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Innovation and Interprovincial Income Inequality in China

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Innovation and Interprovincial Income Inequality in China

Abstract
China’s recent economic growth has turned the country into one of the major players in the global economy, however uneven distribution of its benefits has undermined social cohesion of the country and led to outburst of civil unrest. This paper explores to what extent can innovation and its diffusion help the provinces achieve within-region convergence on income. The study employs Two-Stage Least Squares and Spatial Durbin Models to elucidate differentiate the importance of different types of innovation on inter-provincial income inequality. The results emphasize the importance of innovation, rather than invention, for convergence of income, and underscore the harmful effect of migration restrictions.

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LAKE FOREST COLLEGE

Senior Thesis

Innovation and Interprovincial Income Inequality in China

by

Anna Shcherbiak

April 26, 2017

The report of the investigation undertaken as a Senior Thesis, to carry two courses of credit in the Department of Economics, Business, and Finance

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Abstract

China’s recent economic growth has turned the country into one of the major players in the global economy, however uneven distribution of its benefits has undermined social cohesion of the country and led to outburst of civil unrest. This paper explores to what extent can innovation and its diffusion help the provinces achieve within-region convergence on income. The study employs Two-Stage Least Squares and Spatial Durbin Models to elucidate differentiate the importance of different types of innovation on inter-provincial income inequality. The results emphasize the importance of innovation, rather than invention, for convergence of income, and underscore the harmful effect of migration restrictions.
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1. Introduction

Over the past 30 years China’s rapid economic development has transformed the country from one of the “backward” economies to one of the most powerful players in the global market. However, in addition to extreme pollution, it has also been responsible for the intensified polarization of wealth. Implementation of market oriented reforms in 1989 have caused not only an economic shift, but also a moral shift from one of the world’s egalitarian societies to one of the most unequal ones in the world (Sun & Guo, 2013; Whyte, 2010), making China an excellent model for examining the processes behind income inequality.

At the time of transition from centrally planned to semi-marketized economy, technological capital in China was scarce, hence it made sense to enable some provinces to “get rich first” by opening them up to foreign investment and trade in hope that the economic development will eventually trickle down to the neighboring provinces. Scholars agree that this strategy was preferable to shock therapy employed by ex-Soviet Union countries, and allowed for a smoother transition from state control to trade liberalization, however it also fueled interprovincial inequality that was further deepened by fiscal decentralization and restricted migration. Interregional inequality stimulated competition rather than cooperation between regions (Knight, 2014; Yao, 2005, Wei, 2000) that does not allow provinces to equally enjoy the benefits of the country’s economic growth. Furthermore, Yao (2005) cites evidence suggesting that economic development of a province is strongly dependent on its proximity to the coastal provinces, which underscores the importance of spatial analysis for creating a realistic picture of China’s growth (e.g. Cartier, 2013; Chi, Li, & Yu, 2011; Solinger, 2013; Wang & Zhao, 2014). Geopolitical prioritization of coastal regions has created a regional divide
between regions that were already significantly different in culture, which gave rise to a series of separatist movements (Jacobs, 2017). Wealth disparity undermines people’s confidence in the economic system, which fuels corruption and rent seeking by those in power (Yao, 2005). The central government put forth several initiatives that aimed to reduce interprovincial and between region inequality in China, however their effectiveness is unclear (An, 2015). Scholars highlighted that while between region inequality is still severe, the levels of income and consumption inequality are higher when considering provinces in the same region, suggesting that provinces are failing to retain the necessary fiscal and labor capital to fuel economic development and raise living standards (Wang & Zhao, 2014).

This paper examines to what extent innovation can fuel within-region income convergence by examining the effects of different types of innovation on the levels of income inequality within regions. Moreover, the study aims to explore the effects of diffusion of knowledge on the existing intraregional inequality.

This paper is structured as follows: Section 2 reviews the existing economic theory of income distribution, highlighting potential solutions and its economic significance. Section 3 synthesizes the existing knowledge about income inequality in China, its causes and effects, and poses the research questions. Section 4 introduces the variables that serve as proxies for innovation and income inequality, and introduces the conceptual and empirical models, explaining the construction of the dataset, and presenting findings in detail. Section 5 and 6 introduce the models and the results obtained. Section 7 discusses the implications of the findings, as well as potential for future research.
2. Literature review

The purpose of economics is to understand and design the optimal allocation of scarce resources among individuals and societies. A question of a just distribution of wealth has been approached both by theoretical economists and empiricists, and a clear solution is still not found. As noted by Bigsten (1983), the distribution of wealth is a result of all economic forces that is representative of the state of the economic system, hence it is difficult to take all the factors into account and devise a universal solution. Moreover, Bigsten (1983) argues that to accurately capture it, an ideal model should not only identify the forces acting upon factors of production, but also differentiate between the availability of resources in each country, suggesting that the models that apply in developed countries often do not apply to developing ones. The following section provides a review of theories of economic development that are particularly useful when investigating income distribution in China. It starts with analyzing how economists of various schools of thought have approached the problem of uneven economic development, its causes, and influences, creating a context for the Section 3 that examines the state of income inequality in China, and the historical and economic processes that have led to it.

*The classical school*

Classical economists, such as Adam Smith, David Ricardo, and Thomas Malthus are mostly concerned with the evolution and growth of society. The founder of classical economics, Adam Smith, believed that the “invisible hand” regulates the distribution of resources under the influence of market forces. In his classic work, *The Wealth of Nations*, Smith detailed that economic development of the nation relies on skill and dexterity of the workforce, labor participation rate, whereby societies that encourage
division of labor and specialization can develop faster than others (Khan, 2014). Technological development not only economize the time needed for manufacturing processes, but also fosters further specialization of labor. Smith divided labor into productive that “adds to the value of the subject upon which it is bestowed [machinery]” (Smith, 1904), and unproductive labor such as court services, and military that do not produce value continuously: “great fleets and armies, who in time of peace produce nothing, and in time of war acquire nothing which can compensate the expense of maintaining them” (Smith, 1904). He argued that overinvestment in unproductive labor and institutions that recruit it exhausts the economic potential of a nation as a result of inefficiency that it creates. A desire for better living conditions is a motivating force for an individual, however Smith acknowledged that self-interest of other members of society might impair one’s opportunity to self-actualize. Therefore, this duty shall be placed on the government that serves to protect the poor by regulating monopolies and encouraging healthy competition.

David Ricardo then introduced his labor theory of value under which the price of goods depends on the quantity of goods produced, rather than the price of the factors of production. Like Smith, Ricardo believed that capital accumulation was the main driver of growth, so he was interested in the processes that can impair or stimulate it. Ricardo divided society into capitalists, workers, and landowners, and proposed that income is distributed via profits, wages, and rent. Profits were defined as a surplus of revenue after the subtraction of wages and rent, hence Ricardo stressed the importance of fertile soil and unrestricted imports. High quality soil would result in increased supply of agricultural products, which would drive down the prices of food and wages, hence increasing profits. Agricultural imports would have an analogous effect (Khan, 2014).
Ricardo posited that the returns on labor and land will eventually diminish, suggesting that landowners would be the only party making profit, which would lead to stagnation and widening income disparities. Ricardo suggested that there are ways to improve the quality of land, perhaps by more appropriate use that would prevent the least fertile land from being used, and technological knowledge that would enable the capitalist to pay lower rent for a more fertile soil. Ricardo did not elaborate on the importance of technological advancement much, but he fervently believed that trade liberalization is the key to accelerating economic development because it allows countries to specialize in the production of goods in which they have the highest comparative advantage.

The idea of an egalitarian society first began to appear during the Industrial Revolution, which sharpened the divide between the working class and the bourgeoisie. Marquis de Condorcet and William Godwin were both prominent economists who criticized the destructive nature of capitalism during the Industrial Revolution. The former advocated welfare support for the poor and limited access to credit for the rich. Godwin, on the other hand, took the idea much further by advocating for the need-based distribution of property. Ironically, their ideas were dismissed by Thomas Malthus, who was fortunate enough to be of the upper class. In his first work, *Essay*, Malthus states that egalitarianism would “oppose the progress of man towards perfection” (Malthus, 1798). Furthermore, he believed that, “the inevitable laws of nature” make poverty and inequality is inevitable, and neither taxes on the rich nor the government can alleviate it, (Malthus, 1798).

To summarize, Both Smith and Ricardo have expressed a clear preference for egalitarian society. Smith suggested that the governments and people should strive for perfect competition and allow markets to redistribute resources themselves, such that
everyone’s needs are satisfied. Ricardo has derived a labor theory of value that underscored that rent is not determined by price, rather the opposite is true, which benefits only capital owners. To decrease the disparity between landowners and everyone else, society should strive for technological development that will lower the costs of production. Both Smith and Ricardo believed in trade liberalization as a way of maximizing market efficiency. Conocet and Godwin, like Smith, suggested that government should be in charge of encouraging a more even distribution of resources, however Malthus argued that it would be useless, as income inequality is a part of human nature.

The utilitarian school
Jeremy Bentham took a different approach to capitalism, and believed that “all human activity springs from maximizing pleasure”. He supported the idea of diminishing marginal utility of income that states that pleasure decreases with each incremental increase in income. Therefore, he believed that government should be in charge of redistribution of income from higher to lower classes.

While William Thompson supported Bentham’s idea of hedonic pursuits, he made the first argument in favor of egalitarian market socialism. He believed that constant competition of the capitalist system does not make people feel secure, and, therefore, will always benefit the rich and harm the poor:

to inequality of wealth there is no bound: it becomes the ruling passion: the distinction which it confers, the envy which it excites, urge men to acquire it by any means. Every expedient which force and cunning can use to appropriate the fruits of other men's labour, and with this view to turn the mass of mankind into ignorant contented drudges, is erected into a custom or a law. A universal and always vigilant conspiracy of capitalists . . . exists everywhere . . . to cause the labourers to toil for the lowest possible wage, and to wrest as much as possible of the products of their labour to swell the accumulations and expenditures of capitalists. (...) What accumulated wealth there is in such a community is gathered into the hands of few, and as well from its bulk as from its
contrast with the surrounding poverty, it strikes every eye (Thompson, 1850).

He advocated that the control of production should be put in the hands of the workers, which can be achieved by private ownership of capital and materials of production. This would ensure that the resources be evenly distributed amongst all the members of society, leading to an equal distribution of wealth. Thompson stated that competition does not stimulate innovation because entrepreneurs are concerned with satisfying the needs and demands of the consumers rather than improving the quality of life. Thompson passionately advocated gender equality and emphasized that oppression of women undermines the development of the society and leads to economic waste. He saw the Industrial Revolution as a perfect platform to establish the equality of the sexes because “women, if equally trained… [would] be as productively employed...as men” (Thomson, 1850) hence they could no longer be discriminated against based on physical strength. Overall, Thompson’s vision expressed the first ideas of cooperative socialism, and, though it did not become revolutionary, it addressed the importance of gender equality for achieving sustainable economic development that modern society is still struggling to implement.

In short, utilitarian theory suggests that humans aim to maximize utility, rather than profit, hence the resources should be distributed according to the utility that one derives from them. Thompson argued that as workers derive maximum utility from the means of production, they should be in full control of them, which would then orient them from competition to cooperation, that would improve overall quality of life. The main criticism of the utilitarian theory is its subjective nature. Pleasures and happiness cannot be quantified; hence it is difficult to argue that changing the current distribution of wealth will make the society more equal.
The rise of socialism

Thomas Hodgskin believed that ownership of land is unnatural and often brings inefficiency to the economy. He stood up against private property rights, suggesting that owners of capital are unproductive idlers who contribute little to economic development. For him the concept of private ownership embodied recession of the nation’s economic growth, and the main factor behind inequality between the rich and the poor. Hodgskin believed that goods and services should be valued based on their “natural price,” which is determined by the quantity of labor involved in the production of it; in the ideal society one could only own the capital that they have produced or that they use in future production. Just like Smith, he argued that society’s main purpose is capital accumulation, however he asserted that it is also directly proportional to the accumulation of knowledge. Hodgskin infamously posited that “necessity is the mother of invention; and the continual existence of necessity can only be explained by the continual increase in people” (Hodgskin, 1827), suggesting that population growth is an important factor for innovation, as people are the raw materials for knowledge creation. Hence, Hodgskin suggested that in order to increase knowledge production and capital accumulation, the rewards to labor should be increased to strengthen labor’s motivation to exert their resources into innovation.

The mid-19th century was characterized by the popularization of socialist ideas as well as the writings on pure utilitarianism, such as John Stuart Mill’s Principles of Political Economy and Frederic Bastiat’s Economic Harmonies. In Economic Harmonies Bastiat ignored the idea that wages paid to workers might not sufficiently satisfy their needs or allow them to save enough to become a capitalist. Instead, he defended capitalists, suggesting that capital ownership is a natural law and it is a sin to refute it.
Moreover, capitalist’s suffering, which lies in the production of profitable commodities and maintaining the capital acquired, is comparable to the pain incurred by the workers, hence capitalists are morally entitled to their profits, interests, and rents, and taking this right away undermines the pain and effort invested in profit acquisition. Bastiat believed laissez-faire capitalism to be the panacea for class disputes and inefficiency. He justified it, saying “in proportion to the capital accumulated, the absolute share of the capitalist is diminished. (…) The more plentiful capital is, the lower is the interest rate” (Bastiat, 1964 as cited by Hunt, 2015). However, there is no evidence to prove that decrease in the profit rate is followed by the increase in the workers’ relative share of production. Instead, if the relative increase in capital exceeds the relative decrease in the rate of profit the opposite effect will be observed.

John Stuart Mill was against the idea of private ownership, and, like Hodgskin, opposed the creation of a parasitic class that is able to get rich without toil. His major work, *The Principles of Political Economy*, explored the potential of economic development to promote equality, rather than factors that promoted economic growth. Mill believed that in the long run economic growth will be stationary, and the focus of economics would shift to ensuring equal distribution of resources among all members of society. Mill emphasized that the development of science and technology is not only essential for increasing production at the lowest available cost, but also for fostering social development, as it allows more time to be devoted to improving prosperity of other nations, and preserve nature. As can be drawn from the idealistic arguments above, Mill did not believe in the notion that people are selfish profit maximizers, rather he suggested that capitalism makes them such, therefore after the collapse of capitalism, people all over the world would prioritize virtue and leisure over capital accumulation. Every
member of society aims to improve the quality of life for others, hence once capitalism is abolished, rich members of society will devote their resources to bettering lives of the poor:

When the rich are content with being rich, and do not claim as such any political privileges their interest is that of the poor are generally the same (Mill, 2009).

Contrary to the central assumption of utilitarianism, Mill infamously asserted that it is “better to be Socrates dissatisfied than a fool satisfied” (Mill, 2011), hence some pleasures are more valuable than others. Mill believed that through education the working class can learn to prioritize worldly pleasures, which would then help them move up in social hierarchy:

there is need of a twofold action, directed simultaneously upon their intelligence and their poverty. An effective national education of the children of the labouring class, is the first thing needful: and, coincidently with this, a system of measures which shall extinguish extreme poverty for one whole generation. (Mill, 2009)

Mill’s idealistic view of humankind, though admirable, makes it hard to apply his theory to real life. He asserted that even at his time, developed economies have already satisfactory level of development, and should shift their objective from growth and prosperity to preservation and equality. However, as data shows, just as rich individuals are not so keen to cooperate with the poor, and give up their “political privilege,” developed economies do not perceive their level of economic development as adequate and aim to develop further, rather than to assure that every member of society benefits from it.

The works of Karl Marx had an apparent focus on the interactions of labor and capital in the time of rampant colonization. Marx believed that capitalists’ insatiable appetite for profit maximization extends the borders of their motherlands in search of new markets, cheaper raw materials, and labor. Marx noted that the expansion of markets
benefits only the those that are able to incur technological and fixed costs that are needed
to optimize production abroad. This implies that capitalist competition forces small
entrepreneurs out of the market, concentrating wealth in the hands of a small group of
people. The working class, struggling to survive and unable to obtain education,
degenerates. In Marx’s words:

Accumulation of wealth at one pole is, therefore, at the same time accumulation of
misery, agony of toil, slavery, ignorance, brutality [and] mental degradation at the
opposite pole (Cunningham Wood, 1998).

Even if capitalists decided to raise wages to above the sustenance pay, it does little to
change the overall state of inequality:

A rise in the price of labor, as a consequence of the accumulation of capital, only
means, in fact, that the length and weight of the golden chain the wage-worker has
already forged for himself, allow of a relaxation of the tension of it…. Such an increase
only means at best quantitative diminution of the unpaid labor that the worker has to
supply. This diminution can never reach the point at which it would threaten the system
itself (Cunningham Wood, 1998).

The oppressive nature of capitalism will eventually serve as a catalyst for a revolution
that will give rise to a socialist system that encourages cooperation and human
development. However, Marx also recognized that while the process of colonization is
violent and exploitative, the colonies also benefit from a more rapid diffusion of
technology. He observed British imperialism in China that had disrupted local production
of handicrafts with introduction of machine-made products. Marx encouraged such
disruptions, especially if the local mode of production is stagnant, however he also
recognized that successful adoption of capitalism in non-capitalist countries depends on
the willingness of the local culture to adapt (Ping, 2009).

Rosa Luxemburg extended Marx’s theory, offering a deeper analysis of
modernization of Oriental economies in the imperialist era. She asserted that the Opium
Wars pushed China to realize its backwardness, thereby forcing the country to “open up”
and abandon stagnating focus on self-sufficiency. European invasion started the process of modernization by destroying feudalism and the natural economy, and encouraging the adoption of capitalist values. Luxemburg then asserted that capitalism will continue to reign as long as non-capitalist countries exist, offering capitalists new markets to exploit. Only after the world has embraced capitalist ideology will socialist revolution begin, prioritizing equality and cooperation. Luxemburg hinted that while European invasion was an impetus for modernization of China, the loss of sovereignty has undermined the country’s ability to realize its full potential, however this idea was not fully developed in her works (Ping, 2009).

The marginalist school

The end of 19th century was characterized by the entrance of three major economists, namely William Stanley Jevons, Carl Menger, and Leon Walras, who took a new stance on the theories of utilitarian economists by introducing the concept of marginal utility. While classical economists believed that the equilibrium price would equal the cost of production, thereby implying that income dictates the price, marginalists proposed that the prices of goods reflect the marginal utility of consumption and production, which then implies that the factors of production - such as wages, rent, capital - are dependent on the prices of commodities. Neoclassical marginalism then goes on to assume that individuals are not aiming to maximize profits, but are rather trying to achieve the maximum pleasure from the scarce resources available. However, as consumption patterns of the working class were strictly fixed by their incomes, their purchasing decisions were based solely on what they could afford, rather than what would please them more. In this context, proprietors, whose decisions were guided by the greatest return on the distribution of their resources, were the only party that could derive
optimal utility.

Alfred Marshall has built on Ricardian labor theory of value to examine the role of demand in determination of market prices. He mathematically demonstrated that perfect competition eliminates all the profits in the long run, and firms are forced to set the price that equals to marginal cost, suggesting that in the long run, workers will receive subsistence wage. Marshall was a strong supporter of the invisible hand doctrine proposing that human nature determines one’s social status; only workers that possess the necessary moral virtues could then become capitalists (Khan, 2014). He acknowledged that while capitalism might be oppressive to the working class, an endeavour for social improvement that is imbedded into human nature will slowly mold it into a more equitable economic system.

John Bates Clark built on Marshall’s work and devised a principle of substitution of labor and capital, that suggests that the wages of workers are determined by their productivity in comparison to productivity of capital. He explained that the profitability and efficiency of a firm depends on its ability to optimize the use of labor and capital, producing the highest quantity at the lowest cost. Technological advancement lowers the cost of labor, as the larger share of business tasks can be automated. Highly skilled workers, who cannot be easily substituted by the machines, are then rewarded by higher incomes, while less educated labor is pushed into low-skill jobs. Both Marshall and Clark believed that market forces maximize everyone’s utility, hence income is distributed across the population based on workers’ merit. Clark then elaborated:

The welfare of the laboring classes depends on whether they get much or little; but their attitude toward other classes—and, therefore, the stability of the social state—depends chiefly on the question, whether the amount that they get, be it large or small, is what they produce. If they create a small amount of wealth and get the whole of it, they may not seek to revolutionize society; but if it were to appear that they produce an ample amount
and get only a part of it, many of them would become revolutionists, and all would have
the right to do so. The indictment that hangs over society is that of "exploiting labor." "Workmen" it is said, "are regularly robbed of what they produce. This is done within the
forms of law, and by the natural working of competition." If this charge were proved,
every right-minded man should become a socialist; and his zeal in transforming the
industrial system would then measure and express his sense of justice (Clark, 1908).

Hence Clark endorsed capitalism as long as everyone receives the amount that they
produce, and if that’s not the case then the society would shift to socialism.

The role of technological change

While most of the scholastic writers considered workers as an impetus for change,
Joseph Schumpeter believed that it was driven by an innovator. In *Capitalism, Socialism
and Democracy* Schumpeter describes capitalists as rent-seeking entrepreneurs, whose
goal is to maximize profits. To do that they can either lower the costs of labor or capital
involved in production of the commodity, which might give them a comparative
advantage in the short term, or innovate, which would enable them to increase their
productivity at the lower cost and potentially allow for a higher price markup. Radical
innovations might offer a firm long-term leverage over others as the commodity might be
protected by patents or be difficult to imitate, hence allowing successful entrepreneurs to
enjoy monopoly profits. However, Schumpeter himself drew a distinction between
innovation and invention, suggesting that the latter implies a creation of something
unique and new to the world, while the former includes commercialization of already
existing knowledge. More importantly, radical innovation has a potential to reform the
whole market, encouraging companies to compete in pursuit of gaining or maintaining
their market share. In Schumpeter’s words “[innovation] strikes not at the margins of the
profits and the outputs of the existing firms but at their foundation, at their very lives.”

While the consumers might be charged monopoly price or a price higher than in perfect
competition, they also will be able to enjoy higher standards of living and derive higher
utility from the commodities they use. Moreover, because innovation is a continuous process, the entrepreneur will only be able to maintain his monopoly power until someone outperforms him, implying that the benefits of the monopoly profits change hands in a short time.

As mentioned, Schumpeter did not believe in economic sustainability, and suggested that growth could only be supported by the disruption of status quo. However, his explanations of the existing income inequality were brief. In the Schumpeterian model, innovation drives economic growth. Innovative countries enjoy higher rates of economic growth and thus encourage less developed countries to put more emphasis on research and development. Eventually all economies would converge at a steady rate of economic growth that would equal the world technology growth rate.

Robert Solow further built on Schumpeter’s model to explain unequal economic development using innovation. Using a standard production function, he derived that economic growth is determined by capital, labor, and total factor productivity (TFP), which encapsulated technological progress and efficiency improvement. Solow’s model of economic growth states that in the short run, a country’s growth rate is dependent on investment, depreciation, and population growth rates; however, due to diminishing marginal returns on labor and capital economic growth is bound to extinguish in the long run (Solow, 1956). This economic slowdown causes cross-border convergence of income, suggesting that with time poor states will achieve the same levels of economic development as rich states. Similarly, regional convergence occurs once the market forces eliminate temporary misallocation of factors of production. Furthermore, Solow specified that convergence is conditional on the equivalent education, institutional arrangements, and free market exchange. Based on the model, TFP is the only factor that
has no upper limit and does not depreciate with time, hence long term economic growth can only be sustained by innovation (Solow, 1956). While the reality did not seem to always align with Solow’s theory\(^1\), it has significantly contributed to our understanding of the importance of a country’s innovation capacity.

Nicholas Kaldor believed that Solow’s model did not adequately explain cross-cultural differences in economic growth levels, as developing countries were still behind the developed ones due to the low quality of infrastructure. Kaldor showed a significant positive correlation between the growth of the manufacturing sector and economic growth, which undermined Solow’s assumption of diminishing marginal returns on capital and gave rise to Kaldor’s laws of growth. He observed that a rise in investment could closely explain the productivity factor in OECD countries, suggesting that while investment fosters economic growth, it is only affordable to the richer class of the population that has enough disposable income to save and invest, thereby suggesting that inequality fuels growth (Kaldor, 1961).

The inequality-growth relationship was further developed by Simon Kuznets, who compared income disparities in the United States, Germany, and the United Kingdom from 1880 to 1947. He found that income inequality increased as a society was moving towards a manufacture-driven development, then it peaked for several years after industrialization, and then decreased over time (Kuznets, 1955). This finding was quite surprising to Kuznets himself, who expected that:

*Other conditions being equal*, the cumulative effect of such inequality in savings would be the concentration of an increasing proportion of income-yielding assets in the hands of

\(^1\) For example, increased investment and penetration of information technology, though was expected to boost productivity based on the Solow’s model, has achieved the opposite effect, also known as Solow Computer Paradox. See Brynjolfsson (1993).
upper groups – a basis for larger income shares of these groups and their descendants (Kuznets, 1955).

To fill in the gap between data and theory, Kuznets postulated that with time and patience, economic growth will trickle down to the poor class, and the income gap will shrink, suggesting that the relationship between income and inequality would trace an inverted-U shape. Kuznets speculated that the pattern observed results from the country’s transition from primarily agriculture-driven to manufacture-driven economic development (Kuznets, 1995). Though the data from Western European countries has supported Kuznets’s hypothesis, Acemoglu and Robinson (2002) argued that the same pattern is not replicated in Asia, where the economies start off with initially low levels of inequality, but then experience miracle growth and rapidly produce high levels of output. Based on this incongruence, the scholars have devised a political economy theory of the Kuznets curve, and suggested that the inverted-U relationship between inequality and growth is mediated by the implementation of political reforms. When the benefits of economic development are not equally distributed across the population, social unrest pressures the governments to implement redistributive reforms. Acemoglu and Robinson (2002) proposed that in East Asia, where the economies started off with low levels of income inequality and rapidly achieved high levels of economic growth, the rise in average per capita income has discouraged the population from initiating political transition of power from rich to poor.

Francois Perroux was also skeptical of regional convergence, hence he relied on Schumpeter’s idea of propulsive entrepreneurs that revolutionize the industry with commercialization of novel ideas. Perroux was a regional economist, so he was interested in the influence of the interdependence of firms on economic development. He posits:
(...) growth does not appear everywhere and all at once; it appears in points or growth poles with variable intensities; it spreads along diverse channels and has varying terminal effects for the whole of the economy (Perroux 1950, as cited by Parr, 1999).

A growth pole is a large firm that is interdependent with other firms in the industry, but can influence the course of development through its innovative capacity and market share. Perroux suggested the more connected firms are in the industry, the more polarized regional growth is. The region that has the highest concentration of growth poles is dominant, and is expected to be more technologically advanced, due to the innovation from the growth poles, and wealthier due to increased investment in the development of the region (Parr, 1999). Furthermore, Perroux considered that a dominant region to be essential for higher economic development and higher income (Speakman & Koivisto, 2013). The main drawback of the theory is that it does not explain how poor regions that are not capital-intensive can catch up with economic development of the dominant regions in terms of socio-economic wellbeing.

While divergent in many ways, the aforementioned economists supported the idea that capital accumulation is at the core of economic development. Smith advocated minimal government intervention, and allowing market forces to redistribute resources across the population. Ricardo analyzed potential hindrances to capital accumulation and proposed that technological advancement might prevent stagnation by lowering rents and raising profits, thereby raising worker’s wages above sustenance pay. Bastiat firmly believed that inequality is a part of the natural order. He argued that increasing profits of capitalists will eventually benefit the lower class by lowering the interest rate; this argument was later refuted by proponents of socialism, who suggested that the lower class receives little benefit from the enrichment of the richer class. Mill argued that economic progress fails to benefit all members of society, and suggested that economies should rely on technological advancement to maximize productivity and allow workers to
have more spare time, that would give rise to a stationary but virtuous society. Like Mill, Hodgskin despised idle earners, and wanted wealth to be concentrated in the hands of its creators, workers themselves. He defined progress of accumulation of knowledge, rather than capital. Marx took Hodgskin’s theory a step further, and affirmed that capitalists will not be satisfied until all the markets have been exploited. He admitted that the spread of capitalism is important to dismantle the rule of self-sufficiency and natural economies in non-capitalist countries, but construed that in the long run capitalism will be replaced by a desire for a fairer society. Luxemburg extended Marxist theories by affirming that capitalism and socialism cannot coexist, such that socialism cannot be brought to fore if capitalism still exists. Clark and Marshal approached Hodgskin’s ideas from the perspective of marginal utility, and highlighted that individual’s utility will be satisfied as long as he receives the fruit of his work; if this cannot be achieved, society should shift to socialism. The importance of technological development has been highlighted by many classical economists. Schumpeter articulated its disruptive potential to revolutionize industry and foster economic growth. Solow then took this idea further suggesting that the country’s innovative capacity is a main determinant of its long run economic growth. Furthermore, he hinted on the potential of the spillover of technological knowledge to stimulate convergence of economic development across borders. This idea was later developed in the regional context by Perroux, who illustrated how diffusion of knowledge from innovation clusters can benefit other regions that do not possess the same level of economic capability.

**Contemporary theories**

Developmental economists drew inspiration from the theories mentioned above to derive reforms that aim to assist developing countries achieve sustainable economic
development and high living standards. The factors that have a potential of lessening income disparity are often the same as the ones that set some countries behind. Hence, this section reviews the theories put forth by the key developmental economists, and integrates their relation to various types of income inequality in China.

Dual economy theory

Arthur Lewis is widely-recognized as a founder of developmental economics, whose dual-economy theory was a breakthrough in understanding the development process of low-income countries. Lewis suggested that developing countries struggle to catch up because they have not fully embraced the dogmas of capitalism, which implied that the neoclassical marginal productivity theory of distribution fails to explain economic development of less advanced countries.

Lewis divided the economy into two sectors: traditional (labor intensive) and modern (capital intensive). The central assumption of the model was based on Lewis’s observation of a rural-urban relationship. Rural wages were expected to go up, as the migration to urban areas has increased, however they did not change. Lewis explained that the surplus of labor in agricultural sector reduces its productivity, and thereby the wages of the workers (Lewis, 1979). The dual economy model assumes that the education level, and the innate skills of workers are the same in both sectors, hence the difference in wages is explained on productivity as a function of working experience. The traditional sector does not incentivize the workers to be productive, hence they acquire little knowledge, and receive subsistence wage (Lewis, 1954), while in the modern sector the worker can move up the career ladder as he gains more experience, thereby increasing the wage he receives. The modern sector has limited absorptive capacity, thus the mobility of labor across sectors is restricted. Lewis therefore proposed that savings,
investment, and technological advancement of the modern sector is the key element of the economic development of the economy. In the process of expansion modern, the sector will innovate and invest in infrastructure, and these benefits will eventually spill over to the traditional sector, however the income disparity between the workers will not cease to exist. Lewis proposed that adoption of capitalism would eliminate the surplus of labor in the traditional sector and achieve convergence of incomes between urban and rural sectors (Lewis, 1979). Some scholars suggest that the predicted pattern of development was observed in China, whereby adoption of capitalist ideology has increased the rise of wages of rural workers, thus eliminating the existing surplus of labor involved in traditional sector (Khan, 2014).

The dual economy model emphasizes the lack of convergence between different sectors of the economy. While dividing it only in two sectors might paint a more simplistic picture, the general framework explains the continuous effect of market imperfections in exacerbating income inequality.

Structuralism

Raul Prebisch was the first to suggest that developed economies like the US are at the center of global economic development, while the other countries are at the periphery. Referring back to classical economists, he underscored that the technological process is a key factor for economic growth of the nation. His theory explored how trade between central and peripheral economies affects a country’s course of innovation and its living standards. Prebisch observed that innovation in the developed countries aims to improve economic efficiency by raising the standards of living of its labor force, as knowledge is their greatest export. In contrast, developing countries are competing for competitive advantage by lowering the price of raw materials that are used to manufacture the
products invented by central economies. This constitutes the foundation of the
dependency theory – while education and technological capital are identical in both
developing and developed countries, due to the lack of a clear development strategy the
former are forced into supplying cheap capital and labor to the latter, which enables
central countries to charge higher prices for the goods they have produced using materials
from the countries at the periphery. The disparity in the revenue creates inequality
between countries, whereby developing countries cannot enjoy the benefits of improved
productivity, and therefore, catch up. The theory suggests that the forces that allow
central economies to advance also stall the development of the countries at the periphery,
meaning that growth of the advanced economies depends on the misery of less developed
ones. Prebish suggested that developing countries should heavily rely on the imports of
technological capital from abroad to absorb technological knowledge from developed
economies, and implement protectionist policies to ensure sufficient demand for locally
manufactured goods.

While Prebish stressed that the power difference between highly developed and
developing countries can be resolved using capitalist approach, Andre Gunter Frank
suggested that there is no universal solution to balance out the asymmetry of power,
rather it depends on the socioeconomic forces of each developing country. In contrast to
Lewis’ model of economic growth, Frank believed that proximity to developed countries
does not facilitate the spillover of technological capital, rather it widens inequality
between them, thus replicating the path of advanced economies will not lift up the
developing ones. He hypothesized that the rate of economic growth in the peripheral
countries is the highest when the contact with central countries is weakened through wars
or trade regulations. Frank suggested that regional inequalities in the developing
countries result from a similar exploitative relationship, whereby stronger regions or regional centers take advantage of the surplus of the factors of production in the less developed regions. Contrary to Frank’s prediction, Khan (2014) cites evidence that adopting successful capitalist strategies brings significant progress for a developing economy.

The theory stresses that lagging economic growth is not a result of lack of education and scientific knowledge, rather the inability of dependent economies to determine their own path to sustainable development due to being forced into supplying cheap raw materials and labor (Ferraro, 2008).

In short, Prebisch was one of the first economists to capture the imbalance of power in international trade. He suggested that developing economies should focus on achieving higher productive efficiency using technological knowledge of rich economies, and ensure sufficient local market demand for locally produced goods by implementing import quotas on everything, but technology. Dependency theory was widely criticized for not taking into account competition that could boost productive and innovative capability of the developing country, such that they would be able to lessen their dependency on imports and increase export revenue (Bigsten, 1983).

*General discussion*

Though economists differ in their theories of development and solutions to market inefficiency, most agree on antipathy to income inequality. Increasing disparity between income levels is viewed as unjust (e.g. Ricardo, Hodgskin, Marx, Luxemberg, et al.), and self-perpetuating (e.g. Lewis, Prebisch, et al.). Smith presents inequality of income as a failure of the invisible hand to allocate resources efficiently, while others emphasize the inequality of opportunity due to lack of education (e.g. Thompson, Mill) or opportunity
(e.g. Hodgskin, Frank). The central aversive property of inequality lies not in the lack of market power of the impoverished individuals, but rather in its ability to undermine social cohesion that leads to the collapse of the entire economic system, which pushes society to implement socialist rule. The literature review highlights the prospect of innovation and technological advancement to facilitate a fairer distribution of income by improving efficiency of the market (e.g. Schumpeter, Solow, Perroux, Prebisch, et al.), and enabling disadvantaged individuals and regions to catch up (e.g. Mill).

While I do agree with the revolutionary power of innovation and technological advancement, the influence of institutions and existing economic and political structures cannot be ignored. The following research aims to provide empirical evidence for the effects of application of Perroux’s growth pole theory in China, highlighting that regional convergence of income, as well as the diffusion of knowledge, is obstructed by fiscal decentralization that encourages competition between provinces as a way of achieving higher economic growth.

3. Rise of inequality in Post-Maoist China

The rise of socialism in China

As per Marx’s prediction, the beginning of 20th century was characterized by the uprising of the proletariat to overthrow the oppression of the bourgeoisie in favor of socialism. The success of the Russian October Revolution coincided with Chinese dissatisfaction with the imperialist rule of Japan and Britain and pursuit of independent path to development (Ping, 2009). Lenin’s principles of “complete equality of rights for all nations; the right of nations to self-determination; the amalgamation of the workers of all nations” (Lenin, 1914 as cited in Rouček, 1961, p.171) have found its manifestation in the establishment of Chinese Communist Party in 1921. Having received support from
Soviet Union, China has embarked on its anti-feudalism and anti-imperialist Civil War (1927-1950) that established the rule of Communist Party. Before 1949, China’s relations with the world evolved around China’s pursuit of sovereignty and war, while after the foundation of the People’s Republic of China, the focus has shifted to empowering and solidifying its role in the world as a powerful socialist country. The political and economic development of China in the 20th century provides a different perspective on Luxemburg’s theory, underscoring that she underestimated the role of national conflict between Eastern and Western societies. As Ping (2009) highlights, the 20th century was defined by China’s successful attempt to gain control over its economic development, that challenged Luxemburg’s view of global dominance of capitalism. Contrary to Luxemburg’s prediction, China in the 20th century has proven its ability to gain weight in the world, while being a socialist country.

Under the rule of Mao Tse-tung (1949-1976), China’s focus was on economic and political self-reliance, which ultimately led to excessive investment in national defense and implementation of a series of protectionist policies that stagnated the country’s technological development. After the death of Mao, Deng Xiaoping started China’s transition from socialism to “socialism with Chinese characteristics,” a transition to a market economy under the control of the Chinese Communist Party (CCP). The transition to a market-oriented economy meant moving towards a more unequal distribution of income, which went against people’s expectations and ideals, thus creating fertile ground for social unrest, and a greater divide among people. The current state of regional inequality in China has emerged due to the combination of powerful forces of history, geography, state, and globalization. Before the implementation of the Xiaoping’s economic reforms, China’s society was exemplarily equal, hence examining the
emergence of material inequality in China provides profound insight into the processes that exacerbate and create inequality of wealth.

In the early 1980s China’s infrastructure and technological capital was too weak to compete with other countries. Thus, the series of Chinese Economic Reforms, also known as the open door policy, meant to absorb technological knowledge from multinational companies (Harbody, 1995). In contrast to the “shock therapy” of Eastern Europe, China’s transition was gradual, whereby at first foreign investment was allowed only in Special Economic Zones (SEZs) in Southern China, and later gradually expanded to the Eastern regions. Contrary to Mao’s redistributive policies that aimed at convergence of regional economies, Deng put forth the idea of efficiency-oriented economic development that is guided by the principle of regional comparative advantage. The Seventh Five Year Plan (FYP) put forth the idea of “three economic belts” (sanjia jingji didai) that outlined the principle of comparative advantage that guided the economic development of the regions. Due to favorable location that allowed closer proximity to ports and ocean, the Coastal region was put in charge of export-oriented industrialization and active participation in international market, the Central region oversaw agriculture, and Western region managed the mining industry (Fan, 1997).

Naturally, this strategy raised many concerns due to its potential to create large income disparities between regions to which Deng Xiaoping infamously said: “let some people get rich first.” The reform was rooted in a Chinese version of growth pole theory, called ladder step theory (tidu lilun) that stated that China, as a large developing country, should not focus on the overall development, and should rather concentrate its resources in Coastal regions, as they are more likely to attract foreign investment and advance technologically. The country was told that the focus of economic policies would then
gradually shift to the Inland and Western regions of China. This theory then gave a rise to “anti-ladder step theory,” which was ironically proposed by economists from Western China, who perceived focus on the coastal regions as discriminating against Western China that was better endowed with natural resources. The scholars argued that favoritism of the Coast forced Inland regions into economic backwardness (Holbig, 2004). There is little empirical evidence in support of ladder step theory, while more scholars suggest that the first-mover advantage of coastal provinces was the impetus for the increasing between region inequality (Yueh, 2009; Granneman & Dijk, 2015). Coastal provinces still have a significant geographical advantage over the inland provinces, and, consequently, receive more foreign investment that sets them apart from other provinces in the country (Kanbur & Zhang, 2005). Figure 1 visually demonstrates that, although the reforms have been implemented more than a decade ago, innovative activity is still largely concentrated in the coastal regions. When compared to Figure 2 that shows geographical distribution of per capita income, it is easy to notice that provinces that are responsible for the larger share of economic activity are also the richest.

**Figure 1.** Regional Distribution of Innovation Clusters (CIC) in China

A rapid increase in income inequality created a cognitive dissonance in Chinese society that continued proclaiming social equality, while benefitting a small segment of the population. China became divided not only culturally, but economically, as well as socially, which served as a perfect recipe for social unrest.

The Chinese government has been taking measures to reduce interprovincial income inequality. The Ninth FYP (1996-2000) aimed to reduce regional inequality due to its potential threat to undermine China’s prosperity and unity, hence it put forth policies that encouraged interregional cooperation. Consequently, the “Western Development Program” was launched in 1999 to stimulate economic growth in the Western region of the country. Then in 2003 the “Reviving Northeastern Region” was implemented to raise the level of industrial development in the northeastern provinces.

Qin & Chong (2016) show that the efforts of Chinese government were rather unsuccessful in alleviating poverty in the targeted regions. Granneman & Dijk (2015) present evidence showing that from 1990 until 2012 more than 70% of FDI was allocated to the coastal provinces creating disparity in the levels of economic growth and

**Figure 2.** Geographical Distribution of Income, 1952 and 2008.

development between regions. This evidence demonstrates that, although the country-level income distribution has been slowly becoming more equal, interprovincial inequality that resulted from regional favoritism persists.

Orthodox socialist countries share a tendency of centralization of financial systems, such that the central government decides on the allocation of resources in the regions of the country. China has started to move away from a centralized approach in the late 1950th, by putting local governments in charge of budgeting, resource distribution, and stimulation of economic growth. Fiscal decentralization provides the central government with clear and accurate evaluation of needs and demands of local population, allowing them to adjust policies to the diverse needs of local population. Decentralization allowed a great deal of flexibility and adaptability in terms of resource allocation, which was presumed to lead to more fair and efficient growth. The performance of the local government officials was then evaluated by the state, which resulted in falsification of the data reports, rampant corruption, and further inequality (Wei, 2006; Zhang, 2006). Zhang (2006) has examined the role of fiscal decentralization for unequal of provision of public goods and services across provinces. As the size of the local governments in a province is fixed, poor provinces spend the larger share of government revenue on salaries of government employees, which results in underdeveloped infrastructure, which then drives away investment (Zhang, 2006). Zhang’s work (2006) also raises an important question of quality of government staff, who tend to be more concerned with meeting the targets of CCP, often just on paper, to receive the promotion. Thus, Zhang (2006) proposes to reduce the size of local governments, especially in the Western and Middle regions that rely on agriculture as a main source of revenue. Wei (2006) also suggests that the lack of centralized control and inequality of economic growth across regions
undermines social cohesion of the country, which may lead to separation of culturally distinct regions, like Xinjiang and Tibet. While the central government has implemented strict control of movements for independence in those regions, and is tightly monitoring the presence of any revolutionary activity in the regions, there is an obvious need for unity that cannot be achieved under unequal rates of economic development.

Apart from the regional divide, there is a clear separation between rural and urban China to the extent that scholars often treat the two sectors as two distinct economies (Wang, 2008). While this paper does not separate the two concepts, it is important to understand the forces that cause income inequality within the provinces to analyze the interactions between the provinces and regions. The unequal process of industrialization is believed to handle the urban vs rural divide, whereby rural China was primarily used as a source of raw materials, and received a lower compensation; urban China handled the manufacturing of industrial goods, and hence was able to reap higher profits. The divide between rural and urban areas resembles that described in the dual economy model, whereby the workers in both sectors not only are compensated differently for the same amount of work, but their mobility is restricted by a strict household registration system. Liu & Dai (2014) used the Theil index to evaluate the influence of urban versus rural inequality on the consumer demand among rural citizens. The results showed a significant and negative impact of existing inequality on consumption of rural residents. Furthermore, Yu (2013) used household data in several provinces to examine the determinants of poverty. The research highlights a drastic gap between urban and rural provinces in terms of human capital and development, showing that rural poverty rates are on average 1.5 times higher than those of urban provinces. However, interestingly, rural-oriented government policies that were implemented during 2006-2009 have
significantly improved the income gap between rural and urban citizens (Liu & Dai, 2014).

Over the past three decades China has achieved a tremendous economic development, making it one of the strongest economies in the world. However, its socialist past brought challenges such as within- and between-province inequality. Transitioning from a planned economy to socialism with Chinese characteristics has redefined the roles of state and local governments in economic development, and encouraged regional development based on the provincial competitive advantage. While the deviation from socialist principles was expected to result in increased income disparity, allowing incentivizing individuals based on their contribution, evidence suggests that regional favoritism combined with restricted migration has worsened the divide. Increased economic development of the Eastern regions came at the cost of regional and urban-rural inequality.

From a macro-level perspective, the rise of income inequality accompanied by miraculous economic growth closely follows Kuznet’s inverted-U hypothesis, suggesting that labor force growth, labor specialization, and uneven access to technological capital are the main drivers behind the widening income gap. From a micro-level perspective, the distribution system has become more just, as people are rewarded based on their contribution to the economy, which is perceived favorably by Chinese citizens (Whyte, 2010). The unfairness of income distribution stems from uneven regional capital, which creates disparity between income opportunities available for individuals (Whyte, 2010).

*Innovation in China*

Alas, China’s four great inventions (i.e. compass, gunpowder, papermaking, printing) are no longer associated with China’s innovation capacity. Although
increasingly more scholars and political figures highlight the immense potential China has to become the world’s leading innovator, the majority still believe that cultural and political forces greatly inhibit the country’s innovative capability, making it less suitable for competition with the innovators from the West (Awate, Larsen, & Mudambi, 2014; Farmer, Tierney, & Kung – McIntyre, 2003).

The 20th century was a relatively prosperous time for most Western economies that could enjoy the benefits of the industrial revolution. China, however, was stuck in what Mark Elvin, a historian, referred to as “a high equilibrium trap” - a situation in which the low cost of labor, and high market efficiency eliminated the incentive to invest in technological development (The Economist, 2015). Deng Xiaoping’s economic reform was an attempt to rapidly develop the economy by absorbing technological capital from other counties at the cost of cheap labor. As a result, investment-driven and export-led economic growth has not only improved living standards of millions of people that were lifted from poverty, but also made China the richest economy in the world based on GDP on a PPP-adjusted basis (IMF, 2016). Some sources argue that China is past its prime, as it no longer holds a competitive advantage over other developing countries, which led to decelerated economic growth and social unrest.

Low costs of factors of production and educated human capital allowed the country to gain a competitive advantage over other South East Asian countries, coining the term “China’s price.” At the same time, the term “China’s quality” does not have a positive connotation, and is mostly referring to the country’s inability to innovate independently and guarantee products of a higher standard. Harbody (1995) suggests that at the time of implementation of the open door policy, China focused on absorbing technological knowledge through imitation, rather than innovation, which could have
been achieved if Chinese decided to collaborate with multinational companies (MNCs) and jointly produce commodities. However, Hu (2015) suggests that the indicators that are commonly used to quantify innovation, such as patent filings, are not necessarily indicative of China’s technological potential. As China was lagging for so many years, the technological insights absorbed from MNCs created a solid foundation for the future innovations to come. These insights were a determining factor for rapid economic growth and diffusion of knowledge. Namely, Cheung and Lin (2004) provide evidence for a positive and significant effect of FDI on patent applications, suggesting that technological knowledge spills over to the domestic enterprises stimulating innovation.

Technological upgrades, rising living standards, greater market share, and foreign investment have secured China’s position in the global economy. However, to advance further the country needs to innovate autonomously, prioritizing indigenous innovation (Wu, 2013). China is slowly starting the process of transformation to the innovation-driven growth that might not offer high surges in GDP, rather will promote greater stability, market share in the world economy, and sustainable economic development (Fu & Mu, 2014).

This paper examines the role of innovation and its spillovers on interregional inequality in China. Due to the low costs of information transfer and ever-improving infrastructure, I expect that innovations in the knowledge-intensive regions will disrupt profitability of inefficient industries in other regions, resulting in higher overall productivity and lower between-province inequality, as regions will be given equal opportunities for development. As the literature underscores the spatial heterogeneity of innovation potential, the study also explores the possibility of spillover effects, that is to what extent innovation produced in other regions impacts income inequality between
provinces in a more distant region. The evidence of spillover effects would suggest that the ease of information flow allows for a faster diffusion of knowledge, and propose that the benefits of knowledge extends further than the place of its creation, potentially raising the standards of living in other provinces.

4. Methodology

a. Province as a unit of analysis

This paper takes 31 provincial-level administrative divisions of China as separate units of analysis. While still under the supervision of the central government, local governments are in power to implement autonomous economic policies that are specific to each province, suggesting strong differences in innovation capabilities (Li, 2009). Furthermore, due to China’s rigorous household registration policy, also known as the “hukou system,” labour mobility within the country is restricted. Hukou limits rural to urban migration by restricting employability, access to social services (for oneself and one’s children), and permission to purchase property, suggesting that regions that have significantly more developed urban areas (e.g. Eastern region) are more unequal than the regions that are more rural (e.g. Western region). Lastly, the differences between provinces also extend to the cultural heritage, and the language spoken. These considerations justify using province as an independent unit of analysis (Li, 2009).

According to the previous research, the Coastal provinces are more likely to receive more foreign investment due to a favorable location, further enhancing a disparity between the innovation capability across and within regions (Fan, 2012; Yuan, 2005; Fan

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2 In December 2015, Chinese government announced about potential reform to the hukou system that aims to relax the aforementioned restrictions. While the dataset covers the year of 2015, I presume that the time delay is too small to exert significant effects.
et al., 2012). Hence, the provinces are grouped into three regions to assess potential regional differences in economic development.

b. Data

This paper constructs the panel dataset by merging socio-economic variables at the provincial level from the *China Statistical Yearbook on Science and Technology* (National Bureau of Statistics of China (NBSC), 2000-2014), *China Statistical Yearbook* (NBSC, 2000-2014), and country-level macroeconomic variables from the World Bank World Development Index (WDI). The sample consists of 31 provinces using data from 1995-2015, however the years in focus are 2000-2015. The variables and descriptive statistics are summarized in Table 1.

Material status is a well-known indicator of economic prosperity and life satisfaction (Abbott, Wallace, Lin, & Haerpfer, 2015), especially in countries that underwent a series of transitional policies and have experienced rapid economic development (Abbott et al., 2015). However, an unequal distribution of wealth can undermine social cohesion and lower people’s life satisfaction (Abbot et al. 2015; Knight et al., 2009). The average household consumption expenditure serves as a proxy for the material living conditions in each province. The OECD (2013) suggests that consumption, income, and wealth are the determining factors of economic wellbeing, with consumption being the main proxy for one’s living standards. Higher consumption implies higher economic well-being, and vice versa, *ceteris paribus*. As Reich (1987) notes, while income and consumption are related, savings and one’s ability to borrow also influence the amount one spends on goods and services, therefore change in household expenditure is not equivalent to change in income levels. Moreover, Blundell & Preston (1996) highlight that while income fluctuates systematically, consumption
expenditure is more in line with household’s expected permanent income due to borrowing and saving ability. Therefore, the use of consumption can construct a more realistic depiction of one’s ability to satisfy basic needs and access to long run resources such as durable goods. However, some argue that differences in consumption may be due to individual differences in tastes and habits rather than access to resources, hence consumption expenditure might not be the best indicator of welfare (Gustaffson, Shi, & Sicular, 2008).

The dependent variable is income inequality using the Theil index ($theil_{jt}$) or the Gini coefficient ($gini_{jt}$). The Theil index belongs to the class of general entropy measures that estimates the deviations of income distributions within a category from perfect convergence, while the Gini coefficient compares the extent to which income distribution in a region deviates from perfect equality. Both measures satisfy Fields and Fei’s (1978) criteria for inequality, including scale irrelevance, symmetry, rank preserving equalization, and the principle of transfer. Thus, the results of using either measures can be used to make comparisons of income distributions across provinces. However, to achieve the most accurate representation of a country’s Lorenz curve, one needs to collect data on an individual level (Cowell, 2003). Consequently, as the data used in this paper is collected on an aggregate provincial level, the Theil index is used as the primary measure of income inequality between provinces, while Gini coefficient analysis is used for robustness, and can be presented on demand.

The Theil index, also known as the mean logarithmic deviation, reflects the extent to which the distribution of income across groups is different from the distribution of population across groups. and is calculated as:
\[ theil_i = \frac{1}{N} \sum_{j=1}^{N} \frac{x_j}{\mu_i} \ln \left( \frac{\mu_i}{\mu_j} \right) \]

where \( theil_i \) = Theil index for the region \( i \);

\( N \) = the number of provinces in the region \( i \);

\( x_j \) = the consumption expenditure per capita of a province \( j \);

\( \mu_i \) = the mean consumption expenditure per capita in region \( i \);

In contrast to the Gini coefficient, the Theil index does not rely on the equidistribution line, rather it reflects the extent to which income of a province is different from the average income in a region that the province belongs to. Perfect convergence is achieved when each province’s average income equals its share of the population, which defines the minimum value of the Theil index (zero) (Conceição, & Ferreira, 2000). If the province’s income is higher than the average income in the region, then its contribution to the value of the region’s Theil index is positive, and if the province’s income is lower than the regional average, then its contribution is negative (Conceição, & Ferreira, 2000). However, because the former is always higher than the latter, the value of the Theil index is always positive and ranges from zero (perfect equality) to infinity, with higher values representing higher degree of inequality (Blackburn, 1989). To ease interpretation of changes in the Theil index I have computed a log transformed value of the index, therefore regression coefficients can be interpreted as a percentage change in the Theil index as a result of a one unit increase in independent variable.

The count of granted patents \((patnt_{j,t-3})\) is used as a measure of realized regional innovation performance. In order to distinguish between invention that is defined
as the creation of new knowledge from innovation that encapsulates commercialization of new ideas (Schumpeter, 1934), I apply a 3-year lag that is meant to capture the time lag associated with the exploitation of formal knowledge. Since China joined the World Trade Organization in 2001, it was forced to upgrade intellectual property laws to international standards. While a lot of skepticism regarding the extent of law enforcement remains (Yueh, 2009) and the quality of the patent data overall (Dang & Motohashi, 2015; Grilches, 1990), researchers continue using the count of patents as a proxy for innovative output due to the plentitude of data readily available (Fan, 2012; Li, 2009). A common critique of patent data in China is that most of them are directly subsidized by the local governments, hence it encourages influx of patents that hold no economic or social value. However, Dang & Motohashi (2015) demonstrated that government support did not affect the quality or the quantity of patents in China. Moreover, research suggests that patent statistics serve as a significant predictor of financial performance of the province (Dang & Motohashi, 2015).

NBSC categorizes domestic patents into the following groups: inventions \( (invention_{j,t-3}) \), design \( (design_{j,t-3}) \), and utility \( (utility_{j,t-3}) \) patents. Figure 3
demonstrates that the highest number of patents are granted for utility inventions. Utility patents reflect an adjustment, and improvement of the structural properties of the product, and are protected for 10 years, while invention patents are granted to the new technical proposals to the products or methods that often require a longer development time, and higher degree of novelty, granting its holder a monopoly power for the period of 20 years. Li (2009) distinguishes invention and utility patents as “novel-to-the-world” and “novel-to-China” respectively. Design patents are awarded for the new external aesthetic properties of the product, and contain very little or no advancement of the technical properties of the product, thus are protected for 10 years only. These definitions also align with the categorization used in the Oslo Manual (OECD, 2005) whereby design, utility, and invention patents represent marketing, process, and product innovations respectively. This study uses 3-year time lags to account for the time delay associated with the pendency period. While the patent remains under protection of the patent laws for at least 10 years, this paper assumes that it takes much less time for the product to be

**Figure 3.** Average Number of Patents Granted by Region and Type.
integrated into the market and generate value, improving overall economic efficiency.

Prior to the implementation of the Chinese economic reform in 1978, factories and firms in China had little incentive to innovate, and research institutions had little incentive to transfer new knowledge to the firms. Liu & White (2001) argue that even after the implementation of market reforms, universities and research institutions remained responsible for most of the invention and utility models patented, while firms started innovating just recently (Liu & White, 2001). The number of higher education institutions \((eduinstit_j,t)\) as adjusted per 1000 residents in the population, is used as an additional proxy for innovation capabilities of the region. The role of universities in promoting economic growth has been previously examined in the context of knowledge spillover theory of entrepreneurship, in which the presence of education institutions is a valid predictor of the region’s capacity for producing knowledge and fostering the entrepreneurial spirit (Audretsch, Hülsbeck, & Lehmann, 2011; Audretsch, Keilbach, & Lehmann, 2007; Audretsch, Lehmann, & Warning, 2005). The theory proposes that the abundant supply of young educated human capital and potential spillovers of knowledge attract firms and companies to open their offices nearby (Audretsch & Belinski, 2013).

This paper uses the number of private enterprises in a province per 1000 people \((private_{j,t})\) as a proxy for commercialization of the new knowledge and regional entrepreneurship. The rise of private firms can demonstrate the economic utility derived from the new knowledge generated (Audretsch, Hulsbeck, & Lehmann, 2011), which in turn fosters competitiveness of the province. Transition from a planned economy to a market economy has allowed entrepreneurs to focus on profits and efficiency, which has enhanced urbanization in China (Knight, & Song, 2008). However, Feng (2008) also highlights that the ownership type is a significant contributor to the existing income
The quality of human capital is an essential force behind innovation and sustainable economic growth. The OECD’s report on “The Well-being of Nations” defines human capital as “The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being” (OECD, 2001). Fleicher, Li, & Zhao (2007) compared the relative impact of human capital, infrastructure development, and foreign direct investment on economic growth in China. They find that human capital has the most consistent and positive impact on economic growth (Fleicher et al, 2007). Moreover, their research concludes that investment in education is the most economically efficient way to reduce inequality between Western, Central, and Eastern China (Fleicher et al, 2007). However, the literature has not yet reached a consensus on the most optimal measure to assess the quality of human capital. Whalley and Zhao (2013) use educational expenditures, while Ximing, Sicular, & Gustafsson (2008) use average education level of a working adult. These measures fail to account for the skills acquired outside of school, such as job training. The struggle of finding an optimal measure lies not only in the ambiguous definition, but with the limited data available. This paper attempts to capture the quality of human capital by relying on the proportion of individuals in a province that have received a university degree, and spending on education, both government and private, expressed as a proportion of GDP.

The current research utilizes data on university graduates calculated as a
proportion of the population \((h_{grad,j,t})\) to capture local skilled labor force. Education is highly valued in the Chinese culture, such that access to good education can be a ticket to a higher quality of life. Andergassen & Nardini (2007) demonstrate the ability of education to decrease inequality through redistributing income from the rich to the poor. Ximing, Sicural, & Gustafsson (2008) conducted a regression-based inequality decomposition to determine the factors that influence income inequality in China. They analyzed household data from the 1995 through 2002 to understand which variables contributed to the existing income inequality during those years. Interestingly, in 1995 education had a negative impact on the existing income inequality, however, by 2002 it worsened income inequality. According to Ximing, Sicural, & Gustafsson, (2008), education explains one-third of existing income inequality, suggesting that value of education in the job market has increased, which, in turn, widened the gap between those who pursued it and those who did not.

The state’s involvement in setting educational standards is a key indicator of quality of the overall educational system (López-Claros & Mata, 2010). Sylwester (2002) estimated that increased investment in public education consistently lowered income inequality ratings in East Asia, Africa, and Latin America. Hence, this study uses educational funds expressed as a percent of total GRP \((edu_{fund,j,t-3})\) that encompass both private and government investment in education. Over the years, the Chinese government has demonstrated its commitment to improve the quality of public education through rapid increase in average per-capita expenditure (Wang & Zhao, 2014), however between-region differences still exist. As of 2005, between-region inequality accounted for 47.3 % of variation in per-pupil education expenditure, whereby provinces in Eastern China (e.g. Shanghai) spend almost 10 times more than provinces in Central China (e.g.
Hunan) and the gap is growing over the years (Wang & Zhao, 2014). This study assumes that the widening gap in access to quality education is a significant contributor to between-province income inequality. As with patents, I presume that investment in education does not have an instantaneous effect, hence the study employs a 3-year lag to account for delayed time effects. A 3-year time-lag was chosen as the average length of school cycle is 3 years.

As suggested by López-Claros & Mata (2010), higher access to medical services allows more individuals to be active participants in the development process, be employed, generate economic value, and innovate. Moreover, access to basic education and health resources are the important factors that determine life opportunities available for an individual (Sen, 1999). This paper includes health worker density \( (meddens_{j,t}) \) that is measured as the number of health workers available per 1000 residents in the population to account for differences in access to medical resources between provinces. China’s access to healthcare and education has increased tremendously since the implementation of the market reform (Li, 2012), as seen by the increasing number of health workers, and education institutions available (Figure 4).

Xie & Jin (2015) recently found more evidence in support of Piketty’s hypothesis, suggesting that housing assets account for almost 70% of wealth in China, making property-holders the richest class in the country. They further argue that housing prices are highly skewed towards the Eastern region due to its favorable location, higher rates of economic growth, and perceived employment opportunities (Xin & Jin, 2015). Due to the unavailability of residential property prices, this paper utilizes log transformed average selling price for commercial buildings \( (housing_{j,t}) \) as a proxy for the ease and cost of doing business. As expected, cost of commercial property was strongly associated with
innovative activity, thus it is used as an instrumental variable for innovation.

Figure 4. Density of Health Workers and Higher Education Institutions, 2000-2015.

Infrastructure is a crucial factor for a country’s economic growth, as it stimulates foreign direct investment, thereby increasing a country’s productivity and strengthening its position in the global market. Fisher & Chen (1996) stressed that higher government investment in infrastructure is one of the main reasons behind the disparity in factor productivity between the coastal and the inland regions in China. They suggest that better infrastructure not only encourages investment, but also leads to higher retention of talent, which then results in higher economic growth. Fan & Zhang (2004) used data from China’s Agricultural Census to analyze inequality between urban and rural areas, and confirmed that allocation of infrastructure and public capital explains most of disparity in production efficiency and regional equity. The variable $inf_{j,t}$ is measured as the proportion of highways and railways in a province $j$. As the variable is strongly correlated to the number of patents granted and a relatively weak correlation with a natural log of Theil Index, it is used as an instrumental variable to capture innovative activity in a province $j$.  

44
As a proxy for adoption of information and communication technologies, this paper uses the count of fixed telephone subscribers \((fbs_{j,t-3})\) and the count of mobile telephone subscribers \((fbs_{j,t-3})\) per 1000 residents in a province. These variables turned out to be highly correlated, hence only the latter was used in the study to avoid multicollinearity. The importance of telecommunication technology has been widely discussed in the economic literature (Leff, 1984; Levendis & Lee, 2012) due to its ability to decrease the costs of information exchange and positive impact on national income (Leff, 1984). Levendis & Lee (2012) provide evidence in favor of endogenous growth theory, stating that regardless of whether the effect of telecommunications is endogenous or exogenous, increased teledensity has significant and positive effects on economic growth. To account for potential delays in the effect of increasing access to information and telecommunication technology, this study imposes a 3-year lag.

Inflation \((infl_{j,t})\) is calculated at the provincial level using a year-to-year change in CPI. Interest rate spread \((intrst_{t,t})\) stands for the difference between the interest rate charged to borrowers and the interest rate paid to depositors. While the greater interest rate spread demonstrates that the cost of borrowing is significantly higher than the benefit of saving, implicating greater income inequality, it also reflects efficiency of financial institutions; thus, higher interest rate spread indicates of lack of financial structural development. Due to the unavailability of data at the provincial level, the current study utilizes country-level calculations of interest rate spread offered by the World Bank, and assumes that it applies evenly to each province across years.

The relationship between income inequality and the savings rate has been widely discussed in academic literature. The permanent income hypothesis developed by Milton Friedman states that the expectation of future income determines individual’s current
consumption, such that unforeseen gains will increase savings to compensate for an anticipation of negative shocks to income that lie ahead (Freidman, 1957, as cited in Dynan, Skinner, & Zeldes, 2004). Using a wide range of data sources, Dynan, et al. (2004) tested to what extent the current state of economy follows the expected trend. Their results suggest that high-income households consistently save a larger portion of their income than low-income households. Alvarez-Cuadrado & El-Attar Vilalta (2012) built on the existing research suggesting that high-inequality regions are characterized by lower rates of savings when compared to regions with more even income distribution. They propose that households tend to evaluate their income level in relation to other households in the region, hence, when inequality is high poor and middle class families tend to decrease savings and increase spending to protect their social status (Alvarez-Cuadrado, & El-Attar Vilalta, 2012). Unfortunately, the regional data on disposable income was rather sporadic, hence to approximate provincial average savings rate, this paper uses a natural log of saving deposits in the central bank of China ($savings_{j,t}$).

Yang & Qiu (2016) modelled the impact of education on intergenerational mobility of income, and proposed that the more parents invest in the education of their children, the more likely they are to earn higher income in the future. However, their results, in combination with Alvarez-Cuadrado & El-Attar Vilalta (2012), suggest that increased savings exasperate income inequality at least in short run, as those that do not save will not pass down their income to their children, are unable to earn returns on their investment, and cannot secure themselves from temporary fluctuations of income.

As suggested by Li (2009), the annual change in real Gross Regional Product (GRP) per capita ($grp cap_{j,t}$) is used to capture the income fluctuations in the provincial economy, and the ability of the residents to realize the economic value of knowledge
generated. As migration to urban areas is restricted, the urban unemployment rate \( \text{unemp}_{j,t-3} \) is meant to capture the mismatch between the supply and demand for labor in the urban areas. 3-year lag is applied to the variable to control for delayed effects.

Inherited from the Soviet Union, China’s Five-Year Plans (FYP) do not only indicate the direction of economic development that the country is going to undertake, but also dictate the potential reforms that need to be implemented on both regional and national level. The current dataset encompasses the Tenth (2001-2005), Eleventh (2006-2010), and Twelfth (2011-2015) Five-Year Plans, and uses them as dummy variables (e.g. \( \text{tenth}_t, \text{elvn}_t, \text{twelfth}_t \) respectively) to control for the potential impact of government’s economic policies and time effects.

As presented in Figure 3, granted patents are not evenly distributed across regions. The Eastern region is an obvious leader in all three categories of patents, while the difference is less drastic between the Middle and Western regions. Coastal provinces were the first to open High Economic and Technological Development Zones that attracted foreign investment. Hence, the paper includes regional dummy variables \( \text{east}_j, \text{middle}_j, \text{west}_j \) to control for potential regional differences.

5. Two Stage Least Squares Model

Reverse causality makes estimations of economic inequality problematic. Many determinants used in the model are the results of the same economic process, hence ignoring this issue bias the interpretation of data. For example, while higher penetration of mobile phones can decrease income inequality due to a more equal access to information, reverse effect can be true as well – lower income inequality can signal that
more people can afford mobile phones. Endogenous independent variables can become correlated with the error term $\varepsilon$, which would undermine the validity of the estimates of an ordinary least squares regression model.

To disentangle the cause and effect relationship between income inequality and the independent variables, this paper uses a Two-Stage Least Squares (2SLS) Regression model. Using the correlation between independent variables and Theil Index, this study has determined instrumental variables that are highly correlated with the total number of patents, but are not correlated with Theil Index. Below is 2SLS regression model employed in to explain the influence of total number of patents granted on the within-region inequality:

\[
\text{theil}_{j,t} = \beta_0 + \beta_1 \text{patnt}_{j,t-3} + \beta_2 \text{edufund}_{j,t-3} + \beta_3 \text{sbs}_{j,t-3} + \\
\beta_4 \text{grppcap}_{j,t} + \beta_5 \text{intrst}_t + \beta_6 \text{infl}_{j,t} + \beta_7 \text{west}_{j,t} + \beta_8 \text{middle}_{j,t} + \beta_9 \text{tenth}_{t} + \\
\beta_{10} \text{elvn}_t + \beta_{11} \text{savings}_{j,t} + \beta_{12} \text{grprate}_{j,t} + \beta_{13} \text{unempu}_{j,t-3} + \varepsilon
\]

Where the total number of patents ($\text{patnt}_{j,t-3}$) is instrumented by the number of higher education institutions ($\text{eduinst}_{j,t}$), the health worker density ($\text{meddens}_{j,t}$), the number of private enterprises ($\text{private}_{j,t}$), the change in the price of corporate housing ($\text{housing}_{j,t}$), the number of mobile phone subscribers ($\text{msbs}_{j,t-3}$), and the proportion of operating highways and railways to the areas of the province ($\text{infr}_{j,t}$). The main criterion for selection of instrumental variables was the strength of correlation between the variables and the total number of patents, in contrast to the correlation between the variables and the dependent variables. Only the variables that were strongly correlated with the total number of patents and weakly correlated with the log transformed value of the Theil index were used as instruments. Correlation coefficients suggest that the
number of higher education institutions, the density of health workers, the number of private enterprises, the number of mobile phone subscribers, and the proportion of operating highways and railways are positively correlated with the total number of patents granted, while increase in the selling price of corporate housing is associated with lower number of patents granted.

The model posits that within-region inequality of consumption in a region $i$ in the year $t$ depends on total number of patents granted in the province $j$ in the year $t-3$, education funding for the province $j$ in the year $t-3$, the number of mobile telephone subscribers in province $j$ in year $t-3$, the GRP per capita growth rate in province $j$ in year $t$, the inflation in province $j$, the country-level interest rate spread in year $t$, the economic growth rate in province $j$ in year $t$, the savings rate in year $t$, and the urban unemployment rate in province $j$ in year $t-3$, controlling for time and regional differences. The increase in innovative activity, investment in education, penetration of telephones, and interest rate spread are expected to decrease income inequality in a region. Inflation, higher savings, and higher economic growth are expected to worsen the existing state of income inequality. The proposed signs of the regression coefficients are summarized in Table 2.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{patnt}_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{invention}_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{design}_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{utility}_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{infl}_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$\text{intrst}_{t}$</td>
<td>+/-</td>
</tr>
<tr>
<td>$\text{grprate}_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$\text{edufund}_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{hgrad}_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{saving}_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$\text{grppcap}_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{middle}_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{west}_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$\text{tenth}_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$\text{elvn}_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$\text{unempu}_{j,t-3}$</td>
<td>-</td>
</tr>
</tbody>
</table>

To discriminate which types of innovation are responsible for the observed effects, this paper has utilized instrumental variables technique by using 2SLS regression model.
(2) \( \text{theil}_{i,t} = \varphi_0 + \varphi_1 \text{utility}_{i,t-3} + \varphi_2 \text{invention}_{i,t-3} + \varphi_3 \text{design}_{i,t-3} + \varphi_4 \text{edu}fund_{j,t-3} + \varphi_5 \text{saving}_j,t + \varphi_6 \text{grpccap}_{j,t} + \varphi_7 \text{intrst}_t + \varphi_8 \text{infl}_j,t + \varphi_{10} \text{west}_j + \varphi_{11} \text{middle}_j + \varphi_{12} \text{ten}th_t + \varphi_{13} \text{elvn}_t + \varphi_{14} \text{unemp}_j,t-3 + \varphi_{15} \text{grprate}_{j, t} + \varepsilon \)

where \( \text{utility}_{i,t-3}, \text{invention}_{i,t-3}, \text{design}_{i,t-3} \) are instrumented using the same variables as in equation (1). Therefore, inequality of consumption in the region \( i \) in year \( t \) depends on the total number of patents granted for utility, invention, and design in the province \( j \) in year \( t-3 \), the inflation rate in province \( j \) and the interest rate spread in year \( t \), the education funds in province \( j \) in year \( t-3 \), the annual change in savings preferences in province \( j \) in year \( t \), the annual change in GRP per capita and economic growth in province \( j \) in year \( t \), the urban unemployment rate and the number of mobile telephone subscribers \( j \) in the year \( t-3 \). All three equations include dummy variables to control for regional differences (\( \text{west}_j, \text{middle}_j \)) and time effects (\( \text{ten}th_t, \text{elvn}_t \)).

5.1 Results

The empirical results of the 2SLS regressions are presented in Table 2 along with results of OLS models for comparison. The summary of the percentile shifts is presented in Table 6, whereas the more complete version of the table can be found in the Appendix. Model 1 uses the total number of patents granted as a predictor of the change in regional inequality of consumption, while Model 2 differentiates the patent types to highlight how each is responsible for the observed effects. The dependent variables in both models is the log transformed value of the Theil index. To detect potential multicollinearity issues, I used variance inflation factors (VIF tests) for both models, and no evidence of multicollinearity was found in either of the equations. Several independent variables were not normally distributed, resulting in a large kurtosis value, hence I used the change in
percentile range for interpretation of the coefficients.

While the influence of the total number of patents granted per 10000 residents is statistically significant in the OLS model, the significance is lost with the introduction of instrumental variables, which increased the standard error thereby decreasing the statistical significance of the regression coefficient.

When analyzed separately, design patents gain statistical significance, suggesting that when analyzing the influence of patents, the sum is different than its parts. The evidence suggests that an increase from the 10th percentile to the 25th percentile in the number of design patents granted is expected to decrease within region income inequality by 0.8 percentage points, while utility and invention patents fail to reach statistical significance.

The results indicate a consistently significant impact of the savings rate, suggesting than a 10-percentage point increase in the savings rate is associated with a 1.29 percentage point increase in income inequality within a region \( i \). The finding implies that wealthy individuals are able to save more to either secure higher income in the future or pass it on to the future generations, which worsens the inequality within regions, which provides more evidence in support of Alvarez-Cuadrado & Vilalta’s (2012) work.

The interest rate spread had a significant negative influence on the change in income inequality across both models, suggesting that a 1% increase in the difference between the lending and the borrowing rates is expected to decrease interregional income inequality by 0.1 percentage points. This result might seem counterintuitive as the benefit of workers is relatively smaller than that of the bank. However, as the IMF indicated, a wider interest rate spread is associated with the strengthening of financial sector, capturing the increased and efficient flow of capital (IMF, 2017). Therefore, the IMF
suggests that an increased interest rate spread is a valid predictor of poverty reduction, and declining inequality.

Holding all things constant, Model 2 predicts that each percent of the Gross Regional Product invested in education is expected to increase within-region inequality by 4.1 percentage points. One of the potential explanations for this effect is that increased investment in education can widen intergenerational divide between individuals, and offer more wage premium to the younger population. Due to the limited access to education during the Cultural Revolution (1966-1976), nowadays young professionals occupy most of the high-status managerial positions due to their educational advantage. Moreover, the returns to education depend on the availability of educational institutions in a province and its rank, such that the provinces that have a higher concentration of top-tier universities and schools (e.g. Beijing) will benefit from the increased investment more than the ones that do not (e.g. Hubei). Therefore, the potential for increased investment in education to worsen inequality between regions might be explained by differential access to educational institutions and increased intergenerational inequality.

Furthermore, Model 2 highlights the proportion of higher education graduates in a population as a significant contributor to narrowing the income gap between provinces in a region. The coefficient conveys that as a province shifts from the 10th percentile to the 25th percentile in the distribution, within-region income inequality decreases by 8.9 percentage points, ceteris paribus. Access to postsecondary education has been linked to a series of socially desirable outcomes such as higher incomes, greater job satisfaction, and better voting decisions (Hill, 2015). The author also suggests that widening income gap in the US can be explained by unequal access to education, whereby only wealthy individuals can afford the tuition fee, and enjoy the benefits. While this could also be true
in China, I believe that the coefficient reflects the meritocratic aspect of Chinese society, stressing that those who work hard are rewarded. Individuals from low socioeconomic status have the same chance of entering the best university in China as wealthy individuals, and this equal access to higher education puts downward pressure on within-region income inequality.

Both models have demonstrated consistent regional and time effects. According to Model 2 predictions, inequality in the Eastern region is 301.3 percentage points higher than in the Middle region, and 164.6 percentage points higher than in the Western region, suggesting that inequality between provinces is higher in the more developed regions than in the underdeveloped regions. Furthermore, the values of income inequality have been shown to be 32.7 percentage points higher during the Eleventh FYP when compared to the most recent Twelfth FYP. Based on these results, the inequality has decreased during the years (2006-2010), while no significant difference was observed between inequality in 2001-2005 and 2011-2015, ceteris paribus. Tenth and Eleventh FYP are characterized by a series of strategies that aim to stimulate economic growth in less developed areas. For example, the Western Development strategy (xibu dakaifa) prioritizes the economic advancement of the Middle and
the Western regions, and ‘New Socialist Countryside’ (shehui zhuyi xinnongcun) that aims to promote rural sector as a part of a broader ideological campaign that intends to transform China into ‘Universal Society of Moderate Prosperity’ (quanmian jiangshe xiaokang shehui) by the end of 2020. The results suggest that the implementation of policies did have a significant influence on between-province income inequality, but the effect was not instantaneous. While these results seem implausibly large, the model pinpoints significant spatial and time effects, suggesting that although the Chinese government has been taking steps to decrease interregional inequality, spatial differences continue to persist.

6. Spatial Durbin Model

The low cost of information technologies decreases the cost of knowledge transfers across provinces and regions. Differences in human capital and infrastructure, however, slow down the diffusion of knowledge. Constitutional restrictions on migration and cultural disparities suggest that transaction costs increase with distance, and knowledge is more likely to spill to bordering provinces, rather than to distant ones.

Based on highly significant regional differences, I calculated Moran’s I test statistic to test for the evidence of spatial autocorrelation. The coefficients on the patents granted for utility and design indicate statistically significant evidence for negative spatial

<table>
<thead>
<tr>
<th>Variable</th>
<th>2SLS$^H$</th>
<th>Total effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>$invention_{j,t-3}$</td>
<td>ns</td>
<td>0.004***</td>
</tr>
<tr>
<td>$design_{j,t-3}$</td>
<td>-0.008**</td>
<td>-0.007***</td>
</tr>
<tr>
<td>$utility_{j,t-3}$</td>
<td>ns</td>
<td>-0.011***</td>
</tr>
<tr>
<td>$infl_{j,t}$</td>
<td>ns</td>
<td>0.055***</td>
</tr>
<tr>
<td>$intrst_t$</td>
<td>0.001**</td>
<td>-0.000***</td>
</tr>
<tr>
<td>$grprate_{j,t}$</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>$edufund_{j,t-3}$</td>
<td>0.041***</td>
<td>ns</td>
</tr>
<tr>
<td>$meddns_{j,t}$</td>
<td>-0.154***</td>
<td>ns</td>
</tr>
<tr>
<td>$hgrad_{j,t}$</td>
<td>-0.089***</td>
<td>0.196***</td>
</tr>
<tr>
<td>$saving_{j,t}$</td>
<td>0.129***</td>
<td>-0.412***</td>
</tr>
<tr>
<td>$hous_{j,t}$</td>
<td>0.191***</td>
<td>ns</td>
</tr>
<tr>
<td>$grppcap_{j,t}$</td>
<td>ns</td>
<td>-0.116***</td>
</tr>
<tr>
<td>$middle_{j,t}$</td>
<td>-3.013***</td>
<td>ns</td>
</tr>
<tr>
<td>$west_{j,t}$</td>
<td>-1.646***</td>
<td>ns</td>
</tr>
<tr>
<td>$tenth_{j,t}$</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>$elvn_{j,t}$</td>
<td>0.327***</td>
<td>ns</td>
</tr>
<tr>
<td>$unempu_{j,t-3}$</td>
<td>ns</td>
<td>-0.098***</td>
</tr>
</tbody>
</table>
autocorrelation, suggesting that the number of patents granted in one region is negatively correlated with the value of neighboring regions. Kao (2016) cited the backwash effect (Myrdal, 1957 as cited in Kao, 2016) that states that economic development in province \( j \) attracts both human and capital resources from the neighboring provinces, which in turn decreases their economic attractiveness, thus decreasing the rates of economic growth in the neighboring provinces and widening within-region disparity.

To evaluate provincial spillover effects between the independent variables and inter-provincial inequality, I have employed Spatial Durbin Model (SDM) that investigates both exogenous and endogenous interaction effects (Pace & LeSage, 2010). A simplified formula for the model used is presented below:

\[
(3) \quad theil_{i,t} = \rho \cdot W \cdot theil_{i,t} + \kappa X + \theta \cdot W \cdot X + \varepsilon
\]

where \( \rho \cdot W \cdot theil_{i,t} \) is a \( N \times 1 \) vector of a spatial lagged dependent variable, the \( i^{th} \) observation of which measures the consumption inequality in the nearby region, where \( \rho \) is a spatial autoregressive parameter, \( W \) is a \( N \times N \) spatial weight matrix that describes spatial arrangement of the provinces in the sample; \( \kappa \) is the direct effect parameter that estimates the impact of a change in value of the independent variable of a province \( j \) on the interprovincial inequality in the region it belongs to, while \( \theta \) is the spatial spillover parameter that estimates the effect of the change in value of independent variable in a province \( j \) on interprovincial inequality in the neighboring region. The formula suggests that income inequality for each region depends on own-region factors, \( \kappa \), and the average of neighboring region factors, \( \theta \). For example, a higher number of patents granted in region \( i \) can decrease income inequality within a neighboring region, as the new products will stimulate competition within the province allowing more people to enjoy competitive advantage, and lowering the price.
Following Shang, Poon, & Yue (2012), this paper employed a contiguity-based inverse distance spatial matrix. The contiguity based specification assigns equal weight to the provinces that share a border, assuming that economic activity of neighboring provinces equally affects economic activity in region \( j \). As per provinces that do not share a border, the weight applied to the effect of independent variables in province \( j \) on the value of dependent variable in non-adjacent is proportional to the average inverse distance between provincial capitals.

6.1 Results

The results for the SDM model are presented in Table 5 in the appendix, where column \( \kappa \) corresponds to the \( \kappa \) parameter in the equation, and column \( \theta \) represents the impact of the values of the independent variables from the neighboring provinces. The summary of the percentile shifts can be found in Table 6, whereas a more complete version of the table is included in the Appendix. As outlined by LeSage (2008) the estimates from the SDM model cannot be interpreted as partial derivatives as it is done in standard regression models. Hence, to quantify the magnitude of the impacts of the independent variables, I computed the average direct, indirect, and total effects. Average direct effects indicate the extent to which a change in the value in an independent variable in region \( i \) can influence the value of the Theil index in a region \( i \), while the indirect effects elucidate the extent to which changes in an independent variable influence the value of the Theil index in other regions. The summary of the statistically significant percentile shifts is presented in Table 6.

The results indicate that as a province shifts from the 10th to the 25th percentile in the distribution of patents grated for invention, the intraregional income inequality
within the region it belongs to increases by 0.3 percentage points. Moreover, when combined with indirect effects, the regression coefficient suggests an equivalent shift widens interprovincial income inequality by 0.4 percentage points. Of three patent types, invention patent is granted are protected for the longest period of time and are required to demonstrate the highest level of novelty and progress. As per Schumpeter’s prediction, innovative entrepreneurs are rewarded for their novelty with access to monopoly power until someone outperforms them, hence increasing innovation results in higher within-region income inequality.

Interestingly, though both endogenous and exogenous effects of utility and design patents granted are not statistically significant, average total effects show strong statistically significant evidence suggesting that both patent types have a potential to decrease income inequality between provinces in a region. When a province’s patents granted for design shift its position in an overall distribution from the 10th percentile to the 25th percentile, within-region income inequality is expected to go down by 0.7 percentage points. The same percentile shift in the number of utility patents granted results in a highly statistically significant decrease in income inequality by 1.1 percentage points. Both design and utility patents allow the holder to enjoy short-term monopoly power, as the competitive advantage is very fleeting. Nimble competitors quickly adjust to such changes; hence the patent holder is very likely to lose his competitive advantage. Therefore, an increased number of patents granted in utility and design allow other entrepreneurs to benefit from the invention of a patent holder by adapting the existing knowledge and sharing monopoly profits.

The results for a percent change in GRP per capita demonstrate neither a direct nor an indirect impact, rather strong evidence for a combination of both, as
demonstrated by highly significant $\kappa$ and $\theta$ coefficients, and highly significant total effects. The results suggest that a 1 percentage point increase in GRP per capita growth rate is expected to decrease income inequality by 4.4 percentage points. The significant total effect of GRP per capita demonstrates that as economic growth trickles down to everyone in the population average incomes start to converge across provinces, thereby decreasing intra-regional inequality.

Health worker density has also been demonstrated to be a significant predictor of inequality between provinces, showing that each additional medical professional per 1000 people is expected to decrease income inequality by 22.5 percentage points, *ceteris paribus*. While this result might seem overwhelming, it is worth noting that a 15-percentile shift from the 10th percentile to the 25th results in a 15.4 percentile point decrease. This result highlights a widely-known notion of importance of healthcare for a fairer economic development, suggesting that more access to healthcare means more active and efficient labor force.

In contrast to the results of 2SLS presented in the Table 3, a 1% increase in the savings rate is expected to decrease income inequality by 47.1 percentage points. Furthermore, a 15-percentile shift from the 10th percentile to the 25th is expected to decrease intraregional income inequality by 41.2 percentage points. According to the permanent income hypothesis, an increased saving rate allows the residents to buffer the expected loss of wealth, as well as facilitate the intergenerational transfer of income, thereby decreasing the disparity between generations.

Counterintuitively, the rising urban unemployment rate is expected to decrease income inequality between provinces by 16.4 percentage points. Many studies have highlighted the significance of the urban-rural divide on the total
inequality in China. For example, Yao (2005) suggests that the urban-rural divide accounts for almost two thirds of overall income inequality in China. In the context of these findings, the negative impact of the increasing urban unemployment rate on the disparity between average income in provinces within a region can be explained not by higher income of rural households but rather by a lower average income of urban households, which then decreases the disparity within regions.

The model includes the cost of corporate housing to account for costs associated with starting or sustaining a business. The findings indicate that a 10-percentage point increase in the average selling price of commercial buildings is expected to increase between province income inequality by 6.63 percentage points. The findings suggest that increased fixed cost associated with private entrepreneurship widens the gap between provinces, potentially because individuals are deterred from engaging in entrepreneurial activity due to the high cost associated with it.

The results underscore education as another important factor affecting within-region inequality. Holding all things constant, as a province invests a larger proportion of its GRP into education, inequality between provinces in the region it belongs to is expected to increase by 7.6 percentage points, which is demonstrated by statistically significant direct effect. However, this result fails to reach statistical significance on a country-level. On the same note a higher proportion of higher education graduates in a province causes a higher level of within region inequality. This result is supported by statistically significant total average effect of the regression coefficient that predicts that as a province shifts from the 10th percentile to the 25th percentile in the distribution of the number of higher education graduates,
the within-province inequality increases by 19.6 percentage points. An increased proportion of educated labor can widen the gap between educated and uneducated labor, which would increase the disparity between purchasing ability of both parties. Therefore, the disparity between the provinces with high proportions of university graduates and comparable provinces with low proportions of university graduates is expected to increase. An alternative explanation would suggest that as rural areas that mostly require low-skilled labor force, increased government spending on education and the higher proportion of university graduates encourages young educated labor to pursue employment in more developed areas. Therefore, provinces with suitable economic conditions can attract more educated labor, creating a disparity between provinces within a region.

The results for the inflation rate and the interest rate spread are contrasting. Holding all else constant, a 1% increase in the inflation rate widens the income gap by 3.6 percentage points, while an equivalent increase in interest rate spread is expected to decrease income inequality by 0.4 percentage points. These results reflect a significant influence of the health of financial institutions on income distribution. Rising inflation lowers the value of assets that people own and the wages that they receive, hence increased inflation rate lowers the absolute income that people receive. The effect is much more severe for the lower and the middle class, who are forced into lowering their consumption behavior, while wealthy individuals are largely unaffected. The findings support the idea that, holding all else constant, as the inflation rates rise in the whole country, the within region inequality is more likely to increase too. The negative influence of the interest rate spread seems counterintuitive, as the lenders are relatively at loss, because the cost of
borrowing exceeds the gain of lending. In this case, the IMF’s (2017) reasoning seems the most appropriate, suggesting that increased yields of financial institutions result in a more robust financial sector, which then promotes capital formation and sustainable economic development. IMF also suggests that financial institutions play an important role in poverty reduction, thereby increasing the average regional income and decreasing disparity between provinces. Furthermore, Wei (2000) explains that strengthening of financial institutions as a result of increased saving and borrowing behaviors have facilitated poverty reduction, as more financial resources were channeled into the poorer areas.

7. Conclusions and Future Directions

Transitioning from a planned economy, which was centered around the idea of egalitarianism, to market-based economy, that aims to reward citizens based on their contribution to the economic development, has resulted various types of income inequality. While some of types of inequality was caused by introducing material incentives that aimed to increase economic efficiency and equity, many stemmed from geographical prioritization that increased both provincial and regional divide. Chinese government has expressed concern about the degree of inequality observed, and has taken various steps to improve the situation to avoid social unrest.

This paper used provincial data from the China Statistical Yearbook to examine the impact of innovation on within-region inequality over the course of the last 15 years. It builds on the existing literature on regional inequality by investigating the impact of innovation and its types on interprovincial income inequality, and exploring the spillover effects of innovation as a way of suggests decreasing the effect of provincial segmentation to allow the citizens equal access to income.
opportunities. The findings suggest that: (a) innovation, depicted by the patents granted for design and utility, has a potential to decrease China’s intraregional inequality due to its transitory nature that allows many business owners to profit from building on new ideas, thereby encouraging competition and preventing formation of monopolies. However, invention patents further worsen provincial divide by allowing some entrepreneurs to retain the monopoly power and reap profits; (b) an increased education expenditure and a higher proportion of university graduates widens the gap between the average income levels across provinces as the educated labor force tends to agglomerate in the highly advanced provinces and urban areas, thereby decreasing economic potential of less advanced provinces that is forced into low-return production, and regions with higher proportion of top-tier institutions benefit more from the increased education expenditure; (c) macroeconomic stability that is captured by the distribution of economic development, the inflation rate, and the interest rate spread has a significant impact on differences in provincial income levels, whereby the stability of financial institution and even distribution of economic growth has been found to decrease income inequality across provinces.

A number of major policy implications can be derived from the empirical findings of this paper. Firstly, to decrease inequality among provinces in the same region the government should put more effort into entrepreneurial development, rather than invention, which can be achieved by lowering the costs of entrepreneurial activity. While invention may offer the country more competitive advantage in the global market, innovation has a potential of boosting regional and provincial development as well as lowering the disparity that was created due to
geographical prioritization. The government should encourage more cooperative efforts across provinces that would stimulate a faster and more efficient diffusion of knowledge. Wang & Zhao (2014) has suggested that in order to smooth out provincial differences in fiscal capital, the government should provide less developed provinces with equalizing grants that would facilitate education, infrastructure, and living standards that would in turn boost innovative capacity and lower between-province income inequality.

Several sources have stressed that fiscal decentralization has further enhanced disparities between provinces by allowing local governments to enforce trade barriers to protect local economies (Cannon, 1990; Wei, 2000). Specifically, Cannon (1990) cites the evidence for “resource wars” that refer to the tendency of provinces to restrict supply of raw resources needed for production of goods in another province. Moreover, local governments oversaw the interest rates set by the local branches of bank, and manipulated them to protect provincial economy. Both Cannon (1990) and Wei (2000) suggest that the central government has limited influence on the distribution of monetary and natural resources between provinces, hence as long as interprovincial rivalry persist the diffusion of knowledge and innovation will be obstructed.

The mismatch between the estimates of 2SLS and SDM models can be driven by endogeneity that was not controlled for in the spatial analysis, hence future research should employ a Generalized Spatial Two Stage Least Squares to correct for potential biases. Moreover, several variables could not be included in the spatial analysis due to missing data. Future research should seek out additional approaches of measuring variables such as penetration of information technology, education
expenditures, and infrastructure development.

While the findings failed to provide the evidence for spillover effects, going against Perroux’s growth pole theory, the effect size of the predictions was rather small, thereby suggesting that the estimates lacked precision. This calls for caution in the interpretation of the regression coefficients. Kao (2016) suggested that this might be the influence of existing negative spatial autocorrelation that has been shown to impact both the coefficients and the significance level of the regression coefficients, however the nature of the impacts has not been fully understood. Future studies should employ various spatial autoregressive models to ensure the consistency across results.

One of the major limitation of the study is absence of data on the provincial Foreign Direct Investment. Previous studies that included this variable when examining innovation in China (e.g. Shang, Poon, & Yue, 2012) have found evidence for innovation clustering, in contrast to negative spatial autocorrelation finding of my study. Furthermore, I was unable to obtain the values for the interest rate spread on the provincial level, suggesting that the results obtained should be interpreted with caution. Due to the ability of local governments to directly influence the lending practices of the provincial banks, future studies should strive to obtain the interest rate values on the provincial level. While data availability is often out of the researchers’ control, future studies should explore alternative sources of data to ensure consistent results.
Appendix

Figure 1. Regional Distribution of Innovation Clusters (CIC) in China.

Figure 2. Geographical Distribution of Income in 1952 and 2008.


[http://dx.doi.org/10.1016/j.chieco.2012.08.001](http://dx.doi.org/10.1016/j.chieco.2012.08.001)
Figure 3. Average Number of Patents Granted by Type and Region.
Figure 4. Density of Health Workers and Higher Education Institutions, 2000-2015.
Table 1
Descriptive Statistics.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>(theil_{i,t})</td>
<td>Natural log of Theil index by region</td>
<td>4.170</td>
<td>1.449</td>
</tr>
<tr>
<td>(eduin_{j,t})</td>
<td>Number of Higher Education Institutions (unit/1000 people)</td>
<td>17.569</td>
<td>8.383</td>
</tr>
<tr>
<td>(hgrad_{j,t})</td>
<td>Number of University Graduates (% of population)</td>
<td>.323</td>
<td>.198</td>
</tr>
<tr>
<td>(infl_{j,t})</td>
<td>Inflation rate (%)</td>
<td>.204</td>
<td>2.639</td>
</tr>
<tr>
<td>(intrst_{i})</td>
<td>Interest Rate Spread (%)</td>
<td>4.963</td>
<td>6.630</td>
</tr>
<tr>
<td>(private_{j,t})</td>
<td>Private enterprises (unit/1000 persons)</td>
<td>0.099</td>
<td>0.120</td>
</tr>
<tr>
<td>(grppcap_{j,t})</td>
<td>Change in GRP per capita (%)</td>
<td>13.501</td>
<td>6.342</td>
</tr>
<tr>
<td>(grprate_{j,t})</td>
<td>Real GRP rate (%)</td>
<td>1.536</td>
<td>5.167</td>
</tr>
<tr>
<td>(patnt_{j,t-3})</td>
<td>Total number of patents granted per 10000 persons (3-year lag applied)</td>
<td>2.168</td>
<td>4.233</td>
</tr>
<tr>
<td>(utility_{j,t-3})</td>
<td>Number of patents granted for utility models per 1000 persons (3-year lag)</td>
<td>1.062</td>
<td>1.862</td>
</tr>
<tr>
<td>(invention_{j,t-3})</td>
<td>Number of patents granted for invention per 1000 persons (3-year lag)</td>
<td>0.301</td>
<td>0.826</td>
</tr>
<tr>
<td>(design_{j,t-3})</td>
<td>Number of patents granted for design per 1000 persons (3-year lag)</td>
<td>0.804</td>
<td>2.034</td>
</tr>
<tr>
<td>(eduFund_{j,t-3})</td>
<td>Education funds as % of GRP (3-year lag)</td>
<td>4.736</td>
<td>1.676</td>
</tr>
<tr>
<td>(saving_{j,t})</td>
<td>Saving rate (natural log of saving deposits)</td>
<td>8.372</td>
<td>1.239</td>
</tr>
<tr>
<td>(msbs_{j,t-3})</td>
<td>Mobile telephone subscribers per 1000 persons (3-year lag)</td>
<td>360.941</td>
<td>297.331</td>
</tr>
<tr>
<td>(unempu_{j,t-3})</td>
<td>Urban unemployment rate (%), 3-year lag</td>
<td>3.581</td>
<td>.812</td>
</tr>
<tr>
<td>(meddns_{j,t})</td>
<td>Health worker density per 1000 residents</td>
<td>5.734</td>
<td>1.904</td>
</tr>
<tr>
<td>(housing_{j,t})</td>
<td>Natural log of average selling price for commercial buildings (yuan/sqm)</td>
<td>8.067</td>
<td>0.626</td>
</tr>
<tr>
<td>(infr_{j,t})</td>
<td>Length of railways and highways over the area of the province</td>
<td>0.687</td>
<td>0.465</td>
</tr>
<tr>
<td>(tenth_{t})</td>
<td>1 if Tenth five-year plan, otherwise 0 (2001-2005)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(elvn_{t})</td>
<td>1 if Eleventh five-year plan, otherwise 0 (2006-2010)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(twelfth_{t})</td>
<td>1 if Twelfth five-year plan, 0 otherwise (2011-2015)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(east_{j}^{3})</td>
<td>1 if Eastern Region, otherwise 0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(middle_{j}^{4})</td>
<td>1 if Middle Region, otherwise 0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(west_{j}^{5})</td>
<td>1 if Western Region, otherwise 0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

3The Eastern region includes: Beijing, Fujian, Guangdong, Guangxi, Hebei, Hainan, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang.
4The Middle/Central region includes Anhui, Heilongjiang, Hubei, Hunan, Inner Mongolia, Jiangxi, Jilin, Shanxi, and Henan.
5The Western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang.
Table 2
Predicted Signs of the Regression Coefficients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sign</th>
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<tbody>
<tr>
<td>$patnt_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$invention_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$design_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$utility_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$infl_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$intrst_t$</td>
<td>-/+</td>
</tr>
<tr>
<td>$grprate_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$edufund_{j,t-3}$</td>
<td>-</td>
</tr>
<tr>
<td>$hgrad_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$saving_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$grppcap_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$middle_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$west_{j,t}$</td>
<td>-</td>
</tr>
<tr>
<td>$tenth_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$elvn_{j,t}$</td>
<td>+</td>
</tr>
<tr>
<td>$unempu_{j,t-3}$</td>
<td>-</td>
</tr>
</tbody>
</table>
### Table 3

Results of 2SLS.

<table>
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<tr>
<th></th>
<th>OLS</th>
<th>2SLS&lt;sup&gt;i&lt;/sup&gt;</th>
<th>OLS</th>
<th>2SLS&lt;sup&gt;ii&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>( patnt_{j,t-3} )</td>
<td>-0.016**</td>
<td>-0.015</td>
<td>-0.025</td>
<td>-0.200</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.011)</td>
<td>(0.051)</td>
<td>(0.221)</td>
</tr>
<tr>
<td>( invention_{j,t-3} )</td>
<td></td>
<td></td>
<td>-0.013</td>
<td>-0.216**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.019)</td>
<td>(0.097)</td>
</tr>
<tr>
<td>( design_{j,t-3} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( utility_{j,t-3} )</td>
<td></td>
<td></td>
<td>-0.017</td>
<td>0.267</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.033)</td>
<td>(0.183)</td>
</tr>
<tr>
<td>( infl_{j,t} )</td>
<td>-0.005</td>
<td>-0.003</td>
<td>-0.005</td>
<td>-0.011</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.010)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>( intrst_{j,t} )</td>
<td>-0.008**</td>
<td>-0.009**</td>
<td>-0.008**</td>
<td>-0.009**</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>( grprate_{j,t} )</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>( edufund_{j,t-3} )</td>
<td>0.082**</td>
<td>0.082***</td>
<td>0.082***</td>
<td>0.101***</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.018)</td>
<td>(0.017)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>( hgrad_{j,t} )</td>
<td>-0.759***</td>
<td>-0.551</td>
<td>-0.739***</td>
<td>-1.166***</td>
</tr>
<tr>
<td></td>
<td>(0.171)</td>
<td>(0.183)</td>
<td>(0.184)</td>
<td>(0.322)</td>
</tr>
<tr>
<td>( saving_{j,t} )</td>
<td>0.104***</td>
<td>0.109***</td>
<td>0.102***</td>
<td>0.147***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.031)</td>
<td>(0.028)</td>
<td>(0.038)</td>
</tr>
<tr>
<td>( grppcap_{j,t} )</td>
<td>0.004</td>
<td>0.000</td>
<td>0.004</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>( middle_{j,t} )</td>
<td>-2.944***</td>
<td>-2.994***</td>
<td>-2.944***</td>
<td>-3.013***</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.065)</td>
<td>(0.061)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>( west_{j,t} )</td>
<td>-1.695***</td>
<td>-1.618***</td>
<td>-1.693***</td>
<td>-1.646***</td>
</tr>
<tr>
<td></td>
<td>(0.069)</td>
<td>(0.072)</td>
<td>(0.069)</td>
<td>(0.086)</td>
</tr>
<tr>
<td>( tenth_{j,t} )</td>
<td>-0.087</td>
<td>0.056</td>
<td>-0.087</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
<td>(0.089)</td>
<td>(0.068)</td>
<td>(0.103)</td>
</tr>
<tr>
<td>( elvn_{j,t} )</td>
<td>0.195***</td>
<td>0.249***</td>
<td>0.195***</td>
<td>0.327***</td>
</tr>
<tr>
<td></td>
<td>(0.065)</td>
<td>(0.071)</td>
<td>(0.065)</td>
<td>(0.103)</td>
</tr>
<tr>
<td>( unempu_{j,t-3} )</td>
<td>-0.083***</td>
<td>-0.029</td>
<td>-0.085***</td>
<td>-0.015</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.033)</td>
<td>(0.031)</td>
<td>(0.046)</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.218***</td>
<td>-3.560***</td>
<td>-3.201***</td>
<td>-3.966***</td>
</tr>
<tr>
<td></td>
<td>(0.296)</td>
<td>(0.371)</td>
<td>(0.301)</td>
<td>(0.449)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.85</td>
<td>0.867</td>
<td>0.850</td>
<td>0.825</td>
</tr>
<tr>
<td>N</td>
<td>496</td>
<td>450</td>
<td>496</td>
<td>450</td>
</tr>
</tbody>
</table>

Standard errors are presented in parenthesis beneath the coefficients. ***, **, * indicate significance at 1%, 5%, 10% level respectively.
Table 4

Moran’s I statistics.

<table>
<thead>
<tr>
<th></th>
<th>Moran’s I</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{invention}_{j,t-3}</td>
<td>-0.057*</td>
</tr>
<tr>
<td></td>
<td>(-0.033)</td>
</tr>
<tr>
<td>\textit{utility}_{j,t-3}</td>
<td>-0.068**</td>
</tr>
<tr>
<td></td>
<td>(-0.033)</td>
</tr>
<tr>
<td>\textit{design}_{j,t-3}</td>
<td>-0.098***</td>
</tr>
<tr>
<td></td>
<td>(-0.033)</td>
</tr>
</tbody>
</table>

Standard errors are presented in parenthesis beneath the coefficients. ***, **, * indicate significance at 1%, 5%, 10% level respectively.
Table 5
Results of the Spatial Durbin Fixed Effects Regressions Model with Marginal Effects.

<table>
<thead>
<tr>
<th></th>
<th>K</th>
<th>Θ</th>
<th>Direct</th>
<th>Indirect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P</strong></td>
<td>0.300***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>design</strong>_{jt-3}</td>
<td>0.248***</td>
<td>0.054***</td>
<td>-0.146</td>
<td>-0.057</td>
<td>-0.203***</td>
</tr>
<tr>
<td></td>
<td>(0.088)</td>
<td>(0.012)</td>
<td>(0.091)</td>
<td>(0.084)</td>
<td>(0.044)</td>
</tr>
<tr>
<td><strong>utility</strong>_{jt-3}</td>
<td>0.196</td>
<td>0.037***</td>
<td>-0.097</td>
<td>-0.043</td>
<td>-0.140***</td>
</tr>
<tr>
<td></td>
<td>(0.149)</td>
<td>(0.011)</td>
<td>(0.076)</td>
<td>(0.068)</td>
<td>(0.036)</td>
</tr>
<tr>
<td><strong>invention</strong>_{jt-3}</td>
<td>-0.277</td>
<td>-0.094***</td>
<td>0.265*</td>
<td>0.077</td>
<td>0.342***</td>
</tr>
<tr>
<td></td>
<td>(0.249)</td>
<td>(0.028)</td>
<td>(0.154)</td>
<td>(0.126)</td>
<td>(0.102)</td>
</tr>
<tr>
<td><strong>grpcap</strong>_{jt}</td>
<td>0.075***</td>
<td>0.011***</td>
<td>-0.029</td>
<td>-0.015</td>
<td>-0.044***</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.001)</td>
<td>(0.022)</td>
<td>(0.022)</td>
<td>(0.005)</td>
</tr>
<tr>
<td><strong>hgrad</strong>_{jt}</td>
<td>-6.937***</td>
<td>-0.606***</td>
<td>1.333</td>
<td>1.208</td>
<td>2.541***</td>
</tr>
<tr>
<td></td>
<td>(1.660)</td>
<td>(0.131)</td>
<td>(1.780)</td>
<td>(1.759)</td>
<td>(0.486)</td>
</tr>
<tr>
<td><strong>meddns</strong>_{jt}</td>
<td>-0.605***</td>
<td>0.074***</td>
<td>-0.275***</td>
<td>0.050</td>
<td>-0.225***</td>
</tr>
<tr>
<td></td>
<td>(0.176)</td>
<td>(0.011)</td>
<td>(0.088)</td>
<td>(0.082)</td>
<td>(0.042)</td>
</tr>
<tr>
<td><strong>housing</strong>_{jt}</td>
<td>-3.551***</td>
<td>-0.130**</td>
<td>0.130</td>
<td>0.533</td>
<td>0.663***</td>
</tr>
<tr>
<td></td>
<td>(0.814)</td>
<td>(0.057)</td>
<td>(0.801)</td>
<td>(0.775)</td>
<td>(0.219)</td>
</tr>
<tr>
<td><strong>saving</strong>_{jt}</td>
<td>5.265***</td>
<td>0.047</td>
<td>0.248</td>
<td>-0.719</td>
<td>-0.471***</td>
</tr>
<tr>
<td></td>
<td>(0.983)</td>
<td>(0.035)</td>
<td>(1.056)</td>
<td>(1.045)</td>
<td>(0.110)</td>
</tr>
<tr>
<td><strong>unempu</strong>_{jt-3}</td>
<td>-0.040</td>
<td>0.047***</td>
<td>-0.150</td>
<td>-0.014</td>
<td>-0.164***</td>
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<tr>
<td></td>
<td>(0.168)</td>
<td>(0.012)</td>
<td>(0.054)</td>
<td>(0.046)</td>
<td>(0.041)</td>
</tr>
<tr>
<td><strong>edufund</strong>_{jt-3}</td>
<td>0.523***</td>
<td>-0.012</td>
<td>0.076***</td>
<td>-0.066</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>(0.134)</td>
<td>(0.010)</td>
<td>(0.099)</td>
<td>(0.096)</td>
<td>(0.034)</td>
</tr>
<tr>
<td><strong>infl</strong>_{jt}</td>
<td>-0.044</td>
<td>-0.010***</td>
<td>(0.026)</td>
<td>0.011</td>
<td>0.036***</td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
<td>(0.002)</td>
<td>0.021</td>
<td>(0.021)</td>
<td>(0.006)</td>
</tr>
<tr>
<td><strong>intrst</strong>_{jt}</td>
<td>-0.049</td>
<td>0.002</td>
<td>-0.009</td>
<td>0.005</td>
<td>-0.004***</td>
</tr>
<tr>
<td></td>
<td>(0.088)</td>
<td>(0.001)</td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.001)</td>
</tr>
<tr>
<td><strong>R^2</strong></td>
<td>0.023</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>496</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Standard errors are presented in parenthesis beneath the coefficients. ***, **, * indicate significance at 1%, 5%, 10% level respectively.
Table 6

Summary of percentile shifts, 10\textsuperscript{th} to 25\textsuperscript{th} percentile.

<table>
<thead>
<tr>
<th>Variable</th>
<th>2SLS models</th>
<th>SDM results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2SLS\textsuperscript{I}</td>
<td>2SLS\textsuperscript{II}</td>
</tr>
<tr>
<td>( patnt_{j,t-3} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( invention_{j,t-3} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( design_{j,t-3} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( utility_{j,t-3} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( infl_{j,t} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( intrst_t )</td>
<td>-0.001**</td>
<td>0.001**</td>
</tr>
<tr>
<td>( grprate_{j,t} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( edufund_{j,t-3} )</td>
<td>0.008***</td>
<td>0.041***</td>
</tr>
<tr>
<td>( meddns_{j,t} )</td>
<td>ns</td>
<td>-0.188***</td>
</tr>
<tr>
<td>( hgrad_{j,t} )</td>
<td>ns</td>
<td>-0.089***</td>
</tr>
<tr>
<td>( saving_{j,t} )</td>
<td>0.095***</td>
<td>0.129***</td>
</tr>
<tr>
<td>( hous_{j,t} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( grppcap_{j,t} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( middle_{j,t} )</td>
<td>-2.994***</td>
<td>-3.013***</td>
</tr>
<tr>
<td>( west_{j,t} )</td>
<td>-1.618***</td>
<td>-1.646***</td>
</tr>
<tr>
<td>( tenth_{j,t} )</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>( elvn_{j,t} )</td>
<td>-1.646***</td>
<td>0.327***</td>
</tr>
<tr>
<td>( unempu_{j,t-3} )</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

***, **, * indicate significance at 1\%, 5\%, 10\% level respectively, ns indicates statistically insignificant finding.
References


Dijk, M., & Granneman, A. (2015). Foreign direct investment in China, the factors determining a preference for investing in Eastern or Western provinces. *Modern Economy, 6*, 924-936. http://dx.doi.org/10.4236/me.2015.68087


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