Explaining Regional Disparities of China's Economic Growth: Geography, Policy and Infrastructure

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Abstract

While China's fast growth is unquestionable, equally significant is the rising coast–inland inequality. This paper begins with an illustration of China's regional growth episodes and regional inequality, and following with an analysis of the roles of geographic characteristics in shaping the growth paths, together with preferential policy and transportation infrastructure that accommodate or undermine such roles. Geography factors represented by closeness to coastlines and the Open-Door Policy favoring coastal regions were important determinants of the growth rate from the beginning of the reform in 1978 until early 2000. Topographic features created certain adverse effects on growth, but the effectiveness of transportation network on overcoming such obstacles was not exactly clear. Although highways and navigable rivers showed considerable values in promoting growth, the effects of railroads and roads were quite minimal. Decompositions of growth disparities suggest that as geographic endowments could explain one third of the disparities between inland provinces and coastal provinces, transportation facilities are more important for western regions while policy initiatives more critical for central provinces.

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1. Introduction

During the last three decades following the Open and Reform in 1978, China as a country experienced extremely rapid economic growth with an average per capita GDP growth rate reaching 9 percent. Along with such miraculous growth, however, comes growing regional inequalities, in particular a widening income gap between coastal and inland provinces. There is a rich literature on explaining the patterns of China's interprovincial inequality and identifying the factors behind such patterns. My study will focus on analyzing the growth episodes after the Reform but will give special attentions to the roles of geography in explaining variations in provincial growth rates.

This study intends to give a thorough analysis of regional growth experience for the three decades since the launching of the Open and Reform through the lens of geography together with preferential policies and infrastructure construction. What the study wants to answer are the following questions: First, what were the patterns of interprovincial inequality during the last 30 years and if there are any signs of convergence? Second, how did the impact of geographic features on economic development change over time? Third, how did pure geographic effects and preferential policies' influences promote or discourage the growth of coastal provinces? Forth, how did topographic barriers and construction of transportation infrastructure affect regional variations in economic development? Lastly, how much growth disparities between coastal, central and western regions could be attributed to geography, policy and transportation respectively? The four questions related to the roles of geographic variables aim at assessing the impact of geography as well as the effect of geography-related preferential policies and infrastructure build-up in facilitating or undermining the influence of pure geographic endowments.

What distinguishes this study from the previous works are the followings. To begin with, my study is able to take the advantages of the only recently available provincial level data for earlier time periods of all 31 provinces as well as the most recent socioeconomic data (up to 2011). In addition, in terms of preferential polices, my study not only includes the Open-Door policy during 1980s and 1990s that intends to exploit the regional advantages of the coastal provinces by creating favorable conditions for attracting foreign investments and promoting exports, but also takes into account the recent policy shift since 2000, of which the new preferential policies on taxations, land use, etc. are granted to the western provinces. Since 2000, the policy advantages of the coastal provinces gradually phased out due to general opening-up of the entire country, while the western provinces received more and more benefits. Accounting for both sets of policies help better capture recent shifts in the central government's focus. Moreover, although previous studies have given attention to geographic features (e.g. Bao et al. 2002), preferential policies (Mody and Wang 1997) and infrastructure (Démerguer 2000), my study combines all three factors to evaluate the relative importance of each. In particular, the study focuses on assessing how preferential policies and transportation infrastructure helped overcome barriers or exploited advantages of geographic endowments by accommodating or undermining such characteristics. Lastly, although most data used for previous studies are panel data in nature, few studies take the advantages of such data structure since vast majority of the studies use cross-sectional regressions as their models. Parts of my analyses are based on a random effect model in order to explore the provincial panel data.

A glance at China's topographic map suggests that western provinces face several obstacles created by geographic features. To begin with, the entire western regions are land-locked with sizable distance to the coast, yet the coastal provinces have long coastlines. Moreover, most of the plains with arable lands are concentrated on the eastern coast belt, while high plateaus and mountain ranges occupy the western regions. Even more so, western regions have less suitable climate for agricultural production, as the Northwest region is arid and the Southwest region suffers from deficit in energy. The coastal provinces, on the other hand, enjoy humid and temperate monsoonal climate. Thanks to such geographic characters, early Open-Door policy that started from the two southeast provinces Guangdong and Fujian had the intentions to exploit the locational advantages of the coast, especially their proximity to foreign investors, international markets and sea-based transportation routes. In 1978, the opening up of Chinese economy to international markets began with four Special Economic Zones in Guangdong and Fujian that located right next to Hong Kong and Taiwan. Throughout 1980s and early 1990s, the entire country gradually opened up to foreign investments and trades, starting from coastal provinces and gradually expanding to the central and the west. The progression of the Open-Door policy created policy advantages for the coastal provinces that opened up earlier. In 2000, the Open-Door policy phased out as the entire country was subject to similar policies. At the same time, the central government's focus shifted to the western regions through the Western Development Campaign and designated preferential policies to the west to attract foreign investments.

With these backgrounds in mind, I analyze the patterns of regional inequality among Chinese regions. As it turns out, there is sign of σ-convergence among the provinces during the Reform era, as all three measures, CV, Gini coefficient and Theil Index, of such convergence reach lower level in 2011 than in 1978. Without doubts, there are periods of ups and downs. Degrees of inequality started out high in 1978 and began to decline until reaching the trough in the early 90s. Then inequality among provinces demonstrated a pattern of slight upturn during the 90s and early 2000s. The upward trend terminated around 2005, when all three measures show continuously declining interprovincial inequality. After all, although there is still significant divergence in terms of per capita GDP levels for coastal and inland provinces, the Open and Reform did not cause further dispersion of the gap. The results for testing β-convergence also confirm the fact that although the western provinces lagged behind initially, they are also catching up during the time period. Overall, provinces that started out poor did grow relatively faster than the rich provinces, indicated by highly significant estimated coefficients of the initial per capita GDP level being large and negative. Besides the sub-period from 1992 to 2002 that shows a weak trend of unconditional divergence, during other time periods, the poor provinces grew faster than their rich counterparts. Conditioning on geographic characters, namely average elevations and distance to the nearest coast, the sign for β-convergence is even stronger for the entire 30-year period averaged and for each individual sub-period.

Given the general patterns of regional economic growth, the next step is to analyze how geographic variables help explain such growth patterns. The geographic variables of interest here are distance to the coast, length of coastlines (access to international trades and investments), and average elevation (transportation costs induced by topographic barriers). The results turned out as expected, closer to the coast, longer coastlines and lower average elevation all contribute positively to economic growth for the entire period. Among all, length of coastline alone could explain 20 percent of cumulative growth over the 30-year interval. The explanatory power of geographic variables, however, did not remain stable over time. These variables demonstrated greatest significance for the 1978 to 1991 interval, with the three variables explaining 42 percent of divergence in annualized growth. Looking at each variable individually, length of coastlines was most important for 1984 to 1991 period, while the distance to the coast was most significant for 1992 to 1998 interval, same as the average elevation. Not so surprisingly, the explanatory power and magnitude of impacts for the three geographic variables are all in general trend of decline. Such pattern of declining importance might hint on the fact that thanks to recent development of transportation and telecommunication facilities, the barriers and obstacles caused by natural geographic barriers could be more easily overcome, so that they no longer remain as strong limiting factors of growth. Similarly, as western provinces developed, the locational advantages of the coastal regions are also declining, together with favorable conditions for agriculture production that impose declining impacts.

Although the pure geographic effects' influences are worth noticing, what more interesting is how geographic variables act with policy factors in determining growth variations. The next step of analysis is to decompose coastal dummy with pure geographic effect, measured by distance to the coastline and length of coastlines together with policy effects, represented by policy index that assigns certain weights to the Open-Door policy and the Western Development policy. Confirming the expectations, coastal dummy is quite significant in explaining average growth rates (in cross-section regressions and panel regressions). Such impacts are greater during the earlier stage of the Open and Reform, namely sub-periods from 1978 to 1998. As for the results of decomposing the coast dummy, the entire period averaged results suggest that distance to the coast explains 42.8 percent of total variations, while preferential policy's impact account for 30 percent of the remaining. The relative weights of the two variables in decompositions for sub-periods are clearly not stable, even though the general trend for each variable mirrors that of the coast dummy whose significance and explanatory power peaked during the 1992 to 1998. However, as the policy variable's relative weights in decompositions peaked for 1984 to 1991 interval, the weights for distance to the coast reach the top for the sub-period following. The time gap here suggests that there might be time lag before the geographic factors keep up with the policy initiatives to impose influence on economic growth. The Open-Door policy did in fact promoted the growth of the coastal provinces, facilitating their advantages from geographic endowments. The more recent Western Development preferential policies' impacts on helping the western regions to overcome geographic barriers by providing suitable policy initiatives are yet to be clear, indicated by small magnitude of estimated coefficients on the policy variables for the most recent sub-periods.

Besides disadvantages in long distance to the coast, the western provinces also suffer from high transportation costs due to rugged topography. The policy variable related to topographic features is the construction of transportation facilities. The hypothesis that the impact of topography (average elevation) is declining over time while the significance of transportation infrastructure strengthens turns out to be a partial truth. On the one hand, high average elevation clearly has adverse influence on economic growth, and such impacts are gradually diminishing suggested by the results of the random effect model's analysis. On the other hand, both cross section and panel analyses yield consistent results that length (density) of railroads and roads only have very minimal if not adverse effect on promoting economic growth for the time period. What turns out to be more promising is that longer lengths of highways and navigable rivers do have significant positive impacts on facilitating growth. The estimated coefficients for lengths of highways are rather large, for example, results of cross-section estimation for the entire period averaged suggest that construction of 100 additional kilometers of highways may boost average growth rate by 0.13 percent. As it turns out, the estimated coefficients for the length of navigable rivers are the only set of transportation variables' coefficients that remains positive and relatively significant for the entire period and each sub-period in both cross-section and panel analyses. Such results point out the stable and consistent importance of convenient access to water-based transportation on economic development. Since all navigable rivers in China are oceanic, these rivers together with seaports created a network of water transportation that connects inland regions with international trade routes. Even though we could not reach certain conclusions on the effect of transportation network on economic growth, we could not completely deny the contributions from such investments, as many recent investments are for upgrading existing facilities that are not accounted for in the analysis.

To pool everything together, I adopt the decomposition techniques proposed in the Bloom et al. (1998) article to examine the relative contributions of geography, policy and transportation in explaining growth disparities between the western, central and coastal provinces. The results suggest that geographic factors consistently account for about one third of variations, although average elevation is a much more important factor in the case of western provinces than central provinces. For the remaining two, dispersions in endowments of transportation networks prove to be more important than differences in policy initiatives, as the former contributes to around 45 percent of disparities between the inland and coastal provinces, while the latter explains 22 percent. Comparing western regions with central regions, transportation facilities become even more important in explaining the gap, in particular density of railroads stands out. As for the case of central provinces, since these provinces hardly benefited from any preferential policies throughout, policy factor turns out to be crucial in explaining the gap between central and coastal provinces.

As a whole, the paper begins with a general picture of China's economic growth episodes and regional inequality during the era of the Open and Reform and follows by efforts to identify the sources of variations in growth rates and inequality patterns, focusing on regional differences on geographic features, policy initiatives and infrastructure endowments. The rest of the paper organizes as the followings. Section 2 illustrates physical geographic features of China's regions as well as details and progressions of the Open-Door policy and the Western Development campaign. Section 3 begins with an outline of growth episodes for the last three decades and follows by a discussion on the patterns of regional inequality that analyzes signs of σ and β-convergence. Section 4 focuses on assessing the impacts of geographic variables on variations of cumulative growth throughout the time. Section 5 moves one step further with geographic variables by decomposing coastal dummy with pure geographic effects and preferential policy effects. Section 6 discusses the roles of topographic variables and related transportation infrastructure construction in regional growth. Section 7 decomposes regional disparities of growth rates with geography, policy and transportation factors. Section 8 offers conclusions and future policy implications.

2. Backgrounds: China in Time and Space

2.1 China's Geographic Characteristics

China ranks the third in the world in terms of territory areas with 9.6 million km^2 of land. Majority of the country lies in mid-latitude subtropical and temperate zones, with the southern edge extending to the tropic. China is similar in size and climate to the U.S. but differs greatly in topographic features. Even though China has 32,000 km of coastlines, such access to the sea was concentrated on the eastern part of the country, while the provinces in the west are practically land-locked. Urumqi, municipality of Xinjiang autonomous region, is the farthest municipality to the coast, whose straight-line distance to the nearest coast is 2795 km. The center of the Northwest landmass is 1383 km away from the nearest coastline. Although not as dramatic as the Northwest region, average distance to the coast of the Southwest region still remains as 656 km, comparing with that of the coastal provinces being 86 km (table 1). Such striking difference in distances to sea-based transportation access creates significant diversions in transportation costs and great barriers for the western provinces to participate in trading and commercial activities.

Besides considerable distance to the coast, western provinces' geographic disadvantages also lie in their mountainous topographic characters. As a whole, China's plains and basins at less than 500-meter elevation only account for 25 percent of the total land area, yet mountains and plateaus make up 60 percent. Moreover, there is only 13.5 percent of land area being arable and considerable shares of such agricultural land are in the eastern part of the country[2]. Generally speaking, the topography of China is a three-step staircase stepping down from the Qinghai-Tibet Plateau in the southwest to the coastal belt in the east. Beginning with the 4000-meter-high Qinghai-Tibet Plateau, the staircase proceeds to the mountains and basins in the center that are about 1000 to 2000 meters in elevation, and ends with hilly regions and plains that are below 1000-meters high along the coast. On top of the western regions' high elevation, the area is also extremely mountainous. For example, the southwest region has an astonishing average slope of 5.2 degrees with 14.1 percent of the land area has slope greater than 10 degrees. Combination of the high elevation and rugged topography leads to even greater difficulties in construction of transportation infrastructure,

[2] *China Statistical Yearbook 2005,* NBS 2006

Table 1. Summary of geographic characteristics by regions

Region	per capita GDP growth rate (%)	per capita GDP level in 1978 (yuan/person)	Population density (person/km^2)	Distance to the coast (km)	Slope > 10 (% of area)	Average slope (degree)	Average elevation (meters)	Temperature (degrees)	Rainfall (mm)
Metropolises	8.49	1732	1104	77	1.4	1.2	135	10.9	63
Northeast	9.10	560	138	380	2.2	1.6	314	4.5	50
Coast	11.07	351	333	86	2.6	2.4	267	16.4	103
Central	9.62	276	264	492	2.7	2.4	428	14.9	90
Northwest	9.20	322	46	1383	5.0	2.8	1971	6.8	26
Southwest	9.60	246	126	656	14.1	5.2	1428	16.0	98
Nation	9.68	364	290	547	4.3	2.7	804	12.2	74

Source: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations, average slope and percentage of land area with slope greater than 10 are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions, political boundaries and coastline data from calculating average elevation, average slope, slope>10 and distances to the coast are based on Global Administrative Areas (GADM) dataset. Temperature and rainfall data are based on Démurger et al. (2002).

which nevertheless further increases trading costs and prohibits proliferation of economic activities.

On top of the transportation barriers and scarcity of arable lands created by topographic features, western regions also suffer from less suitable climate in terms of agriculture production. While the eastern provinces enjoy the benefits of monsoonal climates of substantial precipitations and high temperature during the summer and temperate weather in winter, the vast majority of the Northwest region is arid or semi-arid with average annual precipitation as low as 312mm contrasting to 1236mm of the humid coast. In addition, although temperatures in July are universally high across China, average temperatures in January are much more lower in the northern part of the country than in the south. In the end, conditions for agriculture production are also more favorable for the coast than for the west, which further creates geographical dispersions among different part of the country.

2.2 Regional Economic Characters Prior to the Open and Reform (1978)

The location of China's economic center has changed over time as it moving eastward. China's economic productivity has been concentrated around the Loess Plateau and the Yellow River Valley in the northwest until Tang Dynasty (618–907). The original location of the economic center was due to high agriculture productivity of the Yellow River area since the beginning of Chinese civilization and importance of land-based trades. The coastal regions of Jiangsu and Zhejiang gradually took over the bulk of agriculture production during the Tang dynasty and remained the most important economic center ever since. The southeastern coastal region, today's Guangdong and Fujian, was considered to be too humid for residential settlement, hence remained uncultured and sparsely populated in early Chinese history. Prevalence of subtropical diseases such as malaria also checked population growth and gains in labor productivity. Over time, population pressure and frequent invasions by the northern tribes (in particular during the late Tang and Song dynasties, 960–1279) caused population center shifting south into coastal and then southeastern regions. The Yangtze River Valley acquired the role of the new agriculture production and commercial centers by the twelfth century. Guangzhou demonstrated its importance as a trading port in international transactions in Qing dynasty, as the port was the only authorized international trading zone when there was a ban on maritime trades. Story changed after the Opium War in 1840, as the Qing government who lost the war was forced to open five trading ports along the coast, Guangzhou, Xiamen, Fuzhou, Ningbo and Shanghai, to participate in international trades. Later on, western colonial powers forced the government to open more and more trading ports and eventually the entire countries for trades until the Qing dynasty was overthrown in 1911. What followed was nearly 40 years of chaos and wars including wars among warlords, anti-Japanese War and the civil wars, which eventually ended with the foundation of the People's Republic of China in 1949.

The economic policy following the foundation of PRC was nearly 30 years of central planning. Chinese economy was predominantly an agriculture economy where primary industry account for more then 50 percent of total GDP[3]. Economic policies of the central planning periods concerned mainly with self-sufficiency, building-up heavy industry capacity that was largely national-defense orientated. Following the Soviet model in building up the heavy industry capacity, majority of the investments in industrialization during the 50s was concentrated in the Northeast region with relatively good starting points. During 1960s, as Sino-Soviet relations worsened, the central planners headed by Mao Zedong were deeply concerned with the safety of the country's industrial production. To undermine the dangers such that majority of the industrial sites were located along the coast, Mao launched the Third Front project that aimed at building industry production sites "in mountains, in dispersion, and in caves" (by defense minister Lin Biao). During the Third Fifth Year Plan (1966–70), most construction of industrial production sites occurred in the Third Front provinces such as Sichuan and Gansu, when the interior regions took 70.6 percent of the state investments in fixed assets (Yang, 1990). Investments in these third front regions where infrastructure were deficient or almost nonexistence proved to be extremely inefficient. As in 1983, although the interior region possessed 56.8 percent of total fixed assets, it only produced 40.5 percent of national gross value of industrial outputs (Yang, 1990). Regional inequality during the central planning period results mostly from rural-urban income gap, rather than the dispersion between the coast and the inland (Lee 2001; Jian, Sachs, and Warner, 1996). The urban-rural income gap, as it turned out, may largely be attributed to heavy industry orientated industrialization policies (Kanbur and Zhang, 2001).

On the eve of the reform, Chinese economy was still largely agriculture based. Although there was some build-up of industrial capacity, the inefficiency of such investments in the central and western provinces together with stagnation of the coast due to discouragement of investments in the area led to the slow pace of industrialization process. Among the regions, except the three metropolises, Beijing, Shanghai and Tianjin that left other provinces far behind, the Northeast region with traditional advantages in heavy industry production was the leader, followed by the coast and then the central provinces. The southwest region that lacked mineral and oil deposits as the northwest did was at the bottom of the list. Even though the regional inequality of this time period was not largely being

[3] *China Compendium of Statistics 1949 – 2008*, NBS 2009

attributed to interprovincial gaps, the low starting points of the western regions together with their unfavorable geographic endowments created immense barriers for future development.

2.3 The Open and Reform Era

The crux of the Open and Reform era following the Third Plenum of Eleventh Party Congress in 1978 was marketization in the domestic front through deregulation and decentralization as well as the Open-Door Policy in the international front. The domestic reforms began with deregulation of agriculture production by replacing the commune system with the household contract responsibility system in 1978, so that producers regained incentives to expand production. Decentralization of fiscal system granted provinces and local governments more authorities over tax revenues collection and allocations, as central government negotiated tax contract with each province. Besides, there were also reforms in deregulating price systems as well as ownership structures. For the latter, government encouraged individual-owned and rural based, collectively owned town and village enterprises (TVEs) to engage in industrial productions. Some scholars argue that such private or semi-private owned enterprises outperformed state-owned enterprises (SOEs) and became drivers of China's economic growth (e.g. Chen and Feng, 2000).

This study focuses on the Open-Door Policy that gave coastal regions special advantages to attract foreign direct investments (FDIs) and to participate in international trades. The process of opening up started with two provinces, Guangdong and Fujian, through the establishment of four Special Economic Zones (SEZs) in 1978 and 1979 to exploit their proximity to Hong Kong and Taiwan. Then gradually the open zones extended to larger areas, first along the coast and then expanding to inland provinces. The opened zones provided investors with various preferential tax treatments and exemptions from duties and labor regulations[4]. There were four broad stages in the implementation of regional preferential policies (table 2 and figure 4 in appendix):

1. Late 1970s and early 1980s: opening limited to Guangdong and Fujian provinces with the establishments of four SEZs in 1978 to 1980.

2. Middle to the end of 1980s: enforcement of coastal preferential strategy with the designation of Coastal Open Cities (COCs) and setting up of city-based Economic and Technological Development Zones (ETDZs) in 1984; followed by the establishment of Coastal Open Economic Zones (COEZs) in 1985; an Open Coastal Belt (OCB) in 1988; granting Hainan as the largest SEZs in 1988; and the Shanghai Pudong New Area in 1990.

3. Early 1990s: further extension of Open-Door Policy to inland China after Deng Xiaoping's

[4] Earliest version of SEZs' general regulations see "Regulations of Special Economic Zones in Guangdong Province", approved by the fifteen meeting of the Fifty National People's Congress Standing Committee

Table 2. Timeline of Open and Reform preferential policies, 1979-2002

Year of approval	**Type of open zones**	**Location**
1979	3 Special Economic Zones	Guangdong
1980	1 Special Economic Zone	Fujian
1984	14 Coastal Open Cities	Guangdong, Hebei, Jiangsu, Liaoning, Shandong, Tianjin, Fujian, Shanghai, Zhejiang, Guangxi
	10 Economic and Technological Development Zones	Guangdong, Hebei, Jiangsu, Liaoning, Shandong, Tianjin
1985	3 Coastal Open Economic Zones	Pearl River Delta, Yangtze River Delta and Fujian
1986	2 Economic and Technological Development Zones	Shanghai
1988	Open Coastal Belt	Liaoning, Shandong, Guangxi, and Hebei
	1 Special Economic Zone	Hainan
1990	Pudong New Area	Shanghai
1992	13 bonded areas in major coastal port cities	Tianjin, Guangdong, Liaoning, Shandong, Jiangsu, Zhejiang, Fujian, and Hainan
	10 major cities along the Yangtze River	Jiangsu, Anhui, Jiangxi, Hunan, Hubei, and Sichuan
	13 Border Economic Cooperation Zones	Jilin, Heilongjiang, Inner Mongolia, Xinjiang, Yunan and Guangxi
	All capital cities of inland provinces and autonomous regions	
	7 Economic and Technological Development Zones	Fujian, Liaoning, Jiangsu, Shandong, Zhejiang and Hainan
1993	9 Economic and Technological Development Zones	Anhui, Chongqing, Fujian, Guangdong, Heilongjiang, Hubei, Jilin, Liaoning, and Zhejiang
1994	2 Economic and Technological Development Zones	Beijing and Xinjiang
2000	11 Economic and Technological Development Zones	Anhui, Guizhou, Henan, Hunan, Jiangxi, Inner Mongolia, Qinghai, Shaanxi, Sichuan, Xinjiang, and Yunnan
2001	4 Economic and Technological Development Zones	Guangxi, Ningxia, Shanxi, Tibet
2002	2 Economic and Technological Development Zones	Gansu and Jiangsu

Sources: Démurger et al. (2002). Ministry of Commerce: list of national Economic and Technological Development zones(ETDZ) (http://www. mofcom.gov.cn/xglj/kaifaqu.shtml) , 10th, 11th and 12th Five-year plans on the development of ETDZs and Border Economic Cooperation Zones(BECZs) (http://www.mofcom.gov.cn/ article/b/fwzl/201211/201211084 55704.shtml). Xinhua News Agency: special reports on celebrating the 30th anniversary of the Open and Reform (http://www.xinhuanet.com/politics/ggkf30zn/).

South Talks in 1992. In the same years, new open economic zones were officially started in Major Cities along the Yangtze River (MCs), Border Economic Cooperation Zones (BECZs), Capital Cities of Inland provinces and autonomous regions (CCs), more ETDZs and Bonded Areas (BAs).

4. Post-2000: Entire China opened up with the Western Development Campaign, former opening concentrated on major cities of the central and western regions extended to all levels of administrative units; every province had at least one national level ETDZs.

As identified by a great number of studies, preferential policies played important roles in explaining the growth during the reform era (e.g. Mody and Wang 1997, Chen and Feng 2000, and Démurger 2000). Most of the studies found that FDI had an impact on economic growth. However, there were significant regional disparities in terms of FDI received by different regions. Major flows of FDI started to pour in in 1984, when the amount of FDI increased from US$0.9 billion in 1983 to US$1.4 billion in 1984. However, the largest increase occurred following the huge wave of opening up in 1992, as FDI in 1993 soared to US$27.5 from US$11 billion in 1992[5]. Throughout the time, coastal provinces acquired disproportional shares of the total investments. Two forerunners, Guangdong and Fujian, took lion shares of the resources. FDI in Guangdong increased from US$245 million in 1983 to US$542 million in 1984, while that of Fujian increased from US$14 million to US$48 million in the same period. From 1992 to 1996, Guangdong along absorbed more than US$40 billion FDIs, accounting for about 30 percent of the nation's total, while Fujian took US$12 billions, thanks to their close proximity to Hong Kong and Taiwan respectively. As the entire country opened up, more and more FDIs flowed to the central and western regions, which slowly closing the gap formed during 1990s.

2.4 The Western Development Campaign

Realizing the immense and increasing gap between rich coastal provinces and poor western provinces, the State Council created the Leadership Group for Western China Development in January 2000 to organize the Western Development Campaign. The campaign is aimed at promoting the growth of the western provinces and amending adverse ramifications due to the "uneven development strategy" (Yang, 1990) that exploited comparative advantages of the coast but in some sense at the expense of the inland provinces. The main components of the western development project include: infrastructure construction that consists of transportation networks, hydropower plants, telecommunication facilities, etc.; development of advantageous industries such as energy, mining, agricultural processing, and tourism; enticement of foreign investments through preferential policies; promotion of ecological protection and environment regulations; and improvement of public services particularly for those related to education and public health[6].

Infrastructure construction along with significant amount of central government's transfers is one of the central elements of the project. Signature projects include Qinghai-Tibet railroad that was completed in 2006, for the first time connecting Tibet with the rest of the country through railroads, and West-East Electricity and Natural Gas Transfer Project that helps transferring rich energy resources in the west to the energy deficit east. On

[5] *China Compendium of Statistics 1949 – 2008*, NBS 2010

[6] See "Tenth and Eleventh Fifth Year Plan for Western Development" by State Council

Table 3. Details of the Western Development preferential policy

Category	West Qualifications	Policies	Coast and Central Policies
Taxations	Tax rates for encouraged industries[a]	15%	33%
	New transportation, electricity, hydraulic, postal and broadcasting projects	First two years tax-free, next three years 50% of original tax rates	None
	Companies in autonomous regions, approved by provincial government	Domestic firms may be exempt from corporate income tax, foreign firms from the local income tax	None
Land	10-15% of minimum industrial land transfer payment		100%
	Reduce land transfer payment for construction projects on undeveloped lands		None
Mineral Deposits	Foreign firms may be exempt from fees for mineral exploration and mining rights for the first year, and pay 50% for the following two years		None
	Foreign firms may be exempt from mineral resource compensation fees for five years		None
Foreign Investment	Foreign invested commercial projects may have 40-year operation life		30 years
	Foreign invested foreign trade firms may lower registered capital to 30 million yuan		50 million
	Domestic banks' loans to infrastructure and encouraged industries' projects by Chinese-foreign joint and foreign-owned firms may be increased to 120% of Chinese capital and 100% of foreign registered capital, respectively		None

Sources: National Development and Reform Commission, office of Western Development, "State council's announcement on implementing Western Development preferential policies (2000)" (http://xbkfs.ndrc.gov.cn/qyzc/t20090119_257194.htm), 11th and 12th Five-year plans on Western development (http://xbkfs.ndrc.gov.cn/qyzc/t20090118_256835.htm). Xinhua News Agency: Patterns of China's regional economic development, Western Development campaign (http://news.xinhuanet.com/ziliao/2005-11/02/content_3719691.htm).

a. For detailed list of encouraged industries, see "The Catalogs of Encouraged Industries, Products and Technologies", revised and issued by National Development and Reform Commission in 2000 (http://www.sdpc.gov.cn/zcfb/zcfbl/zcfbl2003pro/t20050708_28193.htm).

top of the major projects, the construction resulted in better transportation networks of the western provinces, as total length of highways in western provinces by the mid 2011 reached 18000 km, 7.4 times of 2000 level. For example, transportation density of Sichuan province increased from 0.19 km/km^2 in 1978 to 0.61km/km^2 in 2011, more than three times of previous level (Figure 5 in Appendix).

Another important aspect of the Western Development Campaign is the preferential policies granted exclusively to western regions in order to attract foreign investments (table 3). The policy set is a combination of lowered tax rates, more flexibility and lower costs in land use, lowering administration fees on mining and processing mineral deposits as well as better conditions for obtaining loans. The preferential policies give special emphases on mineral deposits related investments and projects, which follows the idea of exploiting regional advantages of the western regions that lie in abundant mineral and energy resources. Such preferential policies are not as substantial as the deregulations granted to SEZs, yet they are comparable to policies for Bonded Areas in terms of actual benefits to foreign and domestic investors. Different from the previous Open and Reform policy that tried to attract investments for all kinds of industries, the Western Development policies try to direct investments to mineral mining, infrastructure projects and other industries that are either more suitable or most needed for the development of the western regions. In recent years, the amount of FDIs flowing the west experienced fast increasing, rising from US$2.3 billion in 1998 to US$6.6 billion in 2008. The level still could not match with that of the coast, but inherent disadvantages of the west should not be ignored.

Also important for the western region is the fact that vast majority of the ethnic minority population is concentrated among the western provinces. To begin with, all five autonomous regions (Inner Mongolia, Ningxia, Xinjiang, Tibet and Guangxi) are western provinces. The cultural and religious differences in a sense created further barriers in economic development as such distinctions may increase the difficulties of integration and regional communications. To help autonomous regions overcome such disadvantages, central government offers sizable direct transfer payments to these regions and also granted preferential policies targeting ethnic minority population and regions. Recent economic growth of autonomous regions is quite noticeable, as the average annual per capita GDP growth rate from 2001 to 2011 of such regions reached 18 percent[7]. Infrastructure construction represented by length of transportation routes was also relatively rapid, as length of railroads and roads increased at annual rates on average of 4.4 and 7.9 percent respectively for 2001 to 2011 interval[8]. In all, promoting economic growth of the autonomous regions is a critical part of the Western Development Campaign.

3. Regional Growth Episodes and Patterns of Inequality

3.1 Episodes of Economic Growth

During the last three decades, China experienced rapid, almost miraculous growth with per capita GDP in 2011 reaching 35 times of 1978 level thanks to the 9 percent average growth rate (table 4 and 5; figure 2 in Appendix). Seven coastal provinces are the absolute leaders of such growth, whose average growth rates were as high as 11.07 percent. A closer look at the regional growth rates by sub-periods, one would notice that inland provinces, in particular western provinces, are gradually surpassing the coast to lead the recent growth. From 1978 to 1991, coastal provinces quickly took the advantages of their superior locations and preferential policies under the guidelines of the Open and Reform to achieve fast development. While the inland provinces went through the transitions from central planning to market economy and reaching growth rates of 7 percent, the coast was already enjoying

[7] *China Statistical Yearbook 2012*, NBS 2013
[8] *China Statistical Yearbook 2012*, NBS 2013

Table 4. Growth episodes by regions

	1978-83 Medium growth	1984-91 Medium growth, Coast led	1992-98 South led growth	1999-2002 Even medium growth	2003-08 Even high growth	2009-11 High growth, West caught up	1978-2011
Metropolis	7.52	6.52	10.80	8.68	10.01	6.99	8.49
North East	6.73	7.17	9.15	8.56	12.54	12.70	9.10
Coast	9.47	10.18	14.02	8.64	12.19	10.74	11.07
Central	8.19	6.86	10.97	8.89	12.28	12.34	9.62
North West	7.26	7.94	8.40	8.73	12.56	12.20	9.20
South West	8.57	6.71	11.10	8.59	11.54	13.30	9.60
National	8.23	7.80	10.88	8.65	11.95	11.67	9.68
Gap between highest and lowest growth	2.75	3.66	5.62	0.33	2.55	6.31	2.58

Sources: *China Compendium of Statistics 1949 – 2008* (NBS 2010) and *China Statistical Yearbook 2012* (NBS 2013), Aggregated growth rates calculated based on raw data.

Table 5. Growth episodes by provinces

	1978-2011	1978-83	1984-91	1992-98	1999-03	2003-08	2009-11
Metropolis							
Beijing	7.81	7.45	7.53	9.09	8.13	8.55	4.40
Tianjin	9.70	8.02	6.00	11.66	10.23	12.92	11.23
Shanghai	7.96	7.08	6.03	11.67	7.70	8.55	5.33
Northeast							
Jilin	9.91	8.77	7.49	10.03	8.43	13.33	13.50
Liaoning	9.26	5.62	7.98	9.69	8.80	12.80	12.53
Heilongjiang	8.12	5.80	6.04	7.73	8.45	11.48	12.07
Coast							
Guangdong	10.95	7.37	12.43	12.93	8.13	12.35	10.57
Fujian	11.54	10.43	10.29	15.21	7.70	12.30	12.13
Zhejiang	11.91	12.47	11.43	15.29	9.20	11.78	8.13
Jiangsu	11.99	11.22	10.06	15.21	9.83	13.33	11.37
Shandong	11.12	8.83	9.00	14.24	9.80	13.57	10.92
Hebei	9.72	6.50	8.10	13.27	8.55	11.65	9.87
Hainan	10.25	9.50	9.96	12.01	7.25	10.35	12.17
Central							
Henan	10.27	10.17	7.05	12.00	8.48	13.10	11.77
Hubei	10.15	8.67	7.69	11.13	9.70	12.22	13.83
Hunan	9.22	7.77	6.29	9.96	9.40	11.98	12.43
Anhui	9.74	6.45	6.35	12.99	8.40	12.17	14.74
Jiangxi	9.29	7.50	7.66	9.43	8.55	12.03	12.43
Shanxi	9.04	8.62	6.10	10.31	8.83	12.17	8.84
Northwest							
Xinjiang	8.48	8.28	9.36	7.79	6.58	9.42	8.83
Inner Mongolia	11.38	8.00	8.11	10.37	10.30	19.28	14.80
Shaanxi	9.95	6.82	9.39	9.27	9.75	12.93	13.57
Gansu	8.75	5.12	8.51	8.87	8.77	11.28	11.35
Qinghai	8.53	9.63	5.11	6.98	8.79	11.82	12.12
Ningxia	8.10	5.68	7.19	7.14	8.18	10.60	12.50
Southwest							
Yunnan	8.98	8.98	8.41	9.26	6.40	9.63	12.00
Sichuan	10.26	9.78	7.36	10.90	8.83	12.35	15.20
Guizhou	9.02	10.48	7.06	7.43	7.43	10.67	13.90
Guangxi	8.92	6.08	5.78	11.41	7.83	11.77	12.93
Tibet	9.03	8.42	4.30	11.63	10.40	10.88	11.23

Sources: per capita GDP, real per capita GDP growth data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Aggregations are computed based on the raw data.

double-digit growth. The seven provinces' performances were even more astonishing during 1992 and 1998 following Deng Xiaoping's South Talk that led to another wave of openness. In the 1990s, nearly all southern provinces started to take off, including geographically disadvantaged provinces such as Yunnan and Guangxi. The traditionally rich, resource abundant provinces in the northeast and northwest lagged behind. The growth rate diverged dramatically during the time as the fastest growing region grew 5.62 percent fastest average than the slowest one. Then, at the turn of the century, growth rates converged as the policy advantages of the coast phasing out and western provinces caught up. 1999 to 2002 became a short period of medium growth with average growth rate at 8.65 percent, following a longer interval of even high growth, during which the average growth rate was 11.95 percent. For the last three years, western provinces indeed started to boom and took the leading role in economic growth. From 2009 to 2011, the fastest growing southwest region grew 6.31 percent faster than the three metropolises (Beijing, Shanghai and Tianjin), and also 2.56 percent faster than the coast.

3.2 Patterns of Regional Inequality

There is a rich literature on explaining the patterns of China's regional inequality and reasons behind such dispersions. Earlier studies using diverse datasets and methods in 1980s and 90s yielded rather consistent observations about interprovincial inequalities, which say such inequality declined during the 1980s and showed signs of increase in 1990s, while the gap between eastern coast and inland regions enlarged ever since 1980s (e.g. Tsui 1991; Fan 1995; Chen and Fleisher 1996; Jian et al. 1996; Yao and Zhang 2001; Démurger et al. 2002). Recent study by Fan and Sun (2008) extends the analysis to 2006, showing that there was declining inequality since 2004. These studies have also identified a variety of determinants that drive regional inequality. For example, many studies pinpoint the critical roles of factors endowments such as human capital endowment (Chen and Fleisher 1996; Mody and Wang 1997; Chen and Feng 2000), infrastructure (Démurger 2000; Fleisher and Chen 1997) and in particular coastal location (e.g. Chen and Fleisher 1996; Raiser 1998; Kanbur and Zhang 1999; Jian et al. 1996). Another set of articles focus on the role of policies from different perspectives, for example fiscal transfer (Raiser 1998), deregulation of private enterprises (Tsui 1996; Chen and Feng 2000), and Open-Door Policy that attract FDIs (Fan 1995, Kanbur and Zhang 1999; Yang 2002; Litwack and Qian 1998). Studies by Kanbur and Zhang (2005) attributed regional inequality to three key policy variables: the ratio of heavy industry, the degree of decentralization and the degree of openness. The overall trends show that scholars are giving more and more emphases to policy factors.

To analyze the patterns of China's regional inequality, I first test if there was sign of σ-convergence during the last three decades among Chinese provinces. The dataset being used here contains per capita GDP data of all 31 Chinese provinces, including Chongqing and Tibet that are frequently omitted in previous studies (e.g. Chen and Fleisher 1996; Bao, et al. 2002). To analyze σ-convergence, my study employs three commonly used measures, Gini Coefficient (Gini), coefficient of variation (CV) and Theil Index. Since each of the measure has its own limitations, as CV is sensitive to outliers while Gini is unduly influenced by high values, the analysis uses a combination of the three measures following pervious studies on China's regional inequality (e.g. Tsui 1996; Wu 2000; Fan and Sun 2006).

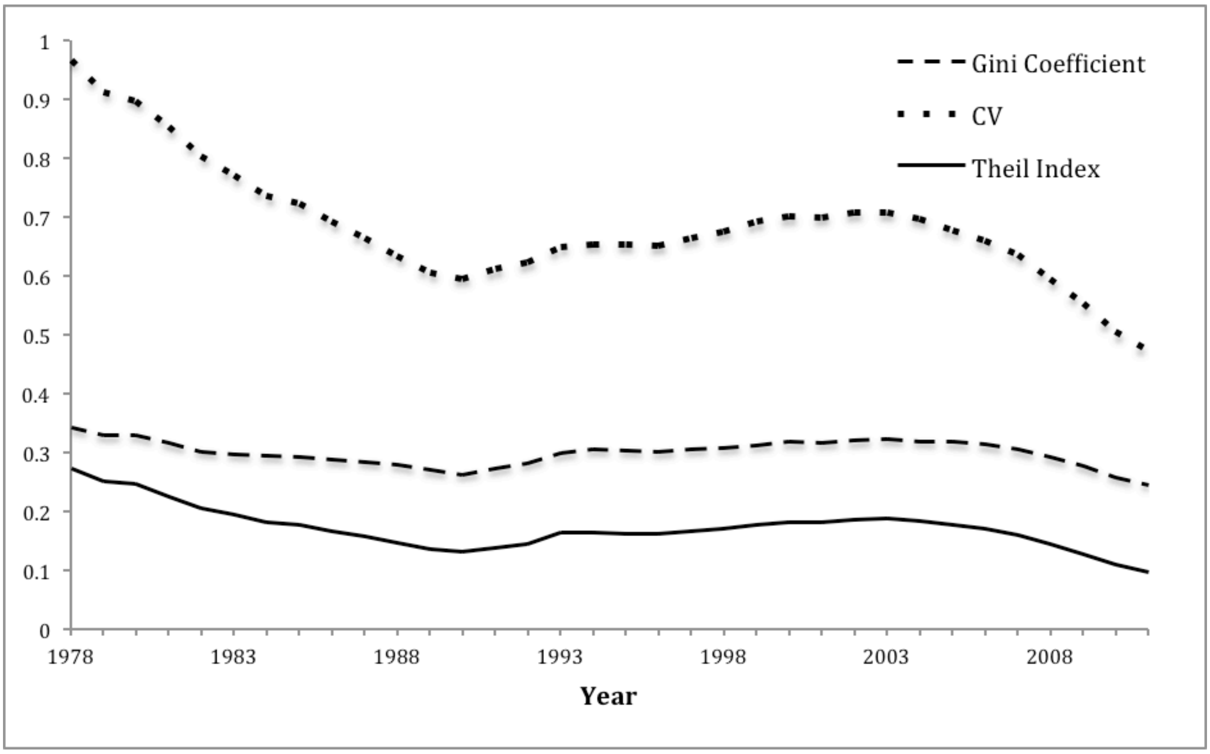

Figure 1. Patterns of regional inequality measured by σ-convergence

Notes: Inequality measures presented are defined as the following, based on Appendix 1 of Fan and Sun (2008).

1. Coefficient of variances (CV) = $\frac{\sqrt{\sum_{i=1}^{N}(y_i - \bar{y})^2/N}}{\bar{y}}$,

where y_i is the per capita GPD of province i; N is the number of provinces (31), and $\bar{y}$ is mean of y_i.

2. Gini coefficient is calculated as $G = \left(\frac{2}{N \cdot \sum_{i=1}^{N} y_i} \sum_{i=1}^{N} i * y_i\right) - 1 - \frac{1}{N}$

where y_i is the per capita GPD of province i arranged in ascending order; N is the number of provinces (31).

3. Theil index is defined as $T(y:x) = \sum_{i=1}^{N} y_i \log(\frac{y_i}{x_i})$

where x_i is the proportion of population of province i to the national population and y_i is the proportion of GDP of province i to the national GDP.

Sources: Calculated based on raw data, where GDP, per capita GDP, real per capita GDP growth and population data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013).

When looking at the inequality patterns by comparing provincial per capita GDP levels, all three measures of inequality, Gini, CV and Theil Index, show similar trends of inequality in the period of 1978 to 2011 (table 6 and figure 1). Degrees of inequality started out high in 1978 and began to decline until reaching the trough in early 1990s. Then inequality among provinces demonstrated a pattern of slight upturn during the 90s and early 2000s. The upward trend terminated around 2005, and then all three measures indicate continuously declining interprovincial inequality. Throughout the entire period, even though there was growing inequality during the peak of economic reforms, degrees of inequality never again restored to the historically high level in 1978. At the end of the period, degrees of

Table 6. Measures of σ-convergence

	Gini Coefficient	CV	Theil Index
Average 1978-83	0.320	0.868	0.233
Average 1984-91	0.281	0.658	0.155
Average 1992-98	0.301	0.658	0.165
Average 1999-02	0.317	0.704	0.185
Average 2003-08	0.312	0.653	0.168
Average 2009-11	0.260	0.510	0.112

Sources: Calculated based on raw data, where per capita GDP, real per capita GDP growth and population data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013).

inequality were 71 percent, 49 percent and 36 percent of 1978 level as measured by Gini, CV and Theil Index, respectively.

The turning points of inequality patterns mirror the policy changes during the opening process, pointing out the significance of policies affecting the growth paths and inter-regional inequality. Starting in late 1978, a series deregulation policies such as household contract responsibility in agriculture and granting greater autonomy to urban enterprises boosted the development of coastal and central provinces, leading to decline in inequality. The declination ceased as coastal provinces experienced miraculous growth following Deng Xiaoping's South Talks in 1992, which not only approved the Open-door policy but also led the way to another weave of opening that benefited coastal provinces disproportionally. Recent years' turn of the inequality pattern to declination was mainly a result of the acceleration of the growth of central and western provinces, which could be the results of preferential policies, vast central government's transfer payments and various major infrastructure projects under the roof of the Western Development Campaign. The growth of western provinces could also be interpreted as a policy-geography story, as new policy measures helped inland provinces overcome geographic barriers characterized by high elevation and long distance to international trade routes, which led to the boom.

Another type of convergence of interest is β-convergence, deriving from the basic idea of the Solow growth model. Since all economies should converge to the same steady state level, initially poor economies should grow faster than the rich to catch up with their growth. Barro et al. (1991, 1992) studies derived methods for estimating β-convergence from the neoclassical model and the empirical analysis on the growth experience of 48 U.S. states confirm the existence of such convergence. Here, I adopt the same technics on 31 Chinese provinces to test if there is sign of any catching up among the poor provinces.

The regression estimates of unconditional β-convergence (table 7) for the entire

1978 to 2011 period show that provinces that started out poor did grow relatively faster than the rich provinces. In fact, the signs of unconditional β-convergence are considerably strong when looking at the results for the entire period as highly significant coefficient for log of initial per capita GDP level as large as -0.013. As for the sub-periods, trends of β-convergence were not consistent. In the early stage of the Open and Reform, that is, from 1978 to 1991, there was catch-up effect among poor provinces, indicating by statistically significant, negative coefficients of initial GDP levels. During the period when the coastal regions boomed, these relatively rich provinces grew so rapidly that further increased the gap

Table 7. Regression estimate results testing β-convergence

	Period	Initial GDP level	Average elevation	Distance to the coast	R^2
Part A: Sub-period					
Eq 1	1978-83	-0.021			0.34
		5.35			
Eq 2	1984-91	-0.014			0.12
		2.85			
Eq 3	1992-98	0.010			0.07
		1.99			
Eq 4	1999-02	0.005			0.05
		1.18			
Eq 5	2003-08	-0.016			0.22
		3.79			
Eq 6	2009-11	-0.035			0.52
		4.21			
Eq 7	1978-83	-0.025	-0.007	0.004	0.53
		4.63	*3.52*	*0.65*	
Eq 8	1984-91	-0.022	-0.002	0.020	0.40
		3.06	*0.6*	*2.99*	
Eq 9	1992-98	-0.000	-0.006	0.009	0.26
		0.07	*3.16*	*1.06*	
Eq 10	1999-02	0.012	0.002	-0.009	0.22
		3.36	*1.09*	*2.29*	
Eq 11	2003-08	-0.018	-0.004	-0.003	0.27
		2.7	*1.72*	*0.36*	
Eq 12	2009-11	-0.040	-0.005	-0.001	0.56
		3.6	*1.16*	*0.16*	
Part B: Entire period					
Eq 13	1978-2011	-0.013			0.39
		5.45			
Eq 14	1978-2011	-0.015	-0.003	0.006	0.62
		5.41	*4.11*	*1.73*	

Notes: Dependent variable is the annualized cumulative growth rate over the indicated period, e.g. for period 1978 to 1984, dependent variable is log(per capita GDP in 1983)/log(per capita GDP in 1978) divided by 6, number of years the interval covers. Initial GDP level is the logarithm of per capita GDP for the first year of each interval indicated. Average elevations are measured in km, distance to the coast = 1/(1+actual distance to the nearest coastline (km)). N = 31 for all periods. Absolute t-statistics in italic and constant terms not reported.
Sources: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions, political boundaries and coastline

data from calculating average elevation and distances to the coast are based on Global Administrative Areas (GADM) dataset.

between rich coastal regions and poor western provinces. The regression estimates also confirm the results, as during 1992 to 2002, there was even a weak sign of divergence. In post-2003 period, as nearly all provinces enjoy similar degrees of deregulation policies launched during the reform yet western provinces obtained additional supports from the central government, the catch-up effect again started, where poorer regions experienced faster growth (as in equation 5 and 6, the estimated coefficients for initial GDP levels are negative and highly significant).

The conditional convergence (table 7) is estimated with conditioning on two geographic variables, average elevation and distances to the nearest coast. Upon conditioning on the two variables, degrees of convergence became stronger for each and every period. For example, the regression estimates for the entire period with geographic variable has highly significant coefficient of initial GDP level being -0.015, an even higher degree than the unconditioned version. In this sense, upon conditioning on average elevation and slope, a province that is 1 percent richer grew 0.015 percent slower annually. Average elevation, as expected, has negative impacts on growth, yet the influence of distance to the coast is also adverse but could not match the level of significance of the elevation features. Similarly for each sub-period, controlling for geographic variables fails to explain reasons of convergence but only strengthens the level of convergence as opposed to the unconditional cases. In addition, the control variables do not change the general patterns of convergence or divergence. During all phases of convergence growth, average elevation had negative influences on GDP growth, while for the short interval at the turn of the century, high elevation seemed to have very small positive effect on cumulative growth. As for distances to the coast, being close to the coast had strong and significant impact on annualized cumulative growth from 1984 to 1991 during which there was also strong sign of conditional convergence. The phenomena could be due to the fact the initial reform policies helped previously not-so-rich coastal regions exploit the new opportunities and catch up with the historically rich northeast provinces (Jilin, Liaoning and Heilongjiang, see table 4 and 5) as well as resources abundant northwest provinces (Inner Mongolia, table 5). Later on, starting from 1999, proximity to the coast began to have minor adverse impact on growth rates, which also accompanied the catching-up of the western provinces. The patterns show that for the recent time periods, growth center is gradually shifting from coastal region to inland central and western regions as these less developed regions gradually catching up.

4.Geography and Economic Growth

With no intentions to think in a geographic deterministic way, scholars still clearly realize the important role that geographic endowment plays in economic development in the world as well as in China. Using cross-sectional country level data for various years, Gallup et al. (1999) study shows that while temperate climate and coastal locations are favorable to economic development, the opposite of such conditions, tropical climate and denial of access to coast or navigable rivers could create immense barriers in development. A famous paper by Bloom et al. (1998) discussing Sub-Sahara Africa's economic growth proved that tropical location, prevalent presence of landlocked conditions and immense distance to developed world's markets created significantly adverse impacts on the continent's growth through channels such as low agriculture productivity, diseases and high transportation costs. In China's case, several studies identified the important role of geography in growth during early stage of Open and Reform. For example, Bao et al. (2002) paper argues that Open-Door policy helped coastal provinces to realize their geographic advantages as coastline length and average elevation could explain 68 and 17 percent respectively of variations in cumulative GDP growth for 1978 to 1997 interval.

To analyze the importance of geographic variables in last three decades' growth, this study follows Bao et al. (2002) model, first comparing the magnitudes of estimated coefficients of each geographic variable for different time periods with cross section regression, and then analyzing the explanatory powers of such variables over time.

The first set of cross-section regressions runs as

$$annual.growth_i = \beta_0 + \beta_1 \log y_{i0} + X * \beta + u_i$$

where y_{i0} is the per capita GDP at the beginning year of each indicated period, X is the set of geographic variables (table 8).

The second set of cross-section regressions aiming at assessing the significance of each geographic variable on explaining variations in annualized cumulative growth rates showing by diversions in R^2 runs as:

$$annual.growth_i = \beta_0 + \beta_1 Y + u_i$$

where Y represents a specific geographic variable of interest (table 9).

The geography variables of interest here are distance to the nearest coast, length of coastlines and average elevation. The former two variables measure a province's accessibility to international trade routes, while the latter is a proxy for the topographic barriers. Since distances to the coast are measured as the inverse of the actual distance, the larger the transformed distance, the closer a province gets to the coast. The transformed distance intends to capture the nonlinear relationship between the distance to the coast and actual growth rates. Other topographic related variables are average slope and percentage of land area with slope greater than certain cutoff (i.e. 10 degrees), which measure the degree of

Table 8. Impacts of geographic features on cumulative growth

	Period	Initial GDP level	Distance to the coast	Length of coastline	Average elevation	R^2
Part A: Sub-period averaged						
Eq 1	1978-83	-0.018	-0.016	0.010	-0.007	0.64
		4.42	*2.14*	*3.91*	*3.59*	
Eq 2	1984-91	-0.016	-0.000	0.010	-0.002	0.55
		2.98	*0.06*	*4.09*	*0.56*	
Eq 3	1992-98	-0.000	0.007	0.001	-0.006	0.26
		0.02	*0.83*	*0.26*	*3.09*	
Eq 4	1999-02	0.012	-0.009	0.000	0.002	0.22
		3.59	*1.97*	*0.20*	*1.07*	
Eq 5	2003-08	-0.018	-0.004	0.000	-0.004	0.27
		2.63	*0.35*	*0.11*	*1.69*	
Eq 6	2009-11	-0.040	0.003	-0.002	-0.005	0.56
		3.59	*0.23*	*0.57*	*1.14*	
Part B: Entire period averaged						
Eq 7	1978-2011	-0.013	0.003	0.003		0.57
		4.79	*0.60*	*2.28*		
Eq 8	1978-2011	-0.014			-0.004	0.57
		5.79			*5.09*	
Eq 9	1978-2011	-0.013	-0.001	0.003	-0.003	0.65
		5.23	*0.16*	*2.39*	*4.17*	

Notes: Dependent variable is the annualized cumulative growth rate over the indicated period, e.g. for period 1978 to 1984, dependent variable is log(per capita GDP in 1983)/log(per capita GDP in 1978) divided by 6, number of years the interval covers. Initial GDP level is log of per capita GDP at the beginning of each period. Distance to the coast = 1/(1+distance to the nearest coastline (km)). Length of coastline measured in 1000 km, average elevation measured in km. N=31, all provinces included. Absolute t-statistics in italic and constant terms not reported.

Sources: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions, political boundaries and coastline data from calculating average elevation, distances to the coast and length of coastlines are based on Global Administrative Areas (GADM) dataset.

"mountainous" of the province. However, the results for these two topographic variables are not presented as they lack explanatory power throughout. The dependent variables of the regressions are annualized cumulative per capita GDP growth rates over the indicated periods. The cumulative growth is calculated as logarithm of per capita GDP for the last year of the period over per capita GDP level in the beginning year and then divided by the number of years the interval spans.

The regression estimations for the entire period averaged results show that controlling for the per capita GDP level in 1978, the annualized growth of a coastal province with average length of coastline (around 640 km) grew 0.48 percent more than an inland province with not coastline on annual base. The aggregate effect of such extra growth is no longer minimal, leading to a 17.67 percent higher cumulative growth rate. As for topographic factor, a province that has average elevation 1000 meters higher than its counterpart would sacrifice another 0.3 percent of annual per capita GDP growth. Considering the fact that western provinces tend to be more distance away from the coastline with higher average elevation, the differences in growth caused by geographic variability become even more significant. In fact, the three geographic variables combine could explain 34 percent of dispersions in terms of annualized cumulative growth rates. More strikingly, length of coastline alone could be accounted for 20 percent of differences, while distance to the coast and average elevation each account for 2.9 percent and 9.9 percent of disparities (table 9).

As distance to the coast functions as an approximation of trade costs, length of the coastline may be viewed as a proxy for the percentage of population with easy access to sea-based trade. The two trade-accessibility-related variables are most significant during the early stage of the Open-door policy, in particular the interval from 1978 to 1991 for the length of coastline. For example, during the sub-period from 1984 to 1991, length of coastline along could explain 37.5 percent of gaps in annual growth among the provinces and a province with typical length of coastline grew 0.64 percent more annually for the eight years than a province with no coastline. Distance to the coast took the lead during 1992 to

Table 9. Significance of geographic variables

Period	**Distance to the coast**		**Length of coastline**		**Average elevation**		**Combined**	
Part A: Sub-period averaged								
1978-83	P-value	0.717	P-value	0.001	P-value	0.042	P-value	0.001
	R^2	0.006	R^2	0.196	R^2	0.096	R^2	0.452
1984-91	P-value	0.082	P-value	0.000	P-value	0.304	P-value	0.000
	R^2	0.122	R^2	0.375	R^2	0.040	R^2	0.407
1992-98	P-value	0.048	P-value	0.111	P-value	0.000	P-value	0.004
	R^2	0.156	R^2	0.099	R^2	0.221	R^2	0.262
1999-02	P-value	0.387	P-value	0.420	P-value	0.437	P-value	0.829
	R^2	0.022	R^2	0.017	R^2	0.029	R^2	0.036
2003-08	P-value	0.114	P-value	0.227	P-value	0.950	P-value	0.445
	R^2	0.071	R^2	0.026	R^2	0.000	R^2	0.092
2009-11	P-value	0.053	P-value	0.043	P-value	0.401	P-value	0.257
	R^2	0.131	R^2	0.073	R^2	0.032	R^2	0.131
Part B: Entire period averaged								
1978-2011	P-value	0.415	P-value	0.002	P-value	0.023	P-value	0.002
	R^2	0.029	R^2	0.200	R^2	0.099	R^2	0.340

Notes: Dependent variable is the annualized cumulative growth rate over the indicated period, e.g. for period 1978 to 1984, dependent variable is log(per capita GDP in 1983)/log(per capita GDP in 1978) divided by 6, number of years the interval covers. Regression equations run as regressing the dependent variable on each geographic variable separately and all combined. Distance to the coast = 1/(1+distance to the nearest coastline (km)). Length of coastline measured in 1000 km, average elevation measured in km. N=31, all provinces included.

Sources: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2009) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation

Data (GMTED2010) 30-arc-second global grid data. Administrative divisions, political boundaries and coastline data from calculating average elevation, distances to the coast and length of coastlines are based on Global Administrative Areas (GADM) dataset.

1998, since the variable not only explains 15.6 percent of provincial variability but also generates 0.66 percent extra annual growth for the coastal region (however, the estimated coefficient of distance to the coast is not statistically significant). The episode coincided with initial launch of the Open-door policy that also aimed at exploiting geographical and locational advantages of the coastal region to promote economic growth of the country as a whole. The distance measurements lost their power since late 1999 as the preferential policy vanished and inland regions also gained more access to international trades.

Average elevation, the indicator for topographic barrier, on the other hand, showed relatively limited impact throughout the time except for the two phases from 1978 to 1983 and from 1992 to 1998. Over the entire growth episode, average elevation could explain 9.9 percent of dispersions. Although the explanatory power of average elevation in sub-period based estimations remain quite limited, the variable showed its power during 1990s by explaining 22.1 percent of variations in annual growth for the interval from 1992 to 1998. The estimated coefficient of average elevation indicated that for the seven-year interval, a province that is 1000 meters higher suffered from 0.6 percent lower annual growth. The large magnitudes of adverse impacts match with the rapid growth of export-orientated industries along the coastal belt during the last ten years of the 20^{th} century. Such industries relied heavily on convenient transportation to seaports for exports. In this sense, barriers created by topography became particularly unconquerable. The pattern of coefficients of average elevation shows that topographic obstacles did induce greater transportation costs, yet such additional costs have been relatively minor and stable over time.

Relating to previous discussion on growth convergence, geography factors, in particular that represented by the distance to the coast, contribute to divergent growth during the 1990s. Central and western provinces' disadvantaged geographic locations as they located far away from sea-based trading ports had severe adverse impacts on their economic growth. On the other hand, all coastal provinces experienced double-digit growth during the time and the average growth rate reached an astonishing level of 14 percent. As a result, both σ and β-divergence increased during the time.

5.Impacts of Geography and Preferential Policy

As noted previously, many studies attribute divergence in regional growth to coastal locations (e.g. Chen and Fleisher 1996; Raiser 1998; Kanbur and Zhang 1999; Jian et al. 1996), yet many more to certain kinds of reform or preferential policies (e.g. Fan 1995, Kanbur and Zhang 1999, 2005; Yang 2002; Litwack and Qian 1998). These studies, however, did not link the two factors together to assess their relative significance. Démurger et al. (2002a, b) moved one step further to decompose the effect of coast dummy into pure geography effect and policy effect with 1978 to 1998 provincial data. The two effects impose different impacts for the western, central and coastal regions, with geographic effect strongest for the coast but policy effect largest for the metropolises. The two papers also established the link between geographic features and FDI, identifying infusion of foreign direct investment as a channel through which geography affected growth.

This section's analysis follows the methods of Démurger et al. (2002) study for cross section analysis and uses a random effect model to analyze 1978 to 2011 provincial dataset. In addition to extension on time coverage to recent years' performance, the analyses also include recent preferential policies granted to western provinces under the Western Development Campaign together with the Open-Door Policy in assessing the importance of the preferential policies.

Geographic features of the coastal provinces are represented by distance to the nearest coast as in the previous section. Policy effect, on the other hand, is measured by a policy index that assigns certain weights to deregulation based, Open and Reform policy for 1978 to 2002 and to investment attracting initiated Western Development policy after 2003. By the time of 2002, nearly all provinces were open to foreign investments and international trades, representing, for example, by at least one Economic and Technological Development Zones and/or one Border Economic Cooperation Zones. Therefore, in terms of degrees of openness for policy purposes, there was no significant variability across provinces. At the same time, central government started to give more and more emphases on inland provinces, especially the western regions. In 2000, a series preferential policies aiming at attracting foreign and domestic investments to western provinces were launched under the general guidelines of Western Development. Hence, starting early 2000, national policy preferences were granted to the western provinces rather than to the east. Therefore, the study uses policy index for Western Development policy for 2003 to 2011 analyses. The creation of policy index follows Démurger et al. (2002) study, which assigns different types of preferential policies different values according to the coverage and strength of the policies. For the Open-Door policy, the weights are given as following in the original study (table 16 in the Appendix for the Open-Door policy index):

Weight = 3: SEZs and Shanghai Pudong New Area

Weight = 2: ETDZs and BECZs

Weight = 1: COCs, COEZs, OCBs, MCs, BAs and CCs

Weight = 0: No open zone

To incorporate the Western Development policy into the same framework, the relative weights of the new policies are distributed as the followings:

Weight = 2: Ethnic minority's autonomous regions[9]

Weight = 1: Subject to Western Development preferential polices[10]

Weight = 0: No preferential policies

By comparing specific details of the two sets of preferential policies, the western regions that could benefit from the policies receive similar degrees of advantages in terms of taxation and land use as the Bonded Areas, hence assigning value 1 to the Western Development policies. Ethnic minority's autonomous regions, on the other hand, received more benefits including larger sum of central government's transfers and direct payments. Also, more industries and business enjoy reduction or exemption of taxations, more flexible land use regulations, etc. Therefore, to accommodate the differences, the scheme assigns weights 2 to these autonomous regions.

5.1 Cross-section Regression Analysis

The cross section regression estimations for this section's decomposition analysis are the following (table 10):

$$avg.annual.growth_i = \beta_0 + \beta_1 \log y_{i,t0} + \beta_2 Coast_i + u_i \quad (1)$$

$$avg.annual.growth_i = \beta_0 + \beta_1 \log y_{i,t0} + \beta_2 Dist\_Coast_i + \beta_3 Policy_i + u_i \quad (2)$$

The dependent variables are annualized cumulative per capita GDP growth rates of each indicated periods at provincial level. $Coast$ is a dummy variable for being a coastal province[11]. $Dist\_Coast$ is the transformed distance between a province to the closest coastline[12]. The transformation method is as noted previously, intends to catch the non-linear relationship between the distance and the growth. $Policy$ is created according to the weights designated to the Open-Door and the Western Development preferential policies. The cross-section regression results are summarized in table 10.

For the last three decades, coastal provinces on average grew 0.96 percent more annually than non-coastal provinces[13], which means that the cumulative growth rate of coastal provinces is 38.38 percent higher. Decompositions of coastal dummy's impacts into

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[9] Five ethnic minority's autonomous regions are: Inner Mongolia, Guangxi, Ningxia, Xinjiang and Tibet

[10] Provinces that are incorporated into the Western Development Campaign are: Inner Mongolia, Xinjiang, Tibet, Yunnan, Guangxi, Guizhou, Sichuan, Chongqing, Shaanxi, Gansu, Qinghai, Ningxia

[11] Ten coastal provinces are: Liaoning, Hebei, Tijian, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi and Hainan.

[12] Dist_Coast is defined as 1/(1+distance to the nearest coastline, measured in km). For coastal provinces, the variable takes value 1.

[13] Average growth rate of coastal provinces from 1978 to 2011 was 10.30 percent and average growth rate of non-coastal provinces was 9.34 percent.

geography and policy factors by regressing annualized 30-year cumulative growth rates suggested that distance to the coast may explain 43 percent of the total variations while

Table 10. Impacts of geography and policy variables on growth rates with cross-section data

	Period	**Initial GDP level**	**Coast dummy**	**Distance to the coast**	**Policy**	R^2
Part A: Sub-period averaged						
Eq 1	1978-83	-0.024	0.011			0.41
		3.00	*1.64*			
Eq 2	1984-91	-0.021	0.021			0.39
		2.96	*3.43*			
Eq 3	1992-98	0.002	0.013			0.16
		0.47	*1.68*			
Eq 4	1999-02	0.011	-0.010			0.17
		2.91	*3.02*			
Eq 5	2003-08	-0.016	-0.000			0.22
		2.48	*0.00*			
Eq 6	2009-11	-0.036	0.002			0.52
		3.33	*0.21*			
Eq 7	1978-83	-0.023		0.009	0.005	0.43
		3.71		*1.11*	*1.58*	
Eq 8	1984-91	-0.022		0.002	0.011	0.43
		2.97		*0.14*	*1.57*	
Eq 9	1992-98	0.002		0.013	-0.000	0.16
		0.31		*1.90*	*0.13*	
Eq 10	1999-02	0.014		-0.006	-0.09	0.28
		4.39		*1.32*	*2.28*	
Eq 11	2003-08	-0.015		0.000	0.001	0.22
		1.75		*0.04*	*0.19*	
Eq 12	2009-11	-0.036		0.002	0.001	0.52
		3.16		*0.25*	*0.24*	
Part B: Entire period averaged						
Eq 13	1978-2011	-0.015	0.009			0.53
		5.08	*2.80*			
Eq 14	1978-2011	-0.015		0.009		0.53
		5.09		*2.82*		
Eq 15	1978-2011	-0.015			0.007	0.51
		5.03			*3.98*	
Eq 16	1978-2011	-0.015		0.006	0.003	0.54
		4.95		*1.24*	*0.97*	

Note: Dependent variable is the annualized cumulative growth rate over the indicated period, e.g. for period 1978 to 1984, dependent variable is log(per capita GDP in 1983)/log(per capita GDP in 1978) divided by 6, number of years the interval covers. Distance to the coast = 1/(1+distance to the nearest coastline (km)). Policy = weights given to preferential policies for tax reductions, deregulations on foreign investments, etc. Policy measures Open and Reform policy prior to 2003 and for the entire period averaged, the variable measures Western Development policy for 2003 to 2011 periods. N=31, all provinces included. Absolute t-statistics in italic and constant terms not reported.

Sources: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions, political boundaries and coastline data from calculating average elevation, distances to the coast and length of coastlines are based on Global Administrative Areas (GADM) dataset. Policy index are created based on Démurger et al. (2002)'s Open-Door policy and specific regulations for the Western development policy, see previous explanations (notes of table 2 and 3).

the policies account for even more, about 30 percent. Controlling for initial per capital GDP level, the two factors may explain 54 percent of dispersions in growth rates. The magnitude of coefficient on coast dummy experienced a process of increase and then decrease, reaching the peak in 1984 to 1991 sub-period estimation (equation 2, note the coefficient is highly significant). Such results indicated that the coastal location was most relevant for the economic growth during the takeoff of the reform. Later on, especially after 2000, coastal provinces no longer stood out in terms of growth rates, so that the estimated coefficients of the coast dummy became minimal in magnitude. The fact that coastal location was more important during the beginning of the reform could be due to the limited degrees of openness as the Open and Reform was first launched in early 1980s. Open zones were mostly constrained to the coastal belt during the decade, which gave the coastal regions apparent advantages. The central role of right policy initiatives in growth could be justified with the decomposition of coastal dummy's effect.

Referring to the decomposition regressions of corresponding sub-periods, estimated coefficients of distance to the coast and policy experienced slightly different trajectories. On the one hand, the magnitude the policy's coefficient peaked for the 1984 to 1991's regression (equation 8), reaching 0.011 and explaining astonishingly 98 percent of variations induced by coastal location (figure 2). The overwhelmingly strong explanatory power of the policy variable shows the critical role of policy initiatives for promoting the growth of coastal provinces, which eventually boosted the development of the country as a whole. On the other hand, the coefficients of distance to coast variable peak for the 1992 to 1998 regression and

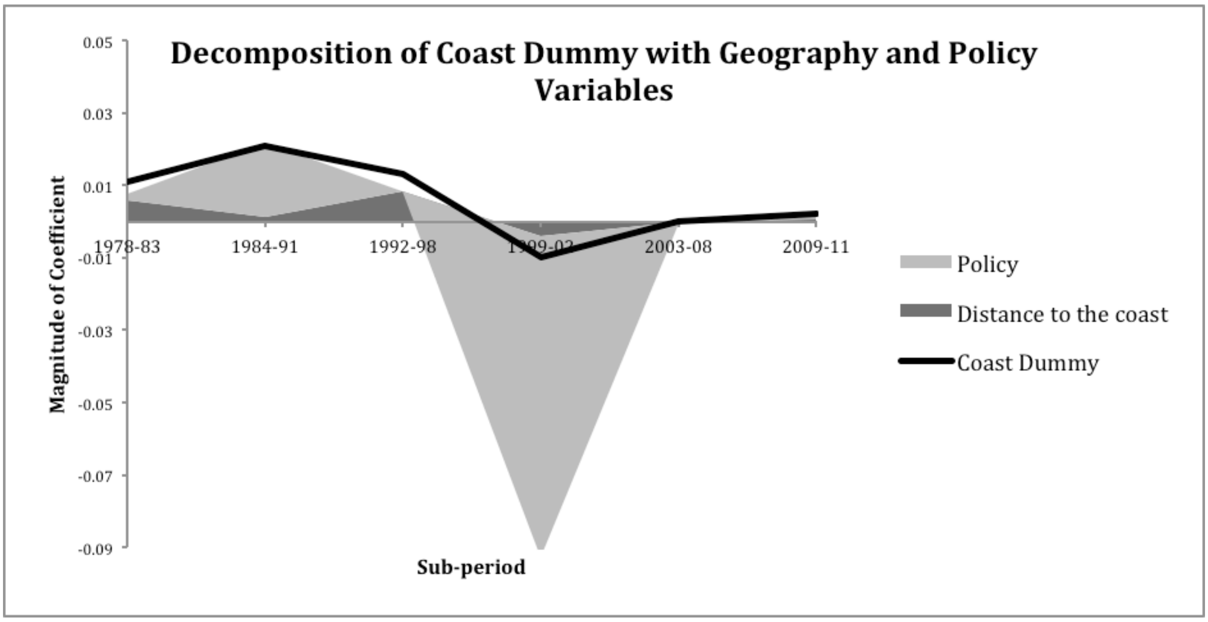

Figure 2. Decomposition of coast dummy with distance to the coast and policy

Notes: calculated based on regression specifications (1) to (12) in table 10. For each sub-period's regression, "coast dummy" takes the values of estimated coefficient in corresponding regression; "distance to the coast" is calculated as the estimated coefficient of distance to the coast in corresponding regression multiply by the difference in transformed distance to the coast between inland provinces and coastal provinces; "policy" is calculated as the estimated coefficient of policy in corresponding regression multiply by the difference in average policy index between inland provinces and coastal provinces. See table 10 notes for sources of raw data.

accounting for 64 percent of variations. The comparison of the two variables indicates that there could be a time lag before geographic advantages being exploited to promote regional economic growth under the right policy settings, yet the preferential policies may act comparatively quick to facilitate growth. After reaching the peak in the 1990s, the estimated coefficients of distance to the coast gradually decrease as western provinces overcome the transportation barriers induced by geographic disadvantages. The curious cases for the policy variable occurred in equation 9 and 10, two regressions that span 1990s. As the slightly negative estimated coefficient on policy is small and insignificant for 1992 to 1998 interval, that for 1999 to 2000 interval is rather surprisingly largely negative (-0.09) and statistically significant. Such phenomena might be coincided with the last large wave of Open-zones' designation along with the initial launching of the Western Development campaign. After 2000, the entire country became open to foreign investments and trades; therefore the three-year interval was a time when the Open-door preferential policy phased out. Consequently, coastal provinces lost advantageous policy initiatives during the time, while western provinces gained. In equation 11 and 12, policy variable takes on values from the Western Development preferential policy's index. For both cases, the estimated coefficients are small, insignificant, but remain positive. Given this fact, it is still too early to either prove or cast doubts on the effectiveness of the new policy set, but at very least the results could not provide motivations to terminate such policy.

5.2 Random Effect Regression Analysis

To exploit the advantages of the panel structure of provincial data sets, I also run the analysis with random effect model. Despite the limitation of the random effect estimation as opposed to the fixed effect, fixed effect estimation cannot be used in this case since all the geographic variables of interests are time-invariant. In order to handle the initial conditions issue with the dynamic panel data, my model follows the method proposed by Wooldridge (2005) that also incorporates initial per capita GDP level. As a result, the random effect model adopted for this section's analysis starts out as the following:

$$annual.growth_{it} = \beta_0 + \alpha_i + \beta_1 \log y_{it0} + X'_{it} + \beta_2 + u_{it} \quad (1)$$

t 1, …, T, T 10, t 1 *covers interval from* 1981 *to* 1983; i 1, …, N, *and* N 31

Dependent variable is annualized cumulative per capita GDP growth in three-year interval starting from 1981. α_i captures province-specific effect. y_{it0} is the per capita GDP level at the beginning year of each three-year interval. X_{it} is the set of time-invariant, exogenous geography variables and also one time-variant policy variable compiled based on the

Open–Door and Western development preferential policy index[14]. However, it is very likely that initial per capita GDP levels of the provinces are dependent on province-specific effect, represent by α_i. Hence, to handle the issue with initial conditions with this panel data, I add per capita GDP level in 1978 as an explanatory variable and write the provincial effect α_i as

$$E[\alpha_i | \log y_{i78}, X_{i1}, \ldots, X_{iT}] = \pi_0 \log y_{i78} + \overline{X'}_i * \pi \quad (2)$$

following the method proposed in Mundlak (1978), where y_{i78} is a province's per capita GDP level in 1978. Plug equation (2) back in (1) get

$$annual.growth_{it} = \beta_0 + \pi_0 \log y_{i78} + \overline{X'}_i * \pi + \varepsilon_i + \beta_1 \log y_{it0} + X'_{it} * \beta_2 + u_{it}$$

$$= \beta_0 + \pi_0 \log y_{i78} + \beta_1 \log y_{it0} + X'_{it} * \beta + u'_{it} \quad (3)$$

Upon controlling for per capita GDP in 1978 as well as per capita GDP level at the beginning year of each interval, the part of provincial effect dependent on initial GDP level could be explained by variations in 1978's per capita GDP level.

The results for random effect model are presented in table 11. Same as the case using cross-section data, the panel data's regression also suggests the positive and statistically significant impact of coastal dummy. The estimated results suggested that being a coastal province could boost annualized growth rate by 1.1 percent, leading to additional cumulative growth over the 30-year period of 38.4 percent. Once confirm the importance of coastal dummy, the next step is to decompose such impact into pure geographic effect and policy initiatives. In equation 2, the regression estimates show the decomposition with distance to

Table 11. Impacts of geography and policy variables on growth rates with panel data

	Initial GDP level	**GDP level in 1978**	**Coast dummy**	**Distance to the coast**	**Coastline length**	**Policy**
Period: 1981 to 2010 with three-year interval						
Eq 1	-0.003	-0.005	0.011			
	0.70	*0.60*	*2.02*			
Eq 2	-0.004	-0.004		0.009		0.004
	0.79	*0.52*		*1.62*		*2.50*
Eq 3	-0.004	-0.001			0.004	0.003
	0.80	*0.14*			*1.65*	*2.49*

Note: Dependent variable is annualized cumulative per capita GDP growth in three-year interval starting from 1981. From 1981 to 2010, there are in total 10 three-year intervals. For each interval, annualized cumulative growth is calculated as log(per capita GDP for the last year of the interval)/log(per capita GDP for the first year of the interval) then divided by 3. Initial GDP level is the logarithm of per capita GDP level for the first year of each interval. GDP level in 1978 is the logarithm of per capita GDP in 1978. Distance to the coast = 1/(1+distance to the nearest coastline (km)). Coastline length measures total length of continental coastlines, in km. Policy = weights given to preferential policies for tax reductions, deregulations on foreign investments, etc. Policy takes value of the Open and Reform policy index prior to 2000, then the variable measures Western Development policy for 2000-10. For the panel data, T=10 for 10 three-year interval and N=31 with all provinces included. Absolute t-statistics in italic and constant terms not reported.
Sources: same as table 10.

[14] For details of explanatory variables, refer to notes and sources of table 11.

the coast and policy, same as that in cross-section regression. The policy variable, in this case, takes value from the Open-door policy index for pre-2000 observations and then from the Western Development index for post-2000 data. Relation between the magnitudes of the coefficients for the two variables mirrors the patterns of cross-section regressions. For this decomposition, distance to the coastline explains 52.6 percent of variations induced by coast dummy, while the policy factor accounts for 18 percent of the gap. Still, pure geography effect gains upper hand in explaining disparities as the case with cross-section regression. Such outcomes show that right policy initiatives need to build on suitable geographic setups in order to impose desired influence on promoting growth. Besides decomposition with distance to the coast, equation 3 decomposes the coast dummy with policy and length of coastline. Since only coastal provinces have coastline, this specification in a sense intends to explore the disparities among the coastal provinces represented by divergence in coastline lengths. For the two variables, 13.5 percent of variations may be attribute to policy factors, while 65.7 percent of dispersions are due to difference in length of coastlines between a coastal province with "typical" coastlines and an inland province with none. Still, geographic variables that measure accessibility to trades, seaports and international markets seem to be more consequential in determining economic growth comparing to preferential policies.

6. Impacts of Geography and Infrastructure

One key part of the Western Development Campaign is vast investments in the western regions' transportation infrastructure construction. The past literature, however, witnesses a debate on the effectiveness of transportation network's development in promoting economic growth. For the case of the U.S., Fogel (1962) argued the economic benefits of the railroads were too small to prove the indispensability of the new transportation means to economic growth of the U.S. in early 1900s, while Huang (2008) also argues that public investments in transportation after 1990 had limited effect on promoting China's growth.

Although some papers argue against investment in transportation facilities, others notice the values of such investments. International examples come from Donaldson (2010) study that shows the success of colonial Indian railroads in promoting growth and Guy (2006) study that demonstrates advancement of interstate highway in the U.S. increase trade activities of counties along the line. Several studies on China's economic development also point out the gains from infrastructure construction (e.g. Mody and Wang 1997, Fleisher et al. 2010). Banerjee et al. (2012) study employs a similar method as Guy (2006) paper and finds that proximity to transportation networks has a moderate positive causal effect on per capita GDP levels across sectors but no effect on per capita GDP growth using county level data.

More specifically, Démurger (2001) assesses exclusively the effect of infrastructure development on growth in China, reaching the conclusion that transport facilities are key differentiating factors in explaining the growth gap and there is a nonlinear and concave relationship for the impact of transport endowment on economic growth.

6.1 Cross-section Regression Analysis

In this section, I want to test the hypothesis that infrastructure construction, namely the development of transportation networks, helps overcome topographic barriers. Figure 4 in appendix illustrates the average elevation and densities of transportation networks in 2011 for each province. To examine the validity of the statement, I look at explanatory power of average elevation and length of various forms of transportation routes on per capita GDP growth rates overtime. The data for lengths of transportation routes are taken from the *China Compendium of Statistics 1949 – 2008* for the period from 1978 to 2008 and data for the period from 2009 to 2011 are collected from *China Statistical Yearbook 2010, 2011, 2012*.

The regression models employed in this section, as previously, are first cross section regression regressing on average per capita GDP growth rate and then random effect regression. The specific regression for cross-section analysis is

$$avg.growth_i = \beta_0 + \beta_1 \log y_{i0} + \beta_2 avg.elev._i + \beta_3 area_i + X'_i * \beta + u_i$$

The dependent variables are annualized cumulative per capita GDP growth rates of each indicated periods at provincial level, and y_{i0} is the per capita GDP at the beginning year of each indicated period. $avg.elev.$ is the average elevation of the province, the topographic variable of interest. $area$ measures the land area of the designated provinces and X is a set of transportation variables that include length of railroads, roads, highways and navigable rivers of a given province. Although I am interested in the density of transportation network, by controlling for land area, length of transportation routes could serve the desired function.

Table 12 presents the results of cross section estimations. To begin with, the regression estimations for the entire period (1978 to 2011) averaged growth rate indicate that topographic barrier, represented by high altitude, did have highly significant adverse effect on growth rate. Moreover, as expected, the adverse effect of high average elevation diminishes once controlling for transportation variables as the magnitude of such influence changed from 0.4 percent lower average annual growth rates (equation 7) to 0.1 percent lower (equation 9) with 1000 meter higher elevation. However, such adverse effect remains statistically significant even if conditions of transportation network are taken into account. Among all variables that measure length of routes, highway and river are the significant ones that contribute to growth (equation 8 and 9). The magnitude of estimated coefficients is worth

Table 12.Impacts of geography and infrastructure variables on growth rates with cross-section data

	Period	Initial GDP level	Average elevation	Railroad	Road	Highway	River	R^2
Part A: Sub-period averaged								
Eq 1	1978-83	-0.022		0.025	-0.002		0.012	0.42
		4.45		*1.06*	*1.05*		*1.74*	
Eq 2	1984-91	-0.009		-0.026	0.003	0.045	0.007	0.25
		1.32		*0.74*	*1.00*	*0.80*	*1.36*	
Eq 3	1992-98	0.011		0.009	0.002	-0.013	0.009	0.30
		1.42		*0.39*	*0.92*	*0.37*	*2.10*	
Eq 4	1999-02	0.002		0.001	-0.002	0.005	0.003	0.31
		0.49		*0.06*	*3.20*	*1.01*	*0.89*	
Eq 5	2003-08	-0.018		0.072	-0.002	0.009	0.004	0.63
		4.09		*2.32*	*2.20*	*1.56*	*0.91*	
Eq 6	2009-11	-0.045		0.070	-0.002	0.000	0.015	0.68
		5.49		*3.03*	*2.47*	*0.01*	*3.95*	
Part B: Entire period averaged								
Eq 7	1978-2011	-0.014	-0.004					0.57
		5.79	*5.09*					
Eq 8	1978-2011	-0.014		0.017	-0.002	0.017	0.006	0.65
		5.47		*0.95*	*3.31*	*3.26*	*2.29*	
Eq 9	1978-2011	-0.003	-0.001	0.001	-0.000	0.013	0.001	0.69
		4.96	*2.30*	*0.26*	*2.27*	*2.46*	*1.99*	
Eq 10	1978-2011	-0.011	-0.004			0.008		0.63
		4.23	*2.52*			*2.16*		
Eq 11	1978-2011	-0.013	-0.005				0.005	0.63
		4.96	*3.05*				*2.82*	

Notes: Dependent variable is the annualized cumulative growth rate over the indicated period, e.g. for period 1978 to 1984, dependent variable is log(per capita GDP in 1983)/log(per capita GDP in 1978) divided by 6, number of years the interval covers. Average elevation measured in km. Railroad = average length of railroads over the indicated period in 1000 km. Road = average length of roads over the indicated period in 10000 km. Highway = average length of highways over the indicated period in 1000 km. River = average length of rivers over the indicated period in 1000 km. All estimations with transportation variables control for land area, of which the estimated results are not reported. N=31, all provinces included. Absolute t-statistics in italic and constant terms not reported.

Sources: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions and political boundaries data from calculating average elevation are based on Global Administrative Areas (GADM) dataset. Lengths of transportation routes (railroads, roads, highway and navigable rivers) and areas at provincial level are collected from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013).

noticing, as construction of 100 additional kilometers of highway could boost overall annualized average growth rate by 0.13 percent. The strong explanatory power of rivers is deeply connected with the fact that most rivers in China are oceanic, longer length of navigable rivers in some sense reduce the distance from the province to the coast. What turns out to be striking is that lengths of railroads and roads have very limited explanatory power on average growth rate, if not adverse impacts. Such outcomes might be due to the fact that since Chinese government traditionally emphasized on railroad and road construction starting in 1900s, most provinces were already equipped with comparatively dense railroad and ordinary road networks at the beginning of the reform. Hence, for railroads and roads, what matter more is the quality, rather than the quantity.

Turning to the explanatory power of transportation variables in the sub-period estimations, different forms of transportation gained upper hands for different time interval. Surprisingly, the magnitude of estimated coefficients for length of railroads increased overtime and became significantly positive after 2000. Since most of the railroad construction after 2000 occurred in western provinces and these provinces are also catching up in the last decade (e.g. the Qinghai-Tibet railroad in 2006 that first connected Tibet to railroad network), such results hint on the facilitating role of the newly constructed railroads on these provinces' development. On the other hand, length of roads fails to possess meaningful explanatory power and for 1999 to 2008 interval, the variable even has small negative coefficients (statistically significant in equations 4 to 6). Last decade was a time when the central government pushed "Cuncun Tong" (link every village with roads and electricity network) heavily. As a result, quite a lot of village roads were constructed during the time. The negative coefficients might in some sense cast doubts on the effectiveness of the project. Similarly, the impact of length of highways has been fluctuating, despite its significance in explaining average growth rate of the entire period. The relatively large magnitude estimated coefficient for length of highways for 1984 to 1992 and 2003 to 2008 regressions (equation 2 and 5, coefficients for highway are 0.045 and 0.009) might result from the scarcity of highway in 1980s and waves of highway construction in 2000s. Since the first highway in China was not being built until 1984, during the 80s, highways were still largely confined in coastal provinces or surrounding the municipalities of the provinces. Such distribution pattern coincides with the high growth episode of the coastal region following a wave of openings in 1984. Length of navigable rivers is the only transportation variable whose estimated coefficients remain positive for all sub-periods and also statistically significant for majority of the estimates. More importantly, the magnitude of the coefficients is not minimal comparing to others (ranging from 0.003 to 0.012), which further demonstrates the importance of navigable rivers in economic development despite rapid constructions of other transportation facilities. Looking at the transportation variables altogether, the explanatory power of these variables is increasing over time, as for the last three-years, these variables together with initial per capita GDP could account for 68 percent of total variations in growth disparities.

6.2 Random Effect Regression Analysis

Following section 5.2's logic, I also adopt previous random effect model to exploit the advantages of the provincial dataset. The model runs as the following:

$$annual.growth_{it} = \beta_0 + \beta_1 \log y_{it0} + \beta_2 \log y_{i78} + \beta_3 avg.elev._i + \beta_4 area_i + X'_{it} * \beta + u_{it}$$

Dependent variable is annualized cumulative per capita GDP growth in three-year interval starting from 1981. y_{it0} is the per capita GDP level at the beginning year of each three-year interval and y_{i78} is per capita GDP level for the province in 1978, starting year of the analysis. $avg.elev._i$ is the average elevation of the given province and $area_i$ is the land area of the province. By controlling for land areas, the regression estimation estimates the effect of changing density of transportation network. However, the estimated coefficients for $area_i$ are not reported. X_{it} is a set of transportation variables, including lengths of railroads, roads, highways and navigable rivers. These transportation variables are time variant and show quite significant variations overtime.

The results of regression with the random effect model are summarized in table 13. As expected, high average elevation has adverse effect on economic growth, whether or not controlling for transportation variables (equation 1, 2, 4 and 5). More importantly, the negative consequences are mostly statistically significant, matching the cross-section results. Taking transportation variables into account certainly help alleviate the adverse effect of topographic barriers (high average elevation) on annual growth, as the coefficient of interest

Table 13. Impacts of geography and infrastructure variables on growth rates with panel data

	Initial GDP level	**GDP level in 1978**	**Average elevation**	**Railroad**	**Road**	**Highway**	**River**
Period: 1981 to 2010, with three-year interval							
Eq 1	-0.004	-0.007	-0.004	0.005	-0.004	0.016	0.001
	0.66	*1.10*	*1.19*	*1.15*	*1.10*	*0.89*	*1.29*
Eq 2	-0.003	-0.004	-0.006				
	0.72	*0.53*	*2.36*				
Eq 3	-0.005	-0.006		0.006	-0.004	0.017	0.001
	0.70	*1.05*		*1.57*	*1.23*	*0.98*	*1.58*
Eq 4	-0.004	-0.008	-0.008		-0.002	0.013	
	0.62	*1.26*	*2.24*		*0.88*	*0.78*	
Eq 5	-0.004	-0.002	-0.007				0.001
	0.78	*0.28*	*2.03*				*1.40*

Notes: Dependent variable is annualized cumulative per capita GDP growth in three-year interval starting from 1981. From 1981 to 2010, there are in total 10 three-year intervals. For each interval, annualized cumulative growth is calculated as log(per capita GDP for the last year of the interval)/log(per capita GDP for the first year of the interval) then divided by 3. Initial GDP level is the logarithm of per capita GDP level for the first year of each interval. GDP level in 1978 is the logarithm of per capita GDP in 1978. Average elevation measured in km. Railroad = average length of railroads over the indicated period in measured1000km. Road = average length of roads over the indicated period in measured 10000km. Highway = average length of highways over the indicated period in measured 1000km. River = average length of rivers over the indicated period in measured 1000km. All regressions that involve transportation variables control for area of the province, for which the estimated coefficients are not reported. For the panel data, T=10 for 10 three-year interval and N=31 with all provinces included. Absolute t-statistics in italic and constant terms not reported.
Sources: same as table 12.

declined from -0.006 to -0.004 and also became a lot less significant. Meanwhile, the impacts of transportation variables on growth are more variable. Similar to cross-section regression outcomes, length of roads has small but negative estimated coefficients (equation 1, 3 and 4), while length of railroads has positive but also small effect on growth (equation 1 and 3). On the other hand, length of highways and length of navigable rivers have positive impacts on cumulative growth. When comparing the two, the coefficients for highway are more than ten times larger than that of the length of navigable rivers, yet length of highways is less significant than that of rivers (equation 1 and 3). Such patterns could be due to the facts that firstly, total length of highways could not match with that of the navigable rivers, consequently, one additional kilometer of highway becomes more influential than rivers; secondly, navigable rivers represents accessibility to water-based networks created by seaports and inland rivers that link the hinterland to coastlines, which is still essential to international trades. These results for random effect estimations are largely consistent with the results obtained through cross-section analysis.

Comparing with limited if not adverse effect of roads, the importance and influence of highway in some sense point out that it is not merely the density, or the quantity of transportation facilities that matters, quality is also a crucial factor. In this sense, it might be equally important to maintain the quality of existing roads as to build new roads. The same logic applies to other means of transportation as well. For the last decades, one important element in construction of transportation infrastructure is to upgrade existing routes, including railroads and navigable rivers. One limitation of the analysis here is that it is hard to account for the improvement in the quality of these networks. However, the importance of highway comparing to the ignorable effect of roads demonstrates the necessity to incorporate such differences in analysis.

7. Decomposition of Regional Growth Disparities: Geography, Policy and Transportation

The main purpose of this section is to tie-up previous discussions on geography and policy as well as topography and transportation by decomposing growth disparities with geographic, policy and transportation variables. The method of decompositions follows that proposed in Bloom et al. (1998) paper on economic development of Sub-Sahara Africa in relation to geography and demography. To begin with, I run a pooled cross-section regression analysis with all variables of interests, results summarized in table 14. For the purpose of pooling results together, all length of transportation routes are transformed into densities of certain facilities, measured by km per square km, and the density of transportation networks

Table 14. Cross-section regressions with pooled geographic, policy and transportation variables

	Initial GDP level	**Average elevation**	**Distance to coastline**	**Length of coastline**	**Policy**	**Density of transportation networks**	**Density of railroads**	**Density of roads**	**Density of highways**	**Density of navigable rivers**	R^2
Period: 1978 to 2011											
Eq 1	-0.015	-0.004				0.004					0.57
	4.32	*2.55*				*0.32*					
Eq 2	-0.015	-0.003	0.003		0.003	0.001					0.63
	4.38	*2.01*	*0.57*		*0.86*	*0.01*					
Eq 3	-0.014	-0.003		0.003	-0.001	0.001					0.65
	4.13	*1.90*		*1.61*	*0.21*	*0.11*					
Eq 4	-0.015	-0.002	0.004		0.004		0.226	0.001	-1.158	0.040	0.64
	2.82	*1.02*	*0.58*		*0.92*		*1.21*	*0.42*	*0.97*	*0.88*	

Note: Dependent variable is the annualized cumulative growth rate over the indicated period, e.g. for period 1978 to 1984, dependent variable is log(per capita GDP in 1983)/log(per capita GDP in 1978) divided by 6, number of years the interval covers. Distance to the coast = 1/(1+distance to the nearest coastline (km)). Policy = weights given to preferential policies for tax reductions, deregulations on foreign investments, etc. Policy measures Open and Reform policy for the entire period averaged index. Average elevation measured in km. Density of transportation networks = average lengths of all transportation routes (railroads, roads, highways, rivers)/total area of the province, measured in km/km^2. Density of railroads = average total length of railroads/total area of the province, measured in km/km^2. Density of roads = average total length of roads/total area of the province, measured in km/km^2. Density of highways = average total length of highways/total area of the province, measured in km/km^2. Density of navigable rivers = average total length of navigable rivers/total area of the province, measured in km/km^2. N=31, all provinces included. Absolute t-statistics in italic and constant terms not reported.

Sources: per capita GDP data at provincial level are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions, political boundaries and coastline data from calculating average elevation, distances to the coast and length of coastlines are based on Global Administrative Areas (GADM) dataset. Policy index are created based on Démurger et al. (2002)'s Open-Door policy and specific regulations for the Western development policy, see previous explanations (notes of table ? and ?) Lengths of transportation routes (railroads, roads, highway and navigable rivers) and areas at provincial level are collected from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013).

is the sum of total lengths of all transportation routes over the land area. It is reasonable to argue that highways should take higher weights than roads in general, but since it is hard to determine specific weights attributed to each facility, all types are treated equally.

Now take a closer look at the results. As expected, estimated coefficients for average elevation consistently show negative signs, regardless what other variables are controlled for. When looking at topography and density of transportation network along, the impact of average elevation is still quite large. As for density of transportation networks, quite disappointingly, the variables fail to demonstrate expected degrees of influence or explanatory power. The estimated coefficients were small and insignificant although always remain positive (ranging from 0.001 to 0.004 in equation 1 to 3). Equation 4 estimates the contribution of each type of transportation facility on growth. While density of railroads, roads and navigable rivers, three traditional transportation means, all have positive impacts on economic growth as hoped, the estimated coefficient for density of highways is curiously negative and large in magnitude, although still insignificant. The large magnitude could be due to comparatively low density of highway networks, but the negative sign is quite contradictory to common knowledge. One reason of the negative signs could be due to the fact that highway networks are particularly dense in three metropolis (Beijing, Tianjian and Shanghai) that actually grew relatively slow comparing to not only coast belt but also western regions because of their high starting points. Similarly, although densities of highways are extremely low in western regions, these provinces did not grow as slow. On the contrary, western regions are surpassing the coast in recent years. Therefore, with these quasi-outliers that grew disproportionally slow (or rapid), density of highways ends up with negative sign. Distances to the coast and length of coastlines, two variables that characterize location factor, both have positive but small impact on growth, helping to explain the gap between inland provinces and coastal provinces. As for policy factor, the variable shows positive influence when regressing with distance to the coastlines and negative but insignificant impact when acting as a right-hand-side variable along with length of coastline. Behaviors of policy variable are mostly consistent with previous cross-section and panel analysis.

Using the pooled results, most specifically, specification given by equation 4 in table 14, I decompose the disparities in average annual growth rates between western, central as well as inland provinces and coastal provinces with two geography (average elevation and distance to the coast), one policy and three transportation variables (densities of railroads, roads and navigable rivers). The results for decompositions are presented in table 15. For the

Table 15. Decomposition of growth disparities

	Impact on growth disparity between coastal provinces and					
	Central provinces		**Western provinces**		**Inland provinces**	
Variable	Percent	Percentage point	Percent	Percentage point	Percent	Percentage point
Geography	33.63	-0.444	33.73	-0.732	33.86	-0.595
Average elevation	3.47	-0.046	16.99	-0.369	12.24	-0.215
Distance to coastline	30.16	-0.398	16.74	-0.363	21.62	-0.380
Policy	29.62	-0.391	16.83	-0.365	21.42	-0.376
Transportation	36.85	-0.485	49.45	-1.073	44.82	-0.788
Density of railroads	11.82	-0.156	19.69	-0.427	16.60	-0.292
Density of roads	7.11	-0.094	15.74	-0.342	12.74	-0.224
Density of navigable rivers	17.82	-0.235	14.01	-0.304	15.49	-0.272
Total disparities	100.1	-1.319	100.01	-2.170	100.1	-1.758

Notes: Decompositions based on equation 4 of table 15. Policy takes on the values of the Open and Reform policy index only. All time-variant independent variables are derived by taking the average of 1978 to 2011 values. For the definitions of densities of transportation variables see notes of table 15. Coastal provinces include Liaoning, Hebei, Tianjin, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong and Hainan; central provinces include Heilongjiang, Jilin, Beijing, Henan, Hubei, Hunan, Anhui, Jiangxi, Shanxi and Chongqing; Western provinces include Inner Mongolia, Xinjiang, Xizang, Yunan, Guangxi, Guizhou, Sichuan, Qianghai, Ningxia, Gansu and Shaanxi; inland provinces combine central and western provinces. The observed disparities in average growth rates of the period between central and coastal provinces are 0.97 percentage points, 1.18 percentage points between western and coastal provinces, and 1.08 percentage points between inland and coastal provinces. Individual components may not add up to 100 percent due to rounding.

gap between central provinces[15] and coastal provinces, the two geographic variables contribute to 33.63 percent of dispersions, with distance to the coast (30.16 percent) much more influential than average elevation (merely 3.47 percent). From geographic perspective, what sets the two regions apart is access to seaports. Meanwhile, policy variable explains 29.62 percent of the gap and transportation variables take care of the remaining 36.85 percent. The reason for the policy variable not as important as the two might be due to the fact that although coastal provinces took the lead in opening-up to foreign investments and trades, central provinces quickly followed during the second and third waves of opening in 1984 and 1992. Also, both regions are not subject to western development policies. Among transportation variables, densities of navigable rivers take the lead, explaining 17.82 percent of the gap. Because of relatively low average elevation and flat topography, the geographic barriers in constructing railroads and roads are not so much more significant than that of coastal belts. Hence, density of navigable rivers becomes the differentiating factor of the two regions.

Decomposition of the growth gap between western provinces and coastal provinces

[15] Central provinces do not have coastlines and also do not enjoy the benefits of Western Development policy.

demonstrates a quite different pattern. Although geographic factors still account for about one third of total variations (33.73 percent), topographic barriers become much more important in this case, as average elevations explain 16.74 percent of the differences. Considering the fact that topography of the western regions is dominated by large plateau and mountain ranges, the central role of elevation appears more apparent. Comparing with central provinces, the policy variable shows less significant explanatory power, most likely due to recent Western Development campaign that provides policy initiatives to these provinces. Another reason why the policy variable is not as crucial could be because of the Border Economic Cooperation Zones designated in 1992. These open-zones offered western regions unique opportunities to engage in international economic activities. As for the transportation variables that altogether explain nearly 50 percent (more precisely 49.45 percent) of the gap, even though the three types of facilities have similar explanatory power, density of railroads takes the lead (19.69 percent). The importance of railroads in this case is most likely due to the scarcity of railroads comparing to the coastal and central provinces, especially among Tibet, Xinjiang and Qinghai where railroads only have minimal presences until very recent, creating immense gap from the coast.

Simple comparison of decomposition results of central and western provinces points out different future policy implications for promoting the growth of the two regions. Since central provinces have been traditionally omitted from various forms of preferential policies, to boost the development of these provinces, a direct choice could be design suitable preferential policies that are unique and specific to the region in order to exploit the regional comparative advantages. As for the case of the western provinces, noticing the central role of transportation facilities, future Western Development campaign could continue with the current path to further build up infrastructure foundations of the region.

8. Conclusions and Policy Implications

This paper investigates the role of geographic characters in combination with preferential policies and transportation infrastructure respectively in explaining variations in economic growth and regional inequality. For the two categories of geographic variables, closeness to coastlines exhibited positive impact on economic growth and such effects were more crucial during the earlier phases of the Reform; high elevations created obstacles on economic growth, yet such adverse impacts were declining over time. These results are consistent with previous studies on geography and growth, further proving that geographic endowments should not be overlooked in analyzing regional growth. As for the contribution of preferential policies, the Open and Reform did achieve the goal of boosting the growth of the open zones, for which the coastal area benefits disproportionally. The Western Development policy that created more favorable conditions for investments in the western provinces did not demonstrate significant positive influence on promoting the growth of western regions yet. Lastly, the transportation variables, in particular the more basic railroads and roads, failed to exhibit desired level of significance and their impacts were also not increasing over time. Slightly more promising results are that the highways were serving facilitating roles in growth and the significance as well as positive impacts of navigable rivers was consistent throughout the time. In the very end, the decompositions of growth disparities suggest that geography along could explain about one third of coast-inland gap, while policy and transportation account for one fifth and two fifth respectively.

The results presented above hint on the necessity of accommodating regional economic policies with local geographic features. The success of the Open-Door policy suggests that right policy initiatives could incentivize the region to exploit its geographic advantages in order to boost economic development. Noticing that there is a time lag between the policies being implemented and geographic characters starting to make impact, the policy initiatives should last long enough for geographic variables to realize their influences. As the central government now focusing on the development of the western regions, preferential policies to these regions should not only cover basic benefits such as tax exemptions, but should also explore specific geographic characters to incentivize the development of advantageous industries and specialized products.

Although this paper could not prove the effectiveness of transportation networks in promoting growth, there are no reasons to conclude that investments in such infrastructure are useless in growth promotion. In fact, the decomposition exercise shows that transportation facilities actually play extremely important roles in explaining the growth disparities between the western and coastal provinces. One limitation of this paper's analysis is that the dataset could only incorporate quantities, namely length, of transportation routes but not the quality of these facilities. Given the fact that a number of recent constructions actually focus on upgrading existing routes rather than building new routes, the effect due to improving quality should also be accounted for. The importance of quality as opposed to quantity could be partially proved by the significance of high quality roads, highways versus that of the roads. In this sense, future construction on transportation infrastructure should at least consider two problems: first, where the new routes should be build to maximize returns on promoting development; second, whether it is better to build new facilities or simply upgrading existing routes that is actually more cost-efficient in yielding similar outcomes.

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Appendix

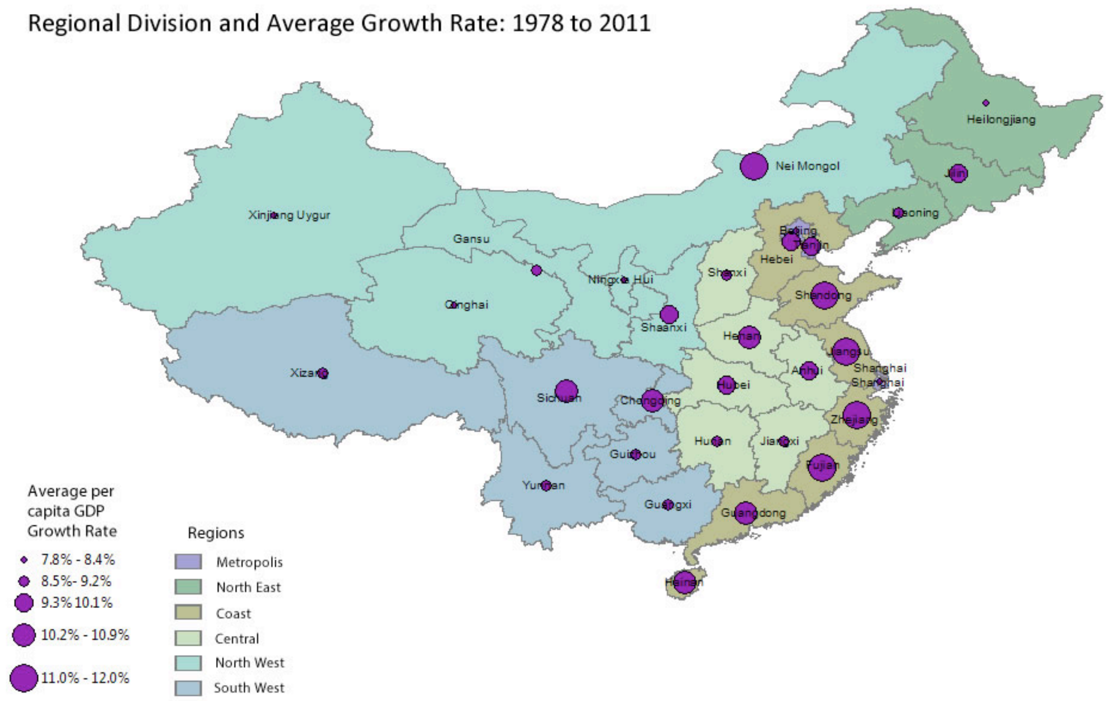

Figure 3. Provincial growth rates and regional divisions

Sources: base GIS map with provincial level administrative divisions from Global Administrative Areas (GADM) dataset. Per capita GDP growth rate are taken from *China Compendium of Statistics 1949 – 2008* (NBS 2010) for year 1978 to 2008, data for 2009 and after are collected from *China Statistical Yearbook 2012* (NBS 2013). Regional divisions based on divisions in 12th Five-year plans on regional economic growth.

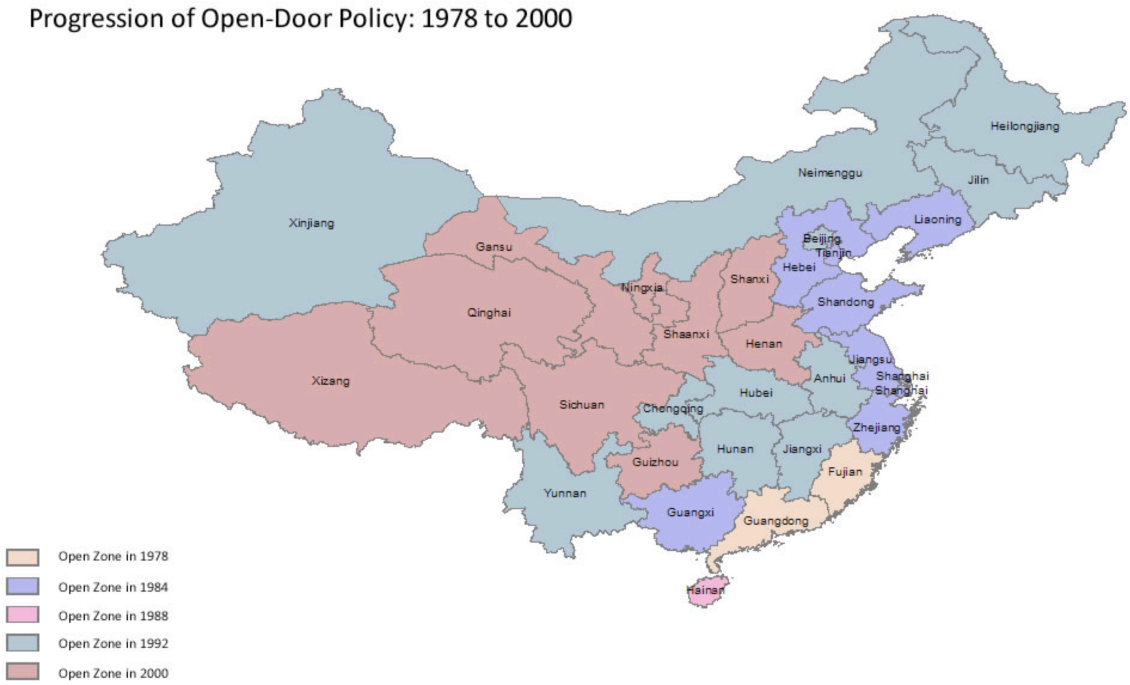

Figure 4. Progression of Open-door Policy: 1978 to 2000

Sources: base GIS map with provincial level administrative divisions from Global Administrative Areas (GADM) dataset. Progression of Open-door policy based on: Démurger et al. (2002). Ministry of Commerce: list of national Economic and Technological Development zones(ETDZ) (http://www.mofcom.gov.cn/xglj/ kaifaqu.shtml) , 10th, 11th and 12th Five-year plans on the development of ETDZs and Border Economic Cooperation Zones(BECZs) (http://www.mofcom.gov.cn/ article/b/fwzl/201211/201211084 55704.shtml).

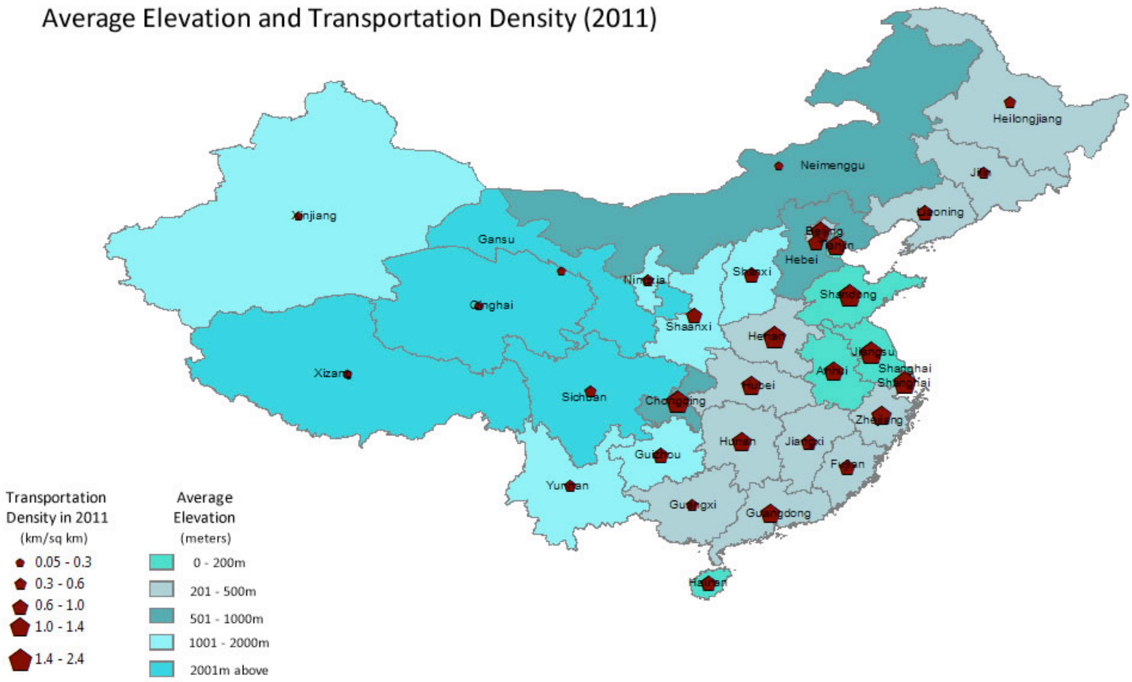

Figure 5. Average elevation and Transportation density

Sources: base GIS map with provincial level administrative divisions from Global Administrative Areas (GADM) dataset. Average elevations are calculated with ArcGIS using Global Multi-resolution Terrain Elevation Data (GMTED2010) 30-arc-second global grid data. Administrative divisions and political boundaries data from calculating average elevation are based on Global Administrative Areas (GADM) dataset. Lengths of transportation routes (railroads, roads, highway and navigable rivers) and areas at provincial level are collected from *China Statistical Yearbook 2012* (NBS 2013).

Table 16. Open and Reform preferential policy index (1978-2003)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Avera
Anhui	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2	0.
Beijing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	0.
Chongqing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	0.
Fujian	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2.
Gansu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	0.
Guangdong	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2.
Guangxi	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	1.
Guizhou	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	0.
Hainan	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1.
Hebei	0	0	0	0	0	0	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.
Heilongjiang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0.
Henan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0.
Hubei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2	2	2	2	2	2	0.
Hunan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0.
Jiangsu	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.
Jiangxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0.
Jilin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	0.
Liaoning	0	0	0	0	0	0	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.
Inner Mongolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0.
Ningxia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	0.
Qinghai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	0.
Shaanxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	0.
Shandong	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.
Shanghai	0	0	0	0	0	0	1	1	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2.
Shanxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	0.
Sichuan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	0.
Tianjin	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1.
Xinjiang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0.
Xizang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	2	2	2	0.
Yunnan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0.
Zhejiang	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	1.

Sources: Specific designations of the open zones see table 2, timeline of the Open-door policy as well as sources of the table. Assignments of weights follow the scheme proposed in Démurger et al. (2002).