model to examine differences across 28 major regions in China for 1953 to 2013. However, the study focuses solely on per capita GDP and identifies supply shocks as those having permanent effects, while demand shocks are assumed to have temporary effects.

The integrative approach we employ synthesizes the frameworks of previous analyses for the US. Analysis by Partridge and Rickman (1999) focused on patterns in traditional labor market indicators such as unemployment rates, labor productivities, wage rates, population growth and employment growth. Partridge and Rickman (2003; 2006) employed a long-run restrictions structural vector autoregression (SVAR) analysis of US population, employment and wage growth to assess the relative roles of labor demand and labor supply. Rickman and Wang employed the spatial equilibrium growth model of Glaeser and Tobio (2008) to decompose the patterns in US regional growth of population, income and housing prices into the three components of firm productivity, household amenity attractiveness and housing supply elasticity. Instead of focusing solely on traditional regional labor market indicators, regional housing prices play a key role in the Glaeser and Tobio model.

In this paper, we further empirically integrate the above approaches into a single framework to examine regional growth in China for the period 1995-2013. Evidence of labor demand-induced growth can be found in increasing per capita income, gross regional product, population and housing prices, and declining unemployment. Evidence of labor supply-induced growth can be found in rising population, housing prices, gross regional product and unemployment, and declining per capita income. Evidence of growth induced by elastic housing supply primarily is evidenced by lower housing prices relative to income and population growth. The patterns among the indicators are identified using principal component analysis. Once the principal components are extracted, principal scores are calculated for the observations and examined for patterns across China's provinces and municipalities under central government control using regression analysis.

The next section discusses the previous studies and their findings for the US, and synthesizes them to provide an integrative framework for analysis of China's regional growth patterns. Section 3 discusses the empirical methodology and data sources and calculation of the outcome variables. The results are presented in Section 4. The primary findings are that over the entire period, labor supply shifts primarily fueled the regional differences in regional growth, though labor demand shifts were almost equally as important, while there a lesser role for housing supply shifts. Notable patterns for particular regions also are highlighted and discussed. Section 5 contains a brief summary and conclusions.

2. Integrative Analysis of Regional Growth

Identifying demand versus supply sources of regional growth has long been problematic. Early US studies attempted to determine whether it was primarily labor demand or labor supply that underpinned interregional migration (Muth, 1971; Greenwood and Hunt, 1989). The identification problem arises because interregional migration and employment growth each are an outcome of shifts in both labor demand and supply. Valid time-varying instruments are difficult to find, particularly for population (Rickman, 2010).

Partridge and Rickman (2003, 2006) used a long-run restrictions structural vector autoregression (SVAR) approach to decompose employment and population growth into labor demand versus labor supply. Identification derived from assuming that regional productivity solely determined nominal regional wages and that internal labor supply shifts had no long-run impact on interregional migration. Regional housing prices and cost-of-living more broadly, were omitted from the analysis, which precluded regional housing supply from affecting growth in the analysis.

Recognizing the difficulty of finding valid instruments and the limitations imposed by using identifying assumptions as in the SVAR approach, Partridge and Rickman (1999) utilized an integrative labor market framework to identify whether labor demand or labor supply shifts were mostly responsible for US state shifts in employment and population over two seven-year periods. Evidence that dominant labor demand shifts underpinned increases in employment and population were found in increased wages, labor productivity, labor force participation and reduced unemployment. Dominant labor supply shifts were associated with decreased wages and labor force participation, and increased unemployment. Aside from wages, regional prices were not examined. Thus, as in Partridge and Rickman (2003; 2006) the potential growth role of housing supply was not considered.

Glaeser and Tobio (2008) developed a spatial equilibrium growth model to explain the economic rise of southern states in the US. Rather than finding increased labor supply through natural amenity attractiveness as responsible for population growth in the states, Glaser and Tobio attribute the growth to more favorable housing supply regulations. The conclusions derive from the spatial equilibrium assumptions of the model. A primary assumption is the continuous equalization of household utility over time, in which household amenity attractiveness is revealed by the inverse of regional wages adjusted for housing prices. Exogenous regional shifts in productivity, household amenity attractiveness and land supply all increase population, but only productivity directly increases wages. Evidence of increased land supply is found in lower housing price growth relative to population and nominal wage growth. Another assumption of the model is full employment, which precludes changes in unemployment and labor force participation as sources of regional growth.

Using the Glaeser and Tobio (2008) model, Rickman and Wang (forthcoming) find that natural amenity rich areas were associated with increased agglomeration, increasing wages rather than reducing wages. They conclude that amenities may have particularly attracted skilled migrants and high productivity footloose firms. Rickman and Wang further find that urban agglomerations were associated with slower growth in housing price-adjusted wages, suggesting that highly agglomerated areas were increasingly more consumer amenity attractive than productive. These results point to the importance of examining patterns in a broad range of economic indicators rather than simply assuming particular outcomes for natural amenities and urban agglomeration.

The analysis above suggests that, taken together, the following economic indicators can be used to understand the sources of regional growth: population growth, per capita income growth, housing price growth, gross regional product growth and changes in unemployment. The results of the previous analyses of the US can be synthesized to better identify the sources of regional growth across China. The synthesis of traditional labor market and spatial equilibrium analysis suggests that increased labor supply will be evidenced by stronger population and housing supply, higher unemployment, and slower per capita income growth. Increased labor demand will be evidenced by stronger population growth, per capita income growth and gross regional product growth, but lower unemployment. Yet, if population growth induces agglomeration economies then the negative labor supply growth on per capita income growth weakens or reverses in effect (Rappaport, 2009). The positive effects of labor demand and labor supply on housing prices also can be mediated by differences in the elasticity of housing supply (Glaeser et al., 2006), which is revealed by lower housing price growth relative to growth in income and population.

3. Data and Empirical Approach

3.1 Empirical methodology

The empirical analysis consists of two steps. First, principal components analysis of population growth, per capita income growth, housing price growth, gross regional product growth and changes in unemployment rates is conducted. The principal components extracted are then interpreted in terms of what best explains the patterns in the correlations of the individual variables with the principal components. Principal component scores for selected principal components are calculated and subsequently used in regression analysis to examine whether there are patterns across China's major regions.

Principal component analysis is used because of the many varied combinations of possible patterns in the outcome variables implied by the integrative analysis in Section 2. The principal components method constructs orthogonal linear combinations of the five variables that explain their variation. For five variables, five principal components are calculated. Each principal component reflects some independent commonality of variation among the five variables. It provides an index value for each unit of observation for each principal component. Alternative criteria are available for selecting the number of principal components to examine. We use the Kaiser method, which selects all principal components with eigenvalues in excess of one.

In the second step, the principal component scores for the selected principal components are regressed on binary indictor variables for the geographic location and administrative status of the observation. China's administrative units are classified according to a three-tier system. Following convention, because of data availability, we focus on the first tier, which includes: 23 provinces, 5 autonomous regions and 4 municipalities directly under control of the Central Government.[2] The areas of study, including their administrative classification and geographic location in mainland China, are presented in Appendix Table 1.[3]

3.2 Data

The regional data we utilize in this paper are all publicly available. Data are obtained from the National Bureau of Statistics of the People's Republic of China for population, gross regional product (GRP), unemployment rate in urban areas, wage and salary income per capita, and the average regional housing price.[4] We calculate the average annual growth rates for the variables over the period of 1995 to 2013.

We begin the analysis in the late 1990s because of the number of reforms implemented during the decade. The banking and housing market sectors were reformed and stock markets were created in the 1990s (Chow, 2004; Ye et al., 2010; Man et al., 2011). Tung (2005) notes that the number of state-owned enterprises declined from 118,000 in 1995 to 23,228 in 2003,[5] while the value added by the high-tech industry increased by a multiple of three from 1995 to 2001. Tung further notes that China's status as the largest recipient of foreign direct investment in the development world began in 1994. China's trade with the rest-of-the-world greatly

[2] The second tier consists of autonomous prefectures, autonomous counties and cities that makeup the provinces and autonomous regions in the first tier. The third tier consists of townships, ethnic minority townships, and towns that makeup the counties, autonomous counties and cities in the second tier.

[3] Because this paper focuses only on mainland China we exclude the two special administrative regions of Hong Kong and Macao. Other empirical studies using provincial data for mainland China include Wu (2007), Fan and Sun (2008), Hao and Wei (2010), Lin et al. (2013), Dreger and Zhang (2014), Yuan and Hamori (2014) and Chen (2016).

[4] National Bureau of Statistics of the People's Republic of China website link is http://www.stats.gov.cn/english/. Data are not available for all variables examined at a finer geographical level across all of mainland China.

[5] In March, 1999, the Chinese Constitution was amended to include private ownership and the rule of law (Tung, 2005).

increased with its membership in the WTO in 2001, though China's exports had increased throughout the previous decade (Wu, 2007).[6]

According to China Statistical Yearbooks, population in 1995 was estimated based on the 1% Population Sample Survey; population in 2013 was estimated on the sample surveys on population changes that cover about 1 per thousand of the total population of the country. The military personnel were not included in the regional population. Housing price refers to average selling price per square meter of commercialized residential buildings that are built by real estate companies and traded in the housing market. Data are obtained from the National Bureau of Statistics of the People's Republic of China. Unlike for average selling prices in 2013, we cannot obtain year 1995 data directly from National Bureau of Statistics of the People's Republic of China. Thus, we use sales value of residential commercial houses divided by floor space of actually sold residential commercial houses that obtained from Table 5-35 of China Statistical Yearbook in 1996.[7]

Regarding wage and salary income per capita, we can only obtain data for urban and rural areas separately. Thus, we use the urbanization ratio, calculated as urban population divided by total population, to weight the urban and rural per capita incomes.[8] For Tibet and Chongqing because of missing the urbanization ratio from 1995-1999, we use 2000 as the beginning year to calculate the average annual growth rate.

Average annual compounded growth rates for the five outcome variables by administrative unit are presented in Appendix Table 2. Fastest population growth occurred in municipalities under central government control, followed by provinces in the East and North. Slowest population growth occurred in Northeast provinces. Both per capita income growth and

[6] Morrison (2015) traces many of the policies implemented by China since 2006 to the document, *The National Medium-and Long-Term Program for Science and Technology Development (2006-2020).*
[7] Chongqing was still included in Sichuan province until year 1997. Thus, we use 1997 as the beginning year to calculate Chongqing's growth rate. For Tibet, we use 1996 as the beginning year to calculate the growth rate since 1995 data were missing.
[8] The online database for rural and urban population is only available since 2005 and afterwards. Therefore, we calculated the 2013 urbanization ratio using rural and urban population. For 1999, we adopted the ratio from http://www.doczj.com/doc/886469aad0d233d4b04e6916.html.

housing price growth were the strongest in the Southwest, though it had the second slowest rate of population growth. Unemployment decreased the most in Northwest provinces and increased the most in provinces located in the North, Northeast and Municipalities. Gross regional product growth was the strongest in the North and weakest in the Northeast.

4. Results and Discussion

4.1 Correlations and Principal Component Analysis

Table 1 presents the correlations between the five outcome variables. The correlations between population and the other four variables fit a supply-driven process. Supply-induced population change is expected to increase housing prices, but is also expected to be associated with higher unemployment and lower per capita income. Consistent with a demand-driven process, gross regional product is positively correlated with housing prices and per capita income and negatively correlated with the unemployment rate.

Table 2 displays the principal components analysis for the five outcome variables over the entire sample period.[9] From the last column, it can be seen that over one-half of the variation is explained by the first two principal components. Based on the Kaiser method, we retain the two principal components with eigenvalues over one for further analysis (shown in the second column). Further support for the use of the first two components is provided by the dramatic drop in eigenvalues between the first two principal components and the third principal component.

The eigenvector loadings for the first two principal components are shown in Table 3. The pattern of loadings for the first principal component is most consistent with dominant supply-induced growth. The component is positively correlated with population growth, the unemployment rate, housing prices and negatively correlated with per capita income and gross regional product. The pattern of loadings for the second principal component is most consistent with dominant demand-induced growth. The component is strongly positively correlated with

[9] The principal components and regression analysis were conducted using the EViews 7 program.

gross regional product and housing prices, while also being strongly negatively correlated with the unemployment rate. There are only slight positive correlations between the second principal component and the outcome variables of population and per capita income. The weak correlations with population and per capita income, but strong correlation with housing prices, also suggests the component reflects more inelastic housing supply (Glaeser and Tobio, 2008).

4.2 Regression Results

The results of regression analysis of the principal component scores for geographical patterns are presented in Table 4. Geographical patterns are examined in terms of the region of the province, whether the observation was a municipality under central government control and whether the observation was autonomous. The results for the first principal component are presented in the first two columns, while those for the second principal component are presented in the third and fourth columns. The t-statistics reflect White heteroscedasticity-adjusted standard errors.[10]

The results in the first two columns reveal positive significant association between first principal component scores and status as a municipality under central government control and location in the Northeast region of China. Recall that the omitted category is location in the Central region of China; i.e., the coefficients reflect principal components scores relative to provinces in the Central region. The coefficient for the municipalities under central government control reflects the effect relative to their region of location; except Chongqing, all the municipalities are in the top five for scores on the first principal component (not shown).[11] Given the interpretation of the first principal component as reflecting a pattern of dominant supply-induced growth, the significantly positive coefficients suggest significant supply-induced growth in these areas. The bottom five scores on the first principal component belong to Anhui, Henan, Inner Mongolia, Shaanxi and Guizhou (not shown). Although the overall regression is

[10] Because of the descriptive nature of the regression analysis, and broad geographic scope of the regions, we do not estimate the equation using spatial econometric techniques.

[11] Chongqing is ranked 23rd for its first principal component score. In order, Heilongjiang and Guangdong are the other two regions with scores above one for the first principal component.

marginally insignificant, it becomes significant below the 0.05 level when variables with t-statistics below one are omitted. The statistical significance of each of the remaining variables is unaffected.

Interestingly, the only statistically significant coefficient for the second principal component scores is the negative coefficient for provinces in the Northeast region of China. All three Northeast provinces are ranked in the bottom five for scores on the second principal component (the other two are Hebei and Yunnan). Given the interpretation of the second principal component as demand-induced growth, provinces in the Northeast region appeared to have suffered from lower demand-led growth. In order, the top five regions (not shown) in terms of scores on the second principal component are Tibet, Inner Mongolia, Ningxia, Qinghai, and Shaanxi, three of which are in the Northwest region.[12] This supports the view that China's Western Development Strategy of infrastructure investments in energy and transportation implemented in 1999 was successful in stimulating demand (Lu and Deng, 2013; Shiu et al., 2016). The overall regression is statistically significant below the 0.05 level, in which the results are qualitatively and statistically unaffected by omitting variables with t-statistics less than one.

Overall, the Northeast can be characterized as relatively positively influenced by supply but negatively by demand. But population growth in Northeast provinces was the lowest in China (Appendix Table 2). The results suggest the dominant force underlying the slower population growth was deficient growth in demand. The positive supply effect appears to reflect lower population outflows than would be expected given the lack of demand growth; this is reflected by the large increases in unemployment over the period (Appendix Table 2). Shaanxi is notable for its position in the bottom five for household amenity attractiveness, while having a position in the top five for firm productivity. The results also suggest that the strong population growth of municipalities under central government control is dominated by supply-induced growth over the entire period. This is notable given the limitations on labor supply movements to

[12] Dropping Tibet from the regression causes the positive coefficient for the Northwest to become statistically significant (t=2.58), while the negative coefficient for the Northeast remains as the only other statistically significant coefficient.

large Chinese cities over much of the sample period by the Hukou System (Au and Henderson, 2006). Chen (2016) likewise notes the strong migrant attractiveness of China's largest cities over even a longer period (1958-2013).

The East region of China does not show up as having either a strong labor supply or demand pattern. In results not shown, both the East and Southwest regions show up most prominently (with positive coefficients) in a regression of the scores for the fourth principal component, which is statistically significant below the 0.05 level.[13] The fourth principal component is highly positively correlated with housing price growth (r=0.75) and unemployment rate changes (r=0.44), but negatively correlated with population growth (r=-0.45), with lower correlations with per capita income (r=0.06) and gross regional product (r=-0.21). This pattern fits one of elasticity of housing supply driving growth differences, where inelastic housing price growth increases housing prices and reduces population growth (Glaeser et al., 2006). The evidence of inelastic housing supply in the East is consistent with the evidence of Yu (2011) that the large cities in the East region of China experienced housing price bubbles during the period.[14]

5. Summary and Conclusion

This study develops an empirical integrative approach to assess the relative roles of firm productivity (labor demand), household amenity attractiveness (labor supply) and elasticity of housing supply in explaining regional growth differences across provinces and municipalities under central government control in China for the period of 1995 to 2013. Firstly, principal components analysis of growth in income, housing prices, gross regional product, unemployment, and population are used to identify the major sources of growth. Over the entire sample period, supply-induced growth had the greatest explanatory power, followed closely by

[13] The third principal component did not exhibit a readily identifiable pattern of correlations with the outcome variables: positive correlations for population, unemployment, per capita income and gross regional product; and approximately no correlation with housing prices. The fifth principal component has an eigenvalue of less than 0.5 and also does not exhibit a readily identifiable pattern of correlations: positive correlations with population, housing prices and per capita income; and negative correlations with gross regional product and unemployment.

[14] The results of estimating sub-periods 1995-2004 and 2005-2013 showed some differences across the two periods. The first sub-period though was the most positively correlated with the overall period. Changing economic patterns may be related to government programs in the West (Wu, 2007) or by regional forces (Wei, 2002).

demand-induced growth. Secondly, regression analysis of principal component scores is used to assess the geographic patterns of demand- and supply-induced growth.

The primary findings include the strong migrant attractiveness of the large municipalities under central government control. We found weaker labor demand for the Northeast region and weaker supply adjustment, causing greater increases in unemployment of the region. Weak labor supply (amenity attractiveness) explains the slower population growth in the Southwest and Northwest (especially Shaanxi), which more than offset the benefits of stronger labor demand such as in Ningxia, Qinghai and Shannxi. This suggests that the Western Development Strategy was successful in stimulating labor demand but could not overcome the negative labor supply effects to produce stronger population growth. Further research would be useful in assessing the roles of various policies for the differences in labor demand, labor supply and housing supply elasticity.

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Table 1. Ordinary Correlations

	POP	UNEMP	HOUSING	INCOME	GRP
POP	1.000				
UNEMP	0.097	1.000			
HOUSING	0.110	-0.112	1.00		
INCOME	-0.375	-0.024	-0.172	1.000	
GDP	0.066	-0.202	0.197	0.203	1.000

Table 2. Principal Components Analysis: 1995-2013
Eigenvalues: (Sum = 5, Average = 1)

Number	Value	Difference	Proportion
1	1.469	0.119	0.294
2	1.350	0.455	0.270
3	0.896	0.094	0.179
4	0.801	0.318	0.160
5	0.484	---	0.097

Table 3. Eigenvector Loadings: 1995-2013

Variable	PC 1	PC 2
POP	0.628	0.093
UNEMP	0.160	-0.524
HOUSING	0.295	0.538
INCOME	-0.685	0.050
GRP	-0.152	0.651

Table 4. Regional Regression Analysis of Principal Components: 1995-2013

	First Principal Component		Second Principal Component	
	Coefficient	t-Statistic	Coefficient	t-Statistic
CONSTANT	-0.34	-0.80	-0.49	-1.83***
CENTRALGOV	1.99	2.53**	-0.20	-0.46
NORTH	-0.19	-0.23	0.51	0.95
NORTHEAST	0.90	1.75***	-1.10	-2.05***
NORTHWEST	-0.45	-0.69	0.87	1.37
EAST	0.02	0.04	0.29	0.94
SOUTHWEST	-0.56	-0.66	1.03	1.23
AUTONOMOUS	1.13	1.17	1.02	1.15
R-squared	0.36		0.44	
Prob(F-statistic)	0.12		0.04	

Note: t-statistics reflect White heteroscedastic-adjusted standard errors
*significant at or below the 0.01 level
**significant at or below the 0.05 level
***significant at or below the 0.10 level

Appendix Table 1. Units of Observation

Province/Municipality	Region	Municipality	Autonomous
Beijing	North	Yes	No
Tianjin	North	Yes	No
Hebei	North	No	No
Shanxi	North	No	No
Inner Mongolia	North	No	Yes
Liaoning	Northeast	No	No
Jilin	Northeast	No	No
Heilongjiang	Northeast	No	No
Shanghai	East	Yes	No
Jiangsu	East	No	No
Zhejiang	East	No	No
Anhui	East	No	No
Fujian	East	No	No
Jiangxi	East	No	No
Shandong	East	No	No
Henan	Central	No	No
Hubei	Central	No	No
Hunan	Central	No	No
Guangdong	Central	No	No
Guangxi	Central	No	Yes
Hainan	Central	No	No
Chongqing	Southwest	Yes	No
Sichuan (excluding Chongqing)	Southwest	No	No
Guizhou	Southwest	No	No
Yunnan	Southwest	No	No
Tibet	Southwest	No	Yes
Shaanxi	Northwest	No	No
Gansu	Northwest	No	No
Qinghai	Northwest	No	No
Ningxia	Northwest	No	Yes
Xinjiang	Northwest	No	Yes

Appendix Table 2. Annual Compounded Growth: 1995-2013

Region Classification	Housing Prices %Δ ’95-‘13 (annual)	Per Capita Income %Δ ’95-‘13 (annual)	Population %Δ ’95-‘13 (annual)	Unemp. Rate %Δ ’95-‘13 (annual)	GRP %Δ ’95-‘13 (annual)
Central	8.32	13.31	0.68	-0.01	13.15
East	8.68	13.15	1.44	0.03	13.33
North	8.25	13.04	1.44	0.07	14.75
Northeast	6.65	11.29	0.29	0.07	12.48
Northwest	7.04	13.09	0.91	-0.11	14.36
Southwest	11.91	13.52	0.41	-0.03	13.83
Autonomous	10.89	12.35	1.00	-0.05	14.62
Municipality	9.42	12.38	1.99	0.07	13.94