The Electronics Hardware Innovation Cluster in Shenzhen, China:

Contemporary and Future Dimensions

from an Agglomeration, Institutional, and Built Environment Context

by

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ABSTRACT

Being on the frontline of China's ambition to internalize hi-tech supply chains (e.g., "Made in China 2025" campaign) and on the cusp of global tech competition (e.g., U.S.-China tensions), much strategic significance is given to the electronics hardware innovation cluster in Shenzhen, better known as "the world's hardware capital". This study investigates the latest dynamics of Shenzhen's electronics cluster from the perspectives of agglomeration, institutions, and the built environment.

The study found that despite different interpretations of the trade-off between agglomeration economies and diseconomies by both firms and analysts, increasingly diverse types of firms and intra-firm functions spillout from Shenzhen to surrounding areas, such as Dongguan and Huizhou in the Greater Bay Area. Institutionally the dissertation found that recent major external context changes, namely the pandemic, trade war, and financial and property economy fever, have not significantly changed the innovation culture in Shenzhen. As for the built environment dimension, in the context of policy thrusts, market forces, and stakeholder interests, gentrification of affordable rental housing in urban villages only happens in a modest way, without significant displacement of labor forces serving Shenzhen's electronics industry.

Policy implications include: (i) More administrative and planning co-operation should occur between Shenzhen and surrounding municipalities, given the increasingly diverse types of firms and intra-firm functions spilling out from Shenzhen; (ii) For local government, cultivating innovation culture in a cluster is a long-term task, which requires persistent building of a favorable policy environment for many years; (iii) In terms of built environment policy-making in innovation clusters (both living and working environments),

more attention should be paid to implementation mechanisms; (iv) Areas surrounding Shenzhen, potentially the future spatial focus for Shenzhen's future innovation, should be of higher policy significance.

Theoretical insights include: (i) Better understanding of mechanisms underlying the spatial growth of clusters at the sub-regional scale; (ii) The importance of the long-term in the formation of cluster institutions and culture, even in the face of short-term strong context changes; (iii) The built environment is both a driver and product of industrial clustering; (iv) Integrated study of the agglomeration, institutional, and built environment dimensions of cluster dynamics will yield new insights.

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CHAPTER 1

INTRODUCTION TO TOPIC

This dissertation studies the latest dynamics of Shenzhen's electronics cluster from dimensions of agglomeration, institution, and built environment, using three case studies to integrate all three dimensions into a more unified theoretical framework of innovation clusters. The concept of clusters, defined as "geographical proximate group of interconnected companies and associated institutes in a particular field, linked by commonalities and externalities", has profound influences on both academic research (Maskell and Kebir, 2006) and policy-making (Palazuelos, 2005). The terms "cluster" and "innovation cluster" are often interchangeable because clusters are perceived to boost innovation (Preissl and Solimene, 2003; Fang, 2015). The discussion of innovation clusters is characterized by dimensions of agglomeration, institution, and built environment (Li et al, 2019). Clusters are the key concept underlying economic development theory and practice.

The electronics industry in Shenzhen is selected as the case not only for its compatibility with the concept of innovation clusters, but also because of its strategic significance both domestically and globally. Frequently referred to as "the world's hardware capital" or "the Silicon Valley of hardware", Shenzhen produces 90% of the world's consumer electronics (Yakowicz, 2015). It challenges the traditional perception that manufacturing in China is just the dumb execution of, and geographically split from, western creativity (Lindtner, 2015). Being home to leading hardware firms (e.g., Huawei - the world's largest telecom equipment maker; DJI - the drone maker accounting for over 70% of global market share)

and an efficient tech manufacturing ecosystem, Shenzhen is on the frontline of China's ambition to be the global technology leader (as described by the, "Made in China 2025" campaign), and consequently on the cusp of global tensions, especially U.S.–China technology competition and trade dispute.

Research significance is stated in chapter 2 which immediately follows this introduction. In chapter 3, relevant academic literature is reviewed to identify research gaps pertaining to the concept of innovation clusters, followed by chapter 4 where research questions are proposed based on the latest dynamics in Shenzhen. Chapters 5 discusses the methodology. Chapters 6, 7, and 8 show the results of agglomeration, institutional, and built environment studies respectively. Chapter 9 puts different dimensions together to yield an integrated vision for Shenzhen's electronics cluster, contributes to the advancement of innovation cluster theory, and puts forward policy implications.

CHAPTER 2

RELEVANCE OF STUDY

2.1 Intellectual Merit

Although Shenzhen's electronics industry attracts massive media exposure, the same superficial story of Shenzhen's transition from sweatshop to fab lab has been told repeatedly by different channels. In contrast, in-depth and critical academic research on this subject matter seems surprisingly scarce. Only a very few peer-reviewed articles assess the ecosystem of electronics production in Shenzhen, all of which reflect authors' fieldwork back in early 2010s. Considering Shenzhen's fast development pace and the rapidly changing global economy, the value of this existing literature is questionable. Therefore, this dissertation provides a much-needed update on the "Silicon Valley of hardware" oriented to contributing to the body of academic literature.

The dissertation will advance knowledge of innovation clusters using Shenzhen as the case. The concept of innovation cluster, informed by several global best practices, e.g., Silicon Valley (U.S.), Tsukuba Science City (Japan), and Emilia-Romagna (Italy), has important policy implications in science & technology and economic development. However, most well-known cases took off and prospered in the late twentieth century; thus learning from their takoffs may be a bit outdated after two decades' of socio-economic changes. In terms of Shenzhen, the rise of "the world's hardware capital" is relatively recent, being able to better put the cluster concept within the context of contemporary urbanization and technological advancement. Moreover, the success of a few "superstar cases" often make policymakers blindly pursue certain panacea industrial pathways or replicate others'

experience without considering the importance of the industrial type underlying the cluster. Local government needs to realistically tailor its cluster policy based on the region's own economic base, since scholars have already identified the huge variation across sectors in terms of clustering mechanisms and impacts. The contribution of this dissertation lies in contributing to the understanding of the innovation cluster model for tech manufacturing specifically.

2.2 Broader Impacts

An associated output of the dissertation is to provide context for international decision-making involving global hi-tech competition, directly or indirectly. Given China's recent aggressive technological moves, other countries, especially developed ones, demand more updated and critical evidence to inform their responses for the sake of their economic prosperity and national security, which have been built upon technological superiority. For the United States, which is currently locked in tension with China, Shenzhen is very likely to be involved in any future agreements made between the two countries. Knowing Shenzhen better could help the U.S. identify potential collaborative opportunities, rather than pushing the rivalry to an extreme. Meanwhile, during the current 4IR (fourth industrial revolution), many countries such as Germany and India have given strategic priority to IoT (Internet of Things) and IIoT (Industrial Internet of Things). Better understanding of dynamics in Shenzhen could be indicative in informing this wave of global tech competition, since Shenzhen is the major manufacturing hub globally of connected devices. More importantly, experience from Shenzhen reflects how the pattern of tech production could be altered under the fourth industrial revolution. It is of precautionary value to

countries like China considering that lower wage developing countries are likely to lose attractiveness in the age of more intelligent manufacturing.

Insights from this study can serve as guidance for foreign multinationals and start-ups who plan to expand their operations to Shenzhen, as companies from other countries do not have as much information on Shenzhen as their Chinese counterparts. Information on Shenzhen from this study may interest a wider audience in the general public, due to the increased prevalence of topics like IoT and 4IR in global media, which will affect everyone's life eventually.

China itself also benefits from this study results. Shenzhen is the core of China's most important national strategies, including "Made in China 2025" and "Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area"[1]. Further revision and implementation of these policy documents can be informed by the dissertation. Shenzhen is a long-time flagship laboratory of economic reform in China. This status was recently reinforced by the State in 2019 as the response to Hong Kong turmoil. The dissertation contributes to policymaking in cities that want to learn from Shenzhen.

[1] "Made in China 2025" is a broad umbrella industrial plan China introduced in 2015—seeks to boost China's economic competitiveness by advancing China's position in the global manufacturing value chain, leapfrogging into emerging technologies, and reducing reliance on foreign firms. It seeks to engineer a shift for China from being a low-end manufacturer to becoming a high-end producer of goods. The goal is to tap into China's increasingly wealthy home consumer base as well as the value-added global sourcing segment

"Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area" is the Chinese government's grand plan to integrate Hong Kong, Macau and nine southern mainland cities into one huge megacity in order to become a leading hub for innovation and economic growth thus rivaling Silicon Valley and Tokyo Bay Area.

CHAPTER 3

LITERATURE REVIEW

3.1 Agglomeration Literature: Agglomeration Asymmetry and "Borrowed Size"

Agglomeration economies are the classical explanation for spatial clustering phenomena based on Marshall's (1919) trinity of specialization, labor pooling, and knowledge spillover. However, clusters may result in agglomeration diseconomies when they become larger and older. Excessive co-location and increased competition result in lower output profit (due to product isomorphism), higher input costs (including land/housing, labor, material, and services), unintentional outflow of valuable knowledge, and degradation of environmental quality (Porter, 1990; Shaver and Flyer, 2000; Zheng, 2001, Lavie, 2006; Folta et al, 2006, Pandit, 2018).

Given agglomeration effects have been widely recognized, empirical studies turned to explore how these effects are moderated by firm heterogeneity. McCann and Folta (2011) found that for U.S. bio-tech firms, those with deeper knowledge stocks and younger firm age benefit more from knowledge spillover in Clusters. Across Canadian manufacturing clusters, Pe'er and Keil (2013) indicated that start-ups with less total assets and superior human resources benefit more from local specialization and labor pooling and suffer less from local competition. In London's Financial service cluster, multinationals benefit less from specialized suppliers and reputational effects but suffer more from agglomeration diseconomies compared to their uni-national counterparts, (Pandit et al, 2018).

Agglomeration literature also features the balance between agglomeration economies and diseconomies, reflected in the discussion of "borrowed size". The term "borrowed size" implies that people and business retain advantages of being in smaller settlements (e.g., lower rents and congestion) whilst reaping advantages from nearby larger settlements (e.g., access to sizeable market, business services, and knowledge, larger and more diverse labor market) (Alonso, 1973; Phelps et al, 2001; Meijers and Burger, 2017). Agglomeration benefits are not as spatially constrained as agglomeration diseconomies in the case of "borrowed size" (Parr, 2002). Meanwhile, different positive agglomeration externalities are borrowed at different spatial scales, as pecuniary externalities (dispersed supply chain) are more mobile than technological externalities (localized learning and innovation) (Phelps 2004; Polenske, 2006). Evidence of "borrowed size" has been found for clusters: for U.S. bio-tech firms, distance from the center of a top-10 cluster matters, but that location within or outside of that cluster per se does not (Maine et al, 2010).

Based on the two lines of literature above, it can be assumed that the "borrowed size" phenomenon should be also asymmetric when moderated by firm heterogeneity. When agglomeration diseconomies in a cluster reach a certain degree, heterogeneous trade-offs between distance-decaying agglomeration benefits and costs are supposed to cause firms' differentiated locational behaviors. Business strategies behind these trade-offs may need particular attention, e,g., establishing branches in clusters and allying with cluster tenants let isolated firms tap into agglomeration benefits (McCann and Folta, 2008). Researching asymmetric "borrowed size" can shed light on the spatial evolution pattern of a cluster and its impact on other areas or even enable exploration of the possibility of a new cluster

spinning off the original one. However, such a perspective is overlooked both conceptually and empirically.

3.2 Cluster Institution Literature: Multi-level Interaction Perspective

The institutional dimension is indispensable in conceptualizing clusters, which explains the performance and development paths of different clusters (Gareev, 2012; Bembenek, 2015). In terms of informal institutions, firms within the same cluster share similar cultural codes to build trust, social capital, and informal networks that facilitate collaboration, learning, or even alliance formation (ibid), as illustrated by Saxenian's (1994) famous work on Silicon Valley and Route 128 in Boston. Formal institutions in clusters reflect what cluster policies try to catalyze (Parto, 2008). Rather than being an individual category, "cluster policy" is actually the repacking of existing instruments in economic and science & technology policies adopted more widely (Nauwelaers, 2001; Hospers and Beugelsdijk, 2002; Burfitt and Macneill, 2008).

Cluster institutions at the local level do not exist independently from larger-scale environments. Both public services and informal practices in a cluster can be considered to bridge the nation's institutional void, which forms a strong attraction to firms, especially SMEs, without sufficient resources (Schrammel, 2013). Empirically, Konstantynova and Lehmann (2017) compared cluster institutions across different European countries, finding that clusters in countries that rank low in political transformation/contract enforcement/access to credit are more likely to offer activities to remedy these deficiencies (and vice versa).

Informal institutions associated with a cluster can also bridge the institutional void in the wider environment. Under weak formal institutions (e.g., legal protection for properties, banking, contract enforcement) in developing countries, informal safeguards based on localized social norms are important for geographically proximate firms (Bell et al, 2009; Geng and Huang, 2017). For example, in the case of Wenzhou's apparel and accessory cluster, considered low-profile in China, financing is mainly conducted through an informal source called "Hui" where borrowing relies on kinship and friendship networks (Cai, 2010).

The structure of informal institutions in a cluster is affected by formal institutions of both the cluster and wide contexts. It is exemplified by two cases documented by Parto (2008): i) in the Durban automotive cluster, South Africa, the shift of national governance ideology from protective self-sufficiency to liberalization brought in international players (e.g., Toyota) whose high production standards create new mental models for domestic producers; ii) in the Damietta Furniture Cluster, Egypt, the officially established Association for Upgrading the Furniture Sector in Damietta (AUFSD) changed cluster members' business attitude from individualistic to collaborative.

Rather than simply describing different cluster institutions per se, scholars started to realize their interactive nature. The formal-informal institutional interaction has been discussed in fields like forest management (Osei-Tutu et al, 2015) and comparative politics (Helmke and Levitsky, 2004; Grzymala-Busse, 2010). But for studies on clusters, normally

considered localized systems, the institutional interaction analysis should go beyond just the study area, so as to achieve a more holistic understanding of why certain cluster institutions exist and how they function within contexts. Therefore, researching cluster institutions needs to consider a wide array of possible interactions between (both formal and informal) institutions of the cluster and wider environments (regional, national, and global contexts).

3.3 Cluster Built Environment Literature: The Overlooked Housing Dimension

The built environment perspective is recently drawing more attention when discussing innovation clusters. The prevailing place-based notion is largely based on Florida's "creative class" theory (2014), where higher-end talents are primarily attracted by the quality of place in a vibrant downtown environment, i.e., mixed-use, compactness, walkability, third space, the authenticity of cultural amenities, and tolerance of diversity, etc. Accordingly, inner-city cluster concepts like "Urban Innovation District" (Katz and Wagner, 2014) were proposed, exemplified by 22@Barcelona (Spain), One-North (Singapore), and the Boston Seaport District (U.S.), etc.

In the built environment dimension, despite the positive correlation between innovation clustering and quality of place (as "soft factors") (Haimidi and Zandiatashbar, 2019; Credit, 2019; Zandiatashbar et al, 2019), housing affordable/availability (as "hard factors") seems more decisive in shaping talents' locational choices (Murphy and Redmond, 2009; Lawton et al, 2013; Frenkel et al, 2013; Brown, 2015). In a cluster where labor is highly concentrated, low housing affordability is inevitable due to the overwhelming demand.

Silicon Valley has the highest housing costs in the U.S. (Brinklow, 2019). For Zhongguancun, Beijing, public affordable housing can only be supplied in inconvenient outer suburbs (Miao, 2017). In the current discussion on cluster built environment, too much focus on Florida's elitist place-making could make the affordability issue even worse. Therefore, housing gentrification in clusters deserves more attention, since it might push out labor, especially those with lower socio-economic status, e.g., young professionals and lower income employees in essential consumer services and labor-intensive sectors. Researching clusters' housing dimension also contributes to the wider discussion on housing's linkage to local economic development, as housing has been historically considered as an economic sector (construction and real estate) or even an adjunct to development (Harris and Arku, 2006).

In literature on clusters and related fields, housing issues are closely related to policy. Severe job-housing imbalance in Silicon Valley is more of a policy failure. In the absence of regional or state pressures or incentives, local communities have restricted housing growth for either fiscal or exclusionary reasons, causing local worker displacement and longer commutes (Cervero, 1996). On the other hand, policymakers often proactively launch gentrification in clusters (Wang, 2011; Gu, 2014), backed by the argument that better physical environments are inputs to higher value production, e.g., reproduction of labor power (healthy and creative laboring bodies) and more diverse social mix with increased knowledge spillovers (Stehlin, 2016). But gentrification always goes with side effects such as exacerbating inequality, reducing affordable housing, and pushing out certain industries (Lees et al, 2008; Booyens, 2012; Lester and Hartley, 2014). In that case,

gentrification is sometimes justified by coupling with policy measures offsetting associated negative impacts, e.g., public efforts to provide affordable housing in Chattanooga's gentrifying innovation district (Morisson and Bevilacqua, 2019).

The literature on gentrification in general also indicates that both causes and effects of gentrification are affirmatively incorporated into public policy (Lees and Ley, 2008). Considering the interests of existing residents in vulnerable social groups, contemporary policy innovation is searching for new ways to justify gentrification through promised benefits (e.g., deconcentration of poverty, better opportunities for local communities) and neutralize negative impacts like displacement (Wyly and Hammel, 2008). Correspondingly, policies supporting gentrification can co-exist with policies modifying gentrification at the same place and the same time (Bernt, 2012). However, those policy combinations always fail to put a halt to displacement epecially in its indirect and long-term impacts (Shaw, 2008). Given public policy's lack of capability to date to manage gentrification's negative effects measured in terms of social justice and equity, it would be interesting to see the effects of gentrification policy when developing high-value innovation clusters is the over-riding goal.

CHAPTER 4

RESEARCH QUESTIONS

4.1 The Shenzhen Case

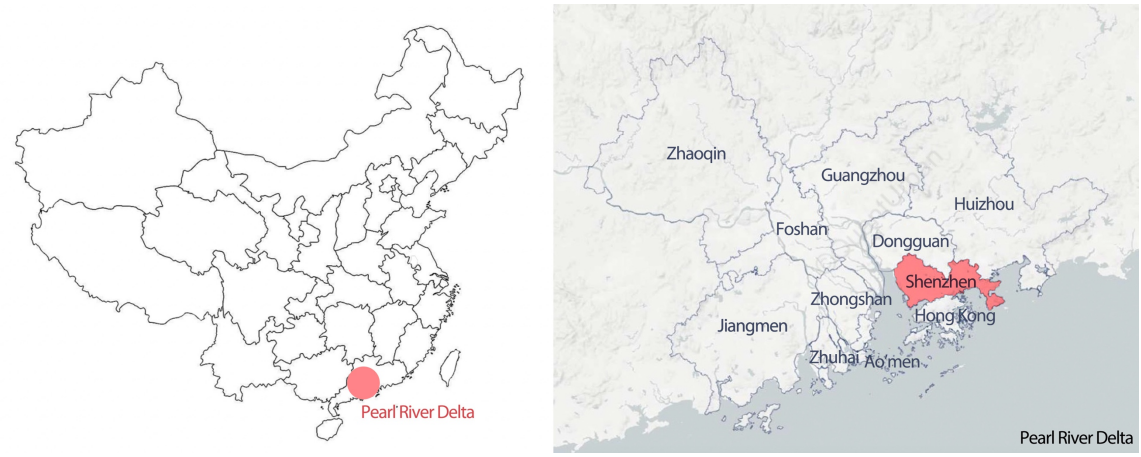

Figure 4.1: Location of Shenzhen

Shenzhen is a sub-provincial level coastal city in Guangdong Province and one of China's first-tier cities. Bordered by Hong Kong on the south, Shenzhen is located in Pearl River Delta – the world's largest continuously urbanized area (The Guardian, 2015). The last forty years have witnessed Shenzhen's urban miracle from a sleepy border fishing village to one of the most developed cities in China. The Gross Domestic Product (GDP) has increased from 196.38 million yuan in 1979 to 2,249 billion yuan in 2018 (ranking 3rd among all Chinese mainland cities) (Shenzhen Statistics Bureau, 2018a; 2018b), with an average annual growth rate of 27.88% over the foregoing period. Four types of industries anchor Shenzhen's economy, namely hi-tech, finance, cultural/creative, and logistics, each account for 32.8%, 13.64%, 6.82%, and 10.15% of GDP respectively (Shenzhen Statistics

Bureau, 2018b). Electronics & information manufacturing make up 61.3% of industrial added value in 2018 (Shenzhen Industrial Internet Alliance, 2019). Driven by a large inflow of migrants from all over China, Shenzhen's population has grown from about 30,000 in 1979 to 22 million today (Kam Ng, 2003; China Mobile, 2018) (the official data only capture 12.53 million residents, omitting large numbers of temporary migrants and informal settlement tenants). Shenzhen has a hilly terrain where about half of its land is unbuildable. Although Shenzhen consists of ten districts with a total area of 1,997 sq.km, it is almost built up with 923.25 sq.km constructed in 2016 (MOHURD, 2018).

Pearl River Delta is at the far southern end of the mainland and separated from the nation's vast territory by a wide range of high mountains, such remoteness underlies the region's historical characteristics of autonomy, flexibility, and revolution regardless of the control by the central state. The delta region's location of coastal frontier has made it China's traditional southern gateway for foreign trade and sea transportation. Although economic activities in the region had been greatly disrupted by the socialist campaigns during the 50s-70s, the delta's close proximity to Hong Kong and Macao have enabled it to become the first region to benefit substantially from China's open door policy initiated in 1979 (Lin, 1994). Long being a sleepy fishing village within the Pearl River Delta, Shenzhen was once only the major source of illegal immigrants into the then booming capitalist haven of Hong Kong. However, since 1979, Shenzhen has rapidly transformed the agriculture-based country into a 21st century metropolis based on the imagination and bold experimentation of the government and urban planners who had no prior experience of planning for the growth of the invisible hand in a fledgling socialist market economy (Kam Ng, 2003).

Shenzhen is selected as the case due to its high concentration of the electronics industry: Shenzhen accounts for 1/6 of China's total in terms of the electronics industry scale, leading the nation (Shenzhen Industrial Internet Alliance, 2019). The city's electronics manufacturing ecosystem has evolved from the early 80s when Shenzhen was designated as one of China's first batch of SEZs (special economic zones) – the flagship laboratory of economic and institutional reform for the whole country. In the 80s, Shenzhen started with exported-oriented manufacturing of simple electronics products (e.g., radios, electronics watches). In the wave of privatization reform in the 90s, emerging local entrepreneurs established self-owned brands for growing domestic demand in home appliance (e.g., video & music players). The ecosystem featuring modularized components, specialized suppliers, and open platforms was formed at that time. Around the mid-late 2000s, the "Shanzhai" mode – the agile production of counterfeits of globally branded goods, especially mobile phones, was derived from this ecosystem. By the 2010s, the legacy of the Shanzhai ecosystem became the gold mine for global hardware innovators working on new digital products, e.g., smart wearable devices, intelligent home appliances, new transport modes, robots.

4.2 Agglomeration Dimension

For electronics hardware making, the industrial chain is highly specialized and horizontal in Shenzhen. Suppliers with less strict minimum order quantity limits, lightning-fast response, and flexible customization make prototyping in Shenzhen take as little as one-fifth the time at half the cost as doing such work in-house (Woetzel et al, 2015). In terms

of knowledge spillover, design schematics and related bills of material (BOM), are often shared publicly as advertisements with explicit references to suppliers who either customize the design or produce certain components (Huang, 2017). Tacit knowledge of factory capacity and component materiality spread on the factory floor (Li, 2014; Lindtner et al, 2015). The labor pooling in Shenzhen benefits from both existing technology giants which is the main source of entrepreneurs or core staff in startups, as well as urban villages that provide affordable housing for massive numbers of migrant workers. Having a critical mass also facilities building social networks and social capital in the local business community, through informal gatherings and co-working in incubators & accelerators (The Economist, 2017).

Despite unparalleled advantages to being in Shenzhen, the electronics industry is reportedly spilling outwards due to rising agglomeration diseconomies. Giant companies keep expanding to surrounding areas, followed by other firms in their supply chains. Huawei started to move its device business around Dongguan's Songshan Lake to the northwest of Shenzhen in 2012 and recently undertook a major expansion involving moving 16,800 employees from Shenzhen to that location in 2018. In 2014, ZTE moved its manufacturing base to Heyuan – a city 200km away from Shenzhen. The major agglomeration diseconomy that pushes firms out is rapidly growing land cost and consequently labor cost. Due to severe land shortages, some firms were charged 40% more for renewing factory leases in late 2018. Labor cost has increased by up to 50% since 2018.

Some firms tend to leave their R&D and marketing departments in Shenzhen while moving larger-scale manufacturing functions to surroundings, as the strategy to take advantage of Shenzhen's industrial chain with lower costs (Want Daily, 2016). Manufacturing functions within Shenzhen are also evolving towards small-scale prototyping and intelligent manufacturing. Nevertheless, in early 2019, the media reported that a few firms came back to Shenzhen after leaving. Moving out of Shenzhen means higher searching costs (for both suppliers/consumers, capital, labor force, information) and institutional transaction costs (immature local policies and regulations), which might not be offset by land and labor cost savings in some places (Fang.com, 2019).

Based on the foregoing dynamics, Shenzhen's electronics cluster is undergoing reconfiguration. With firms' different responses to rising agglomeration diseconomies, firm composition in Shenzhen is likely to change. Therefore, the research question for the agglomeration dimension of the dissertation is:

How does firm heterogeneity affect the trade-off between agglomeration economies and diseconomies, as reflected in different locational behaviors of staying/leaving Shenzhen among firms and in intra-firms functions?

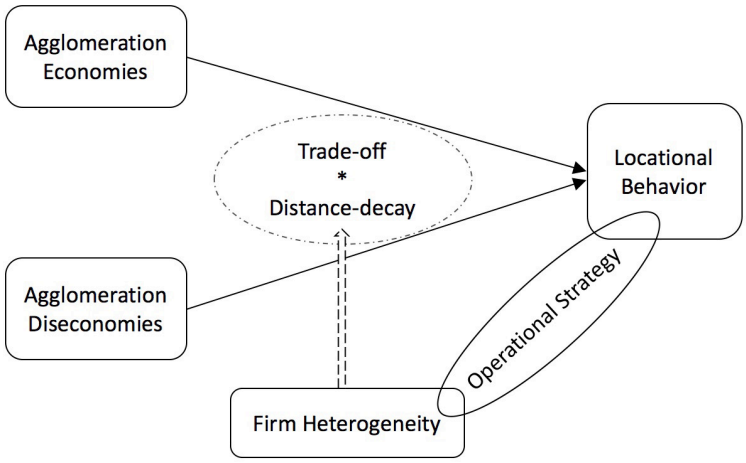

Figure 4.2: Conceptual Framework of Asymmetric "Borrowed Size"

The question above is informed by the asymmetric "borrowed size" assumption conceptualized in Section 3.1. Whether a firm chooses to stay, leave, or move part of its functions out of Shenzhen depends on its balance between distance-decaying benefits and costs related to clustering benefits. Different perceptions on this trade-off across firms lead to spatial evolution and spillover of clusters. The conceptual framework is shown in Figure 4.1. It should be noted that there is a certain overlap between internal firm heterogeneity and locational behavior, e.g., multi-site operations / branch establishment.

4.3 Institutional Dimension

Shenzhen's electronics cluster is characterized by a grassroots innovation culture illustrated by driven migrant entrepreneurs' aggressive survival techniques (e.g., unauthorized reverse-engineering and production, tax evasion). Behind this are the ideologies of anti-authority, democratizing technology production, and valuing material production over intangible ideas (Keane and Zhao, 2012; Cartier et al, 2005; Qiu, 2009;

Huang, 2017). Pursuing quick profit out of rapid and low-cost product iterations is the norm; this culture encourages incremental innovations that apply, modify, or combine existing technologies and designs. Shenzhen's success at mid-low-end electronics production has been largely ascribed to the local government's laissez-faire approach featuring bottom-up experiments and tolerance (China Development Institute, 2016; Peng et al, 2009). Under the strong utilitarian orientation, fundamental innovation in high-value products and cutting-edge fields (e.g., semiconductor chips; numerical control) are far less emphasized. In this regard, despite the proliferation of electronics products designed and made in Shenzhen, the local electronics industry still largely relies on imported core technologies and mainly targets lower-end markets with highly homogenous products, thus not capturing much value added.

However, rapidly changing domestic and international environments seem to be impacting Shenzhen's business culture on its attitude to more critical fundamental innovation. During the U.S.- China trade war, import bans on key components (e.g., integrated circuit chip) drives self-innovation on core technologies to achieve less reliance on the U.S., and higher tariffs make local firms steer to higher-value production for more profits (Lin and Strumpf, 2018). However, China's businesses and investment atmosphere, in general, favors the financial and property economy. High profits in finance and real estate pull capital away from manufacturing, even many tech firms are starting to get involved in these industries. This situation could be worse in Shenzhen where capital and entrepreneurship are more highly concentrated, hampering inputs to more fundamental innovation that needs larger and longer upfront investment.

The current Covid-19 pandemic could bring both opportunities and challenges to the innovation culture in Shenzhen's electronics industry. Firms now have greater incentives to develop and commercialize technologies that address producers' and consumers' demands for health safety and risk mitigation, e.g., roboticized manufacturing and logistics, contactless biometric devices, robots for disinfection and delivery (Luo and Galasso, 2020; Pymnts, 2020; Fretty, 2020; Fannin, 2020). On the other hand, labor shortages, factory closures and shipment delays in the supply chain disrupt the industry, exemplified by Foxconn's 15% revenue decline during the first quarter (Sheng, 2020). During such a tough time, it would be tempting to deprioritize R&D and focus on producing existing products at a manageable cost (Nielsen, 2020).

In a nutshell, Shenzhen's business culture, in terms of its attitude to more fundamental innovation, is being torn in different directions by complex external environments, which obscure and possibly disrupt the cultural evolution trajectory. To clarify this issue, the research question for the institutional dimension component of the dissertation is:

How are cluster institutions formed through multi-level interactions, as illustrated by the net impact Shenzhen's innovation culture receives from changes in domestic and international environments?

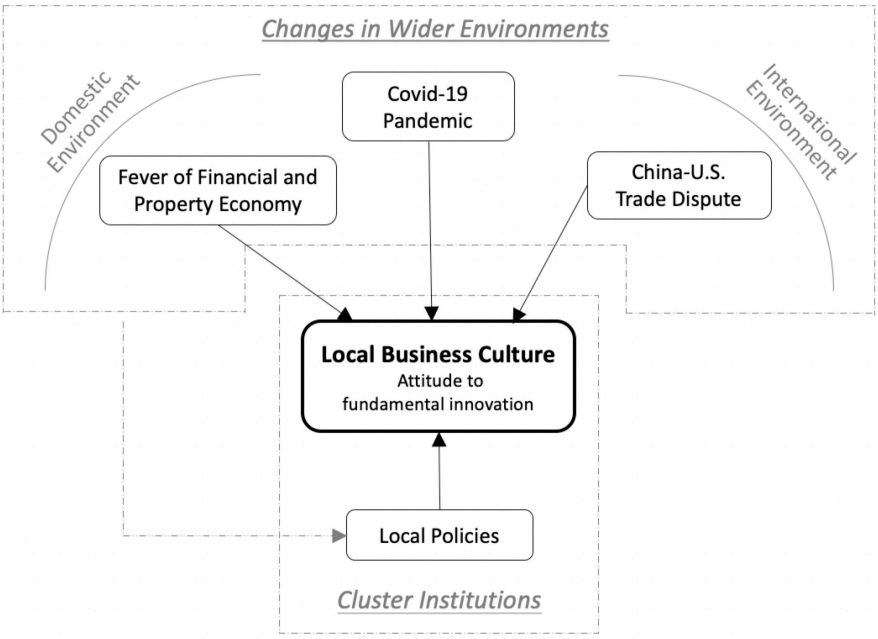

Figure 4.3: Conceptual Framework of Multi-level Institutional Interaction

The question is informed by the perspective of multi-level institutional interaction conceptualized in Section 3.2. The corresponding conceptual framework is shown in Figure 4.2. Although interaction is a two-way process, the study only focuses on impacts the Shenzhen cluster-scale culture receives from potential explanatory factors in wider contexts, since Shenzhen is the study area to be assessed. Cluster-level policy is viewed as the mediating factor for its role in both responding to external changes and affecting local business.

4.4 Built Environment Dimension

Urban villages play a special role in fostering the electronics industry in Shenzhen. Most successful entrepreneurs like Zhengfei Ren (CEO of Huawei) and Frank Wang (CEO of

DJI) had the experience of living or working in urban villages earlier in their careers. There are over 1,000 urban villages in the city, accounting for 70% of all rental housing citywide and hosting almost half of the population. Shenzhen's urban villages are a unique type of informal settlement different from slums and shantytowns or even urban villages in other Chinese cities (Wang et al, 2010). There unregulated assets are often built with modern materials and include basic utilities but are super compact to maximize floor space. Given Shenzhen's heated housing prices (ranked 1st among Chinese cities in Oct 2019), urban villages, especially well-located ones, serve as a vital source (the most important) of affordable rental housing for the industry's human capital with a limited budget (manufacturing workers, young professionals, personnel in start-ups).

However, Shenzhen's urban villages are experiencing gentrification under a series of policy thrusts. Acknowledging urban villages as a valuable heritage, *"Shenzhen Urban Village General Plan (2019-2025)"* (Planning and Natural Resources Bureau of Shenzhen Municipality, 2019) indicates that 75% of villages in the urban core are to be preserved and renovated. According to *"Administrative Measures for Arranging Talent Housing and Public Housing in Shenzhen"* (Housing and Construction Bureau of Shenzhen Municipality, 2020), urban villages will be the main source of rental housing for young talents after being renovated for structural and fire safety concerns. Local government seems ambitious in setting and achieving a goal of 1 million renovated housing units in urban villages to be released in the rental market, as proposed by *"Shenzhen Rental Housing Pilot Work Plan"* (Urban Planning, Land and Resources Commission of Shenzhen Municipality, 2017).

Because there is almost no vacant land left in Shenzhen, urban village renovation becomes a new business opportunity for real estate developers. Supported by related policies, a developer rents housing units from the villagers, and then sub-leases for a premium after renovation. With over 200 villages being renovated in the name of creating more desirable living spaces for talent, the gentrification process is ironically accelerating renovation because renovation takes much less effort than demolition-rebuilding. Renovation normally results in a 50-100% premium in the village rents per se, but also about a 10% premium in surrounding area rents (Shenzhen Government, 2018), leading to some demonstrations by local employees for higher salaries to cover rent increases.

To remedy the current concerns regarding gentrification in urban villages, *"Opinions on Regulating Rental Housing Market and Stabilizing Housing Rents"* specifies a number of policy measures in regards to urban village renovation, including price guidance on rents and utilities, subsidies/incentives for affordable rental housing products, and provision of leasing priority for existing tenants.

The gentrification of urban villages is threatening Shenzhen's electronics industry by potentially displacing its labor force. Policies promoting gentrification and policies countering gentrification currently co-exist, in the hope of achieving a higher quality living environment while lowering the risk of displacement. Although the literature shows that such policy efforts to achieve "positive gentrification" almost always fail, the unique tenant composition in Shenzhen's urban villages (not only lower-end labors, but also tech

professionals, entrepreneurs, etc.) might lead to a different story. Moreover, from the perspective of innovation cluster development, displacing a certain group of labor is not necessarily negative as it might drive industrial transformation and upgrading. Regarding the built environment dimension, the study will address the following questions:

How does the co-existence of policies promoting and controlling gentrification affect the pace and character of gentrification in Shenzhen's urban villages? What is the impact of gentrification on the displacement of labor in the electronics industry?

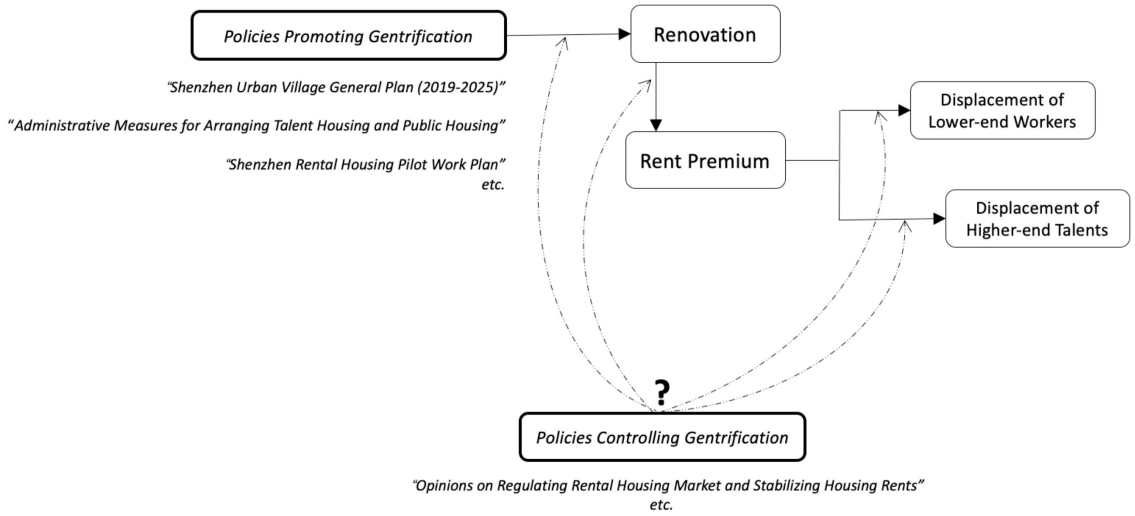

Figure 4.4: Conceptual Framework of Gentrification Policy Effects

The figure above plots different ways that seemingly opposing policies might jointly affect the gentrification process. Ideally, control policies would hinder rent premiums resulting from policy-driven renovation in urban villages. However, there such control policies may directly make promotion policies for developers unattractive, discouraging developers

from getting involved in the renovation project. Higher rents would lead to displacement which unevenly affects tenants of different socio-economic groups. Through influencing the magnitude of the rent premium, price / rent control policies might selectively ameliorate the risk of displacement for a certain group. There is also a possibility that control polices might not work at all. This study seeks to identify actual policy-driven gentrification effects among these possibilities.

To address the research questions above, a case urban village is selected near the Longhua-Bantian area, one of the electronics industry hubs in Shenzhen. The Longhua-Bantian area is home to Foxconn's flagship facility (2.3 sq.km land area; about 200,000 employees) and Huawei's headquarter campus (1.2 sq.km land area; about 80,000 employees). Foxconn is the world's largest electronics manufacturer, and Huawei is the world's largest telecom equipment maker.

Urban villages in the Longhua-Bantian area are labeled as "IT villages" since the majority of their tenants are employees of Huawei and Foxconn. Residents here are representative of labor forces in Shenzhen's electronics industry, as two major employers in the area cover both lower-end (Foxconn - manufacturing) and higher-end (Huawei - R&D) activities along the industrial chain. Among these villages, Xinweizai Village is chosen since it is the first phase for the ambitious urban village renovation campaign by Vanke (a well-known Chinese property development company) – the most active player in the renovation game. Vanke's Xinweizai project was announced in December 2017, which received

massive media coverage due to its position as the demonstration zone of Vanke's renovation-subleasing business model in urban villages.

Figure 4.5: Longhua – Bantian Area and Surrounding Urban Villages[2]

[2] The map is drawn by the author.

CHAPTER 5

METHODOLOGY

The dissertation is based on an exploratory research approach, as proposed research questions in each dimension has been overlooked and thus warrant the generation of new ideas and hypotheses (Swedberg, 2020). Given the exploratory nature of the dissertation, inductive reasoning relying on qualitative data is employed (Singh, 2007; Stebbins, 2008).

Studies on the agglomeration and institutional dimensions draw on primary data from interviews of Shenzhen firms in the electronics industry. Snowball sampling (Mack et al, 2005) was adopted as the sourcing strategy. I first interviewed a Shenzhen-based multi-national in the industry through my existing personal connection, and let this "trigger firm" refer me to other local electronics firms for interviews, based on its supplier network and reputation; then I was further referred to additional firms that I later interviewed. During this process, certain variation in the characteristics of firms interviewed was realized. In terms of the firm size, sampled firms include start-ups, SMEs, and larger corporations. Regarding the business scope, interviewed firms cover R&D, manufacturing, and services related to both intermediate goods and consumer products. Interviews were undertaken based on a semi-structural format where interviewees freely discussed their views and thoughts triggered by open-ended questions. Each interview lasted for approximately 30-40 minutes. At the end of each interview, respondent validation was performed. I showed my quick notes to the interviewee for review, ask them if I correctly got what they meant, and let them instruct me to revise if there was something wrong.

The built-environment part of the dissertation draws upon the observation and interviews of urban village stakeholders in Xinweizai. I spent over two months living in Xinweizai village (prolonged involvement) which enabled me to have persistent observation of environmental characteristics (renovation project progress, building exterior and interior conditions and changes, public space features, etc.), and become familiar with people in the village for conversation opportunities. I recruited interviewees based on stratified sampling (Robinson, 2014), filling pre-defined categories of urban village stakeholders (as showed in table 5.1). I gained information from them via casual conversations that happened daily, and there was no "formal interview" conducted with each person at a specific time and occasion. At the end of each day, by recalling memories, I retrospectively recorded key information from conversations happened that day. For interviews of urban village stakeholders, interview questions served as guidance to myself in regard to the general direction of talks. For decision audit, interviews of firms and urban village stakeholders are listed in table 5.1, and interview questions for them are shown in the appendix.

Interview of Electronics Firms

Code	Person Interviewed	Firm Type	Main Business
A1	Manager	Listed Company	Laser processing equipment (R&D, production, and sales)
A2	Project Manager	Listed Company	Power electronic equipment (R&D, production, sales, and service)
A3	Department Director	Multi-national	Information and communiation technology solutions for consumers,

A6	Senior Scientist (Subsidiary Coporation)		producers, and operators (R&D, sales, and service)
A7	Former Manager (Branch)		
A4	General Manager	Small and Medium-size Enterprise	Electronic instrument, switching power supply, sensor (R&D, production, sales, Service)
A5	Co-founder	Start-up	Media and information technology service
A8	Co-founder	Start-up	Headphone and sound equipment (R&D, sales)
A9	Owner	Small Factory	Original Equipment Manufacturing
A10	Manager	Small and Medium-size Enterprise	Power inductor, voltage transformer, inverter, adapter (R&D, production, sales)

Code	**Year Founded in Shenzhen**	**Year Expanded to Dongguan & Huizhou**	**Employees**	**Registered Assets (Yuan)**
A1	1999	/	10,000 - 15,000	1 Billion+
A2	2007	2018	500 - 1,000	100 Million+
A3				
A6	1987	2012	50,000 - 100,000	40 Billion
A7				
A4	2011	2018	about 50	10 Million
A5	2017	2020	20 - 30	1 Million
A8	2018	2019	10 - 20	200k
A9	2005	2016	/	/
A10	1999	2018	50 - 100	15 Million

Interview of Urban Village Stakeholders

Code	Interview
B1	
B2	Local Villager Property Owners in Xinweizai Village
B3	
B4	A real estate agent familiar with the Longhua-Bantian area
B5	A Cadre in village-level management office in Xinweizai
B6	The Manager of a renovated apartment
BG1	A series of talks with migrant manufacturing worker tenants in Xinweizai Village
BG2	A series of talks with knowledge worker tenants in Xinweizai Village

Table 5.1: List of Interviews

Due to the Covid-19 pandemic, US - China tension, and other practical factors, I only drew on a small sample size and was not able to interview government agencies. However, a few key informants can still provide enough information power (Malterud et al, 2016), because in an exploratory study: 1) a phenomenon only needs to appear once to be of value (Wilmot, 2005; Robinson, 2014); there is no need for an exhaustive description of all aspects of the phenomenon (Malterud, 2012; Morse, 2015). To ensure the validity and reliability of this small sample study, in addition to techniques of respondent validation, prolonged involvement, and decision audit mentioned earlier in this chapter, triangulation was also

deployed using existing secondary research (Long and Johnson, 2000). Triangulation is meant to yield convergence on insights gained by different data sources (Mathison, 1988).

The secondary data was mainly collected via online researching of Chinese media reports on relevant topics. I extracted factoids and key numbers from news to strengthen the discussion of phenomena raised by interview results. Besides media sources, I also turned to technical reports and official datasets for data necessary to plot figures. To make up for the omission of government interviews, I studied policy documents relevant to urban villages which are open to the public online, as preparation before talking to urban village stakeholders.

The analysis of qualitative content from interviews and secondary research was conducted by simplifying a large amount of text into a highly organized and concise summary of key results in a reasonable and logical structure – a process also called "abstraction" (Polit & Beck, 2004; Morse and Richards, 2002). The analysis was undertaken in a manifest manner, which means the author works with the literal meaning of what respondents actually said rather than the latent aspect of conversations including emotions and hidden meanings, because the manifest aspect already yielded enough data to proceed while the latent aspect could be severely distorting (Berg, 2001; Burns and Grove, 2005). All interviews are treated as anonymous during the analysis consistent with research ethics.

Speaking of the major methodological limitation, the sampling only focuses on Shenzhen-based electronics firms to investigate agglomeration effects and institutional changes

originating in Shenzhen, and the case of urban villages is selected within Shenzhen to exemplify the built-environment gentrification of the cluster. Correspondingly, how research questions are framed overlooks the unique dynamics in the periphery which was undergoing the most change as a result of the events in question. Given the fact that the electronics cluster has grown beyond Shenzhen, the study scope could be extended to the Shenzhen-Dongguan-Huizhou sub-region by selecting samples and cases in both the core and the periphery. And research questions could be more oriented to core-periphery comparison. Overall, the study scope largely confined to Shenzhen itself is the major limitation of the dissertation.

CHAPTER 6

AGGLOMERATION DIMENSION COMPONENT FINDINGS

6.1 Spillover Dynamic of Shenzhen's Electronics Cluster

This study focuses on spillover effect at the sub-regional level, that is, Shenzhen municipality and its two neighbors, Dongguan and Huizhou municipalities. Inter-regional or inter-national spillovers are beyond this study's scope. Massive industrial spillovers from Shenzhen started around 2008, since then the growth rate of manufacturing output in the city has been dropping, even to the zero in 2014 (New Fortune, 2017). This trend was reinforced in 2013 when stricter environmental policies were implemented. The Electronics industry dominates industrial spillovers from Shenzhen. From 2016 to 2018, 37.5% of the above-scale firm [3] spilling from Shenzhen were in the Electronics Manufacturing Sector (Shenzhen Government, 2019a), not counting firms indirectly connected to the sector.

Shenzhen's neighboring cities are the major destinations of these industrial spillovers, especially in areas bordering Shenzhen. In Dongguan Fenggang's Tian An Cyber Park, among 450 newly located firms between 2016 and 2020, 60% of them are from Shenzhen (Southern Metropolis Daily, 2020). Taking advantage of nearby resources in Shenzhen, Dongguan has the capacity to manufacture 20% of smartphones in the world (Southern Metropolis Daily, 2017); 95% of components and parts needed to build a computer can be

[3] In China, above-scale firms are defined as firms with 20 million yuan or more annual revenue from the main business. Data are often aggregated for above-scale firms only as an efficient way to roughly reflect the general economic trend. Above-scale firms account for a small part of the total quantity of firms but cover the great majority of the economy, and have more accurate financial report numbers than smaller firms.

manufactured in Dongguan (Huang and Xu, 2010). Huizhou has become the world's largest manufacturing base for televisions, batteries, and laser heads. Creating synergistic effects with manufacturing functions, knowledge institutions are also coming to areas adjacent to Shenzhen. Tsinghua University and the Dongguan government jointly established the Leaguer Innovation Park in Qingxi town where 17 out of 20 newly located high-tech firms (in new energy, photoelectrics, electronic communications, etc.) are from Shenzhen (Big-bit, 2020). In Dongguan's Songshanhu Hi-tech Zone, 35 research institutes and universities from all over China have set up branches or collaborative ventures (Sohu, 2020a).

Figure 6.1-6.3 show the spatial distribution of firms in areas where Shenzhen borders its two neighborhoods. The location quotient is calculated by using aggregated data at the firm scale in each sector at the township/sub-district level. A location quotient larger than 1 means relative concentration in a certain sector. Due to the statistical categorization of sectors and the issue of data availability, it is not possible to precisely capture different types of firms along the electronics industry chain. But the visualization in Figure 6.1-6.3 reflects the dynamics of electronics industry spillover from Shenzhen for the following reasons. Electronics manufacturing is the anchor sector in Shenzhen, accounting for about 60% of the manufacturing output (Southcn, 2018). In addition, the electronics industrial chain also includes other manufacturing sectors such as firms involved in associated printing, and packaging products or plastic components and accessories. In addition to manufacturing functions, other specializations along the industrial chain fall in tertiary

sectors, such as industrial and engineering design, business consulting, and distribution and logistics.

According to Figure 6.1-6.3, the manufacturing function is the dominant component of spillover from Shenzhen. Most towns adjacent to Shenzhen show a high concentration of manufacturing. The scientific research and technological service function also spills out from Shenzhen, but it is far less extensive, particularly in terms of urban form, due to its lower consumption of space. A high location quotient for scientific research and technological services only appears in the Songshanhu Hi-tech Zone where Huawei has expanded its R&D department and consequently has attract many suppliers and research institutes. Wholesaling & retailing still concentrates within Shenzhen; thus a major spillover trend is not identifiable.

However, the cross-sectional view on the degree of specialization across peripheral areas doesn't necessarily reflect the spillover dynamics. Spatial concentrations showed in these maps could be ascribed to the industrial development originating from surrounding cities themselves. For example, Dongguan has long been famous for its garment & shoe manufacturing, so high location quotients of manufacturing in suburban Dongguan might not be mainly driven by the spillover of the electronics industry from Shenzhen. To reconcile this issue, secondary information in a recent report is used. According to Qin and Chen (2020), most of Dongguan's garment & shoe firms were closed down or pushed out in the 2008 financial crisis, and since then Dongguan's industrial development has been mainly fueled by the electronics industry spilling from Shenzhen: by the end of 2017, 5,085

firms have spilled from Shenzhen to Dongguan, and 78% of them are in sectors of electronics information and electrical machinery/equipment. This report also provides a light map indicating that the growth in the sub-region mainly happened on the periphery rather than the core (Figure 6.4). It implies that industrial concentrations in surrounding areas could be a result of the recent spillover from Shenzhen.

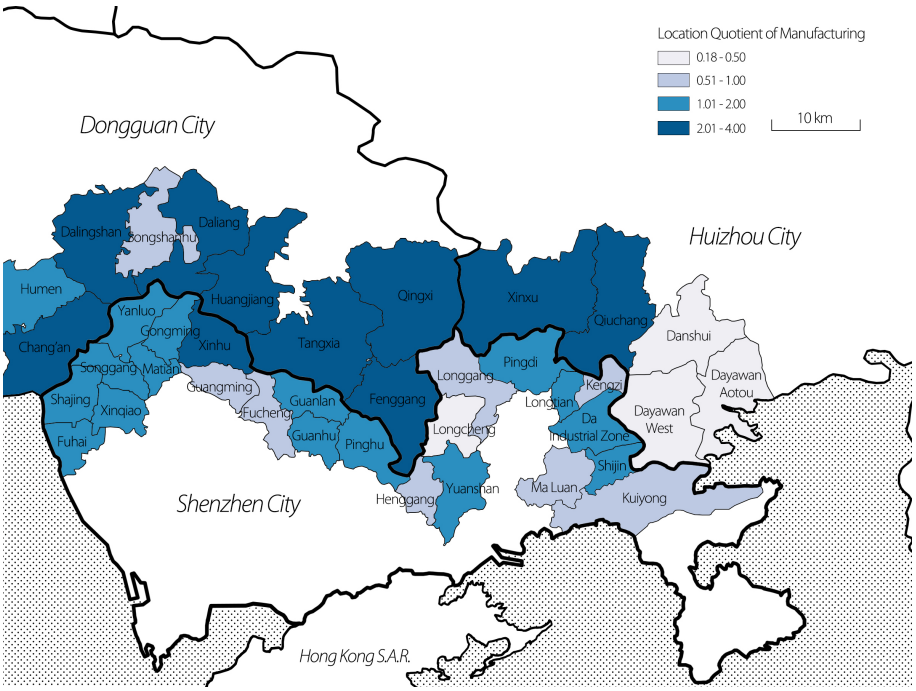

Figure 6.1: Spatial Concentration of Manufacturing across Contiguous Subdistricts/Townships between Shenzhen, Dongguan, and Huizhou Municipalities[4]

[4] Figure 6.1, 6.2, and 6.3 are remade from maps appears in the report "Edge Cities on Urban Peripheries" (in Chinese) jointly by UPDIS (Urban Planning and Design Institute of Shenzhen) and Shenzhen Waybe Tech LLC (2020).

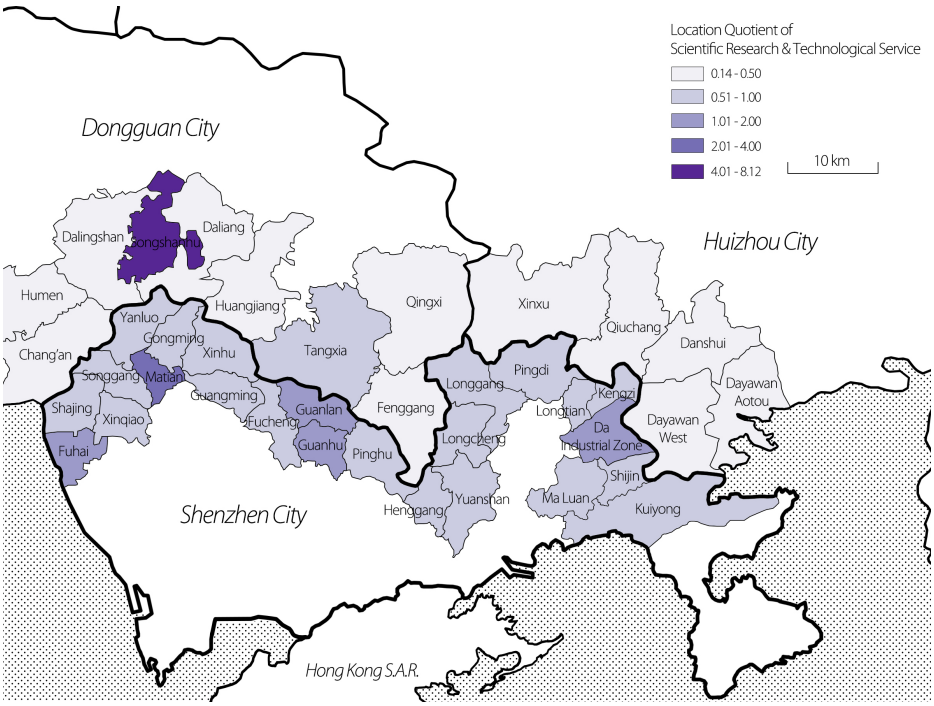

Figure 6.2: Spatial Concentration of Scientific Research & Technological Service across Contiguous Subdistricts/Townships between Shenzhen, Dongguan, and Huizhou Municipalities

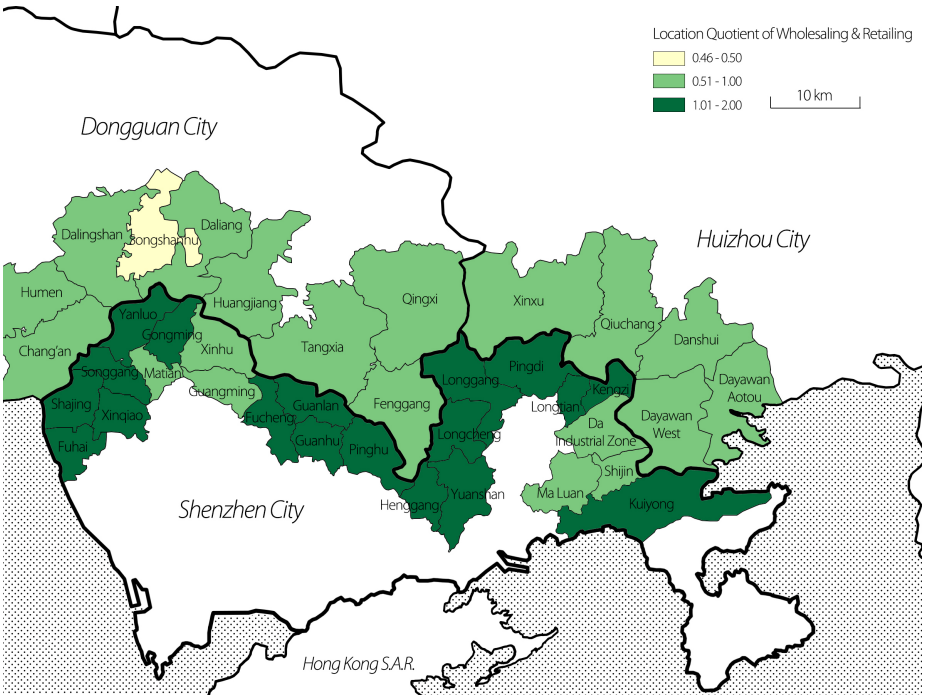

Figure 6.3: Spatial Concentration of Wholesaling & Retailing across Contiguous Subdistricts/Townships between Shenzhen, Dongguan, and Huizhou Municipalities

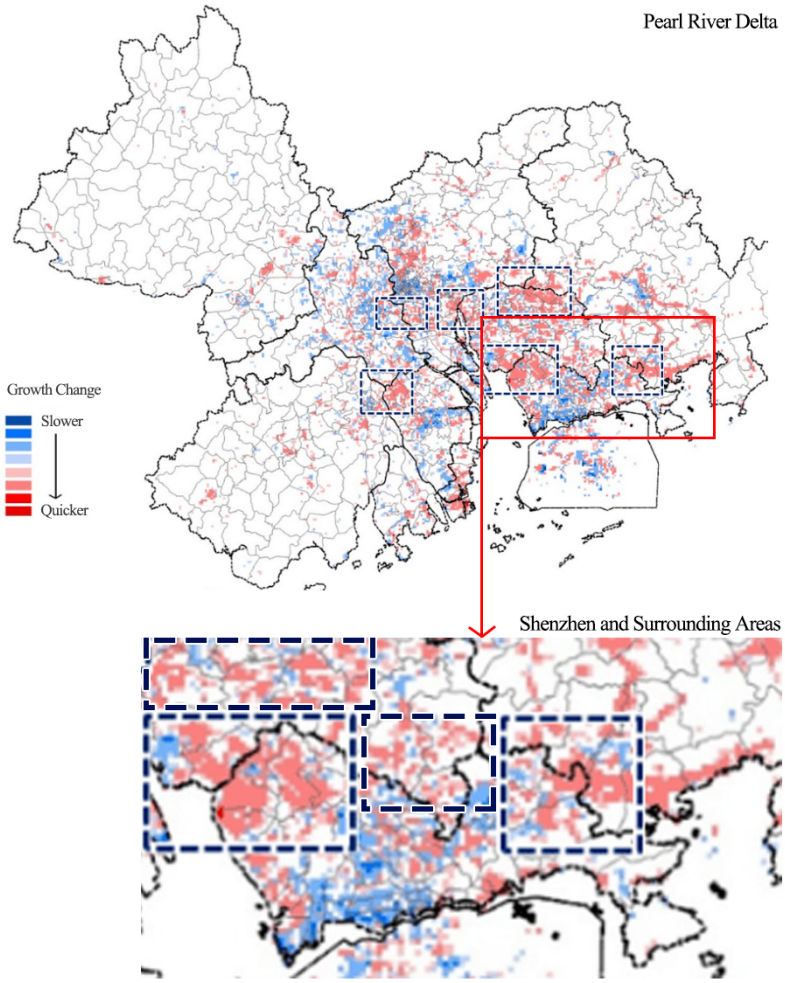

Figure 6.4: Light Growth in Shenzhen and Surroundings Areas, 2013- 2017[5]

6.2 Distance-decaying Agglomeration Effects from Shenzhen

6.2.1 Lower agglomeration diseconomies on the periphery

Bigger firms generally indicate that higher land availability in areas surrounding Shenzhen was the main reason why they expanded both manufacturing and R&D functions outwards. In terms of the spillover of the manufacturing function, a listed laser firm (Interview A1),

[5] Source: Figure 6.4 is remade from a map appears in the report "Receiving spillover: the development logic of Dongguan's areas adjacent to Shenzhen" (in Chinese) by Qin and Chen (2020), Sun Yat-Sen University Urbanization Institute.

a large electrical equipment firm (Interview A2), and a mid-sized inductance firm (Interview A10) indicated that only by expanding to peripheral areas, could they access additional needed space to build new larger and higher-end facilities to increase production capacity and incorporate knowledge based manufacturing. Regarding the R&D function, managers from different sub-divisions of a Shenzhen-based multinational (Interviews A3; A6; A7) agreed that in order to accommodate the rapidly growing body of R&D staff as well as enhance these higher-end talents' sense of belonging and pride, their well-designed new R&D campus was built in Dongguan's Songshanhu because no land with equivalent developable areas and beautiful natural scenery could be found in Shenzhen. The reputational benefits of having new facilities in peripheral areas also works for less famous firms. A mid-sized firm focusing on professional electronic testing and measurement equipment (Interview A4) found that its fancy new facility in suburban Dongguan makes potential clients more willing to undertake the necessary travel to visit and do business.

Advantages associated with more land availability on Shenzhen's spatial periphery reflects the land shortage in the core city, as this form of agglomeration diseconomy drops sharply when moving out of Shenzhen. Shenzhen is fully built-up with almost no developable land left. Most of existing industrial estates are of low quality, as 618 out of 914 industrial parks in Shenzhen were developed considerably earlier during the 90s-00s with disordered layouts, shabby buildings, and deficient supporting facilities and infrastructures (ZhaoShang800, 2020). Therefore, Shenzhen firms normally expand by setting up new operations in surrounding areas while still keeping their base in Shenzhen, as indicated by most of firms interviewed.

Lower costs in areas surrounding Shenzhen is another consideration behind the spillover behavior, especially for smaller firms. A marketing consultancy startup serving big electronics manufacturers (Interview A5) reported that the peripheral location saves about 1/3 - 1/2 in rent and lowers salary expectation of employees. Similarly, a startup making headphones mainly based in Shenzhen (Interview A8) and a small original equipment manufacturer (Interview A9) identified lower land costs, official minimum wages, and utility fees as advantages for them or their partners if they locate manufacturing facilities in suburban Huizhou.

Among agglomeration diseconomies within Shenzhen, the distance-decay of high costs is not as sharp as the land shortage centrifugqal driver, because land costs on Shenzhen's peripheries also rise rapidly. From 2016 to 2019, factory rents in Dongguan's areas adjacent to Shenzhen increased about 60%, to the same level as that of Shenzhen back in 2016 (Southern Metropolis Daily, 2019). Moving to surrounding areas can't essentially solve problems caused by rising costs if productivity and profit remain unchanged. Therefore, among firms spilling out of Shenzhen, about 75% of them look for new space to scale up and upgrade production, while only 25% of them completely leave Shenzhen because of the failure to adapt to high costs (Li and He, 2015).

6.2.2 Spillover of Shenzhen's agglomeration economies

Firms perceived that Shenzhen's advantages in the industrial chain and knowledge spillover can be still enjoyed in areas surrounding Shenzhen without significant decay.

Both vertically-integrated bigger firms (interviews A1; A3; A4) and specialized smaller firms (Interviews A5; A9) thought that once a week is the normal frequency for a firm to visit their core clients/suppliers on-site, or for spatially separated departments within the same firm to physically meet each other; often face-to-face interactions are only indispensable at certain crucial stages during the long duration of a project, while online meetings and phone calls are not significantly inferior at other times. Firms mainly spill to areas which are 30-70km away and can be covered by 1-hour's driving from Shenzhen's city center. This spillover scale is within the acceptable range to allow the aforementioned frequency of face-to-face interactions necessary to tap into Shenzhen's agglomeration benefits.

There are also other factors besides spatial proximity facilitating interactions along the industrial chain, thus making the distance-decay of agglomeration economies less discernable. Some firms (Interviews A1; A3; A7) believe that the electronics supply chain becomes more transparent due to third-party evaluation reports and lists of potential suppliers, lowering the need for on-site searching in the first place. Other firms (Interviews A5; A8) claimed that the outsourcing network is embedded in a complex web of personal stockholding and investment behavior (e.g., a supplier would consolidate the collaboration by inviting senior managers of the client to personally own a share of that supplier). This mechanism is more dependent on social proximity which is not necessarily dependent on physical spatial proximity.

Suburban Dongguan and Huizhou can share the labor pool of Shenzhen. In terms of both well-educated knowledge workers and migrant manufacturing workers, employers found no problem bringing their employees to nearby peripheral areas (Interviews A2; A6; A9; A10), and employees didn't perceive much difference between being in downtown Shenzhen and suburban Dongguan or Huizhou (Interview BG1; BG2). Residential spillover and labor mobility are underlying drivers. Many residential communities in surrounding areas are mainly occupied by tenants from Shenzhen (Southern Metropolis Daily, 2018; Dongguan Vanke, 2019). Intercity commuting across Shenzhen and its two neighbors is common, especially for higher-end talents (UPDIS and Wayhe, 2020).

There are also advantages exclusively available within Shenzhen. Although all interviewed firms indicated that there are considerable functional overlaps between their operations within and surrounding Shenzhen, most of them identified headquarters and sales & marketing as unique functions stayingin Shenzhen to benefit from the city's reputation, i.e., higher visibility by being labelled as a "Shenzhen firm". However, a large electrical equipment firm (Interview A2) is an exception saying that most of its operations, including headquarters, are moving to the new multi-functional complex in suburban Huizhou, while only a liaison office is planned to be kept in Shenzhen. Overall, multi-site operations within and surrounding Shenzhen is an important reason why spillover firms perceive no significant distance-decay of Shenzhen's agglomeration economies

6.2.3 Rising agglomeration economies on the periphery

In addition to lower agglomeration economies on the periphery, rising agglomeration economies on the periphery is also one of the factors driving the spillover of firms. Leading firms in the industry (Interviews A1; A3; A6; A7) indicated that many of their core suppliers or SMEs within their ecosystems tend to co-locate with them, thus following their spillover out of Shenzhen. Correspondingly, according to a small specialized service provider (Interview A5) and manufacturing supplier (Interview A9), although lower costs on the periphery is also an advantage, pursuing immediate proximity to their biggest client's new location on the periphery is the trigger for their spillover.

Media reports also confirm the growing agglomeration economies in surrounding areas. In Dongguan's Songshanhu, branches of Shenzhen's big names such as Huawei and DJI attracted over 300 firms in their outsourcing eco-systems to co-locate (Sohu, 2020a). Over half of the production value in Songshanhu is generated by firms with past and present Huawei ties (STCN, 2018). Fueled by the population spillover from Shenzhen, labor pooling on the periphery is also growing. Firms in Dongguan reported declining demands for intercity commuting buses to and from Shenzhen, as an increasing number of employees from Shenzhen choose to settle down in Dongguan (Southern Metropolis Daily, 2020). People from Shenzhen bought 58.6% of housing in Huizhou and 57.3% of housing in Dongguan (Fang.com, 2018).

6.3 Asymmetric "Borrowed Size" Surrounding Shenzhen

It can be conceptualized that at the sub-regional level, the distance-decay out of Shenzhen is insignificant for agglomeration economies, more than compensated by benefits such as

land and labor costs, labor retention, etc. Lower diseconomies of agglomeration on peripheries are the main driver behind the spillover of Shenzhen's electronics industry into surrounding areas. The spatial diffusion of Shenzhen's agglomeration effects echoes previous quantitative studies on related topics. In China, innovation spillover only begins to recede after 150 minutes-distance of rail traveling (Cai et al, 2019). The optimal range for the spillover of productivity and employment is about 40-50km (Zhang et al, 2012). For Shenzhen's electronics cluster, the sub-regional spillover mainly occurs in a band 30-70km from the city center, still within the range where distance-decay of agglomeration diseconomies is sharper than that of agglomeration economies, especially considering that Pearl River Delta/Greater Bay Area has the strongest internal economic spillover among major city clusters in China (Ren and Li, 2019; Liu and Yu, 2020).

Since distance-decaying agglomeration diseconomies are the major factor affecting spillover decisions, firms spilling from Shenzhen are mainly those sensitive to cost or land demand. In terms of scale, large and medium-sized enterprises or rapidly growing firms, tend more to expand outwards. In terms of functional types, manufacturing is the commonly perceived main force of spillover due to its labor-intensive and space-consuming nature. Meanwhile, there is a trend of locating R&D on peripheries to provide new high-quality space for an increasingly large body of R&D staff, coupled with the emergence of more intelligent manufacturing and prototyping, plus branches of higher education institutes surrounding Shenzhen. On the dimension of firm competitiveness, lower value-added firms leave Shenzhen because they can't afford high costs. The role of firm heterogeneity in determining spillover pattern has related empirical evidence. For

instance, Wang (2017) identified varying transportation-induced spillover dynamics across capital-, labor-, and tech-intensive manufacturing firms.

Certain aforementioned types of firms or intra-firm functions are more inclined to gain advantages of "borrowed size" by being in areas surrounding Shenzhen; however, the outward movement of leading firms will later induce the spillover of other firms who wouldn't move to the periphery by themselves. More specifically, a big electronics firm's new complex in suburban Dongguan can attract smaller suppliers and service providers from Shenzhen to expand nearby. The latest research on the Greater Bay Area statistically identified such temporal and synergistic effects of industrial spillover. Wu (2020) found that the innovation clustering in time t spills to surrounding areas both in time t and t+1. Zeng (2020) found that the clustering of either knowledge-intensive productive services or high-tech manufacturing in a city can influence the co-existence between these two industries in nearby cities. That is to say, even if only a particular function of a firm types spills outwards initially, the firm composition will become more and more similar between Shenzhen and peripheries over time. It corresponds to Zhang et al.'s (2019) warning that the industry homogeneity index between Shenzhen, Dongguan, and Huizhou had been increasing and already exceeded the alarm value, indicating competition rather than cooperation between three cities. Furthermore, firms moving outwards for lower costs will be further squeezed out if they do not scale up and/or upgrade, since costs in peripheral areas also rise sharply as the inflow of firms from Shenzhen continues.

Headquarters and trade and logistics are functions most likely to distinguish Shenzhen from surrounding areas. Most electronics firms spill for the expansionary purposes, which means many firm sub-divisions in peripheral areas are built upon linkages to their Shenzhen headquarters. Besides, electronics firms always need a relatively centralized place to showcase their products for no matter where their production proceeds. The best example of a showcasing facility is Shenzhen's Huaqiangbei, the ultimate electronics marketplace with 30,000 highly specialized stalls serving as the front desk of thousands of factories in/around Shenzhen.

Overall, at the sub-regional scale, the asymmetric "borrowed size" from Shenzhen's electronics cluster is better explained by the heterogeneous sensitivity to distance-decaying agglomeration diseconomies rather than that of agglomeration economies. However, such asymmetry will be attenuated over time (the temporal factor) due to the newly established industrial linkages on peripheries. Thus, it can be seen that the analysis of asymmetric "borrowed size" should consider not only distance-decaying agglomeration effects from the cluster core but also accumulating agglomeration effects on the periphery.

CHAPTER 7

INSTITUTIONAL DIMENSION COMPONENT FINDINGS

7.1 Innovation Atmosphere in Shenzhen

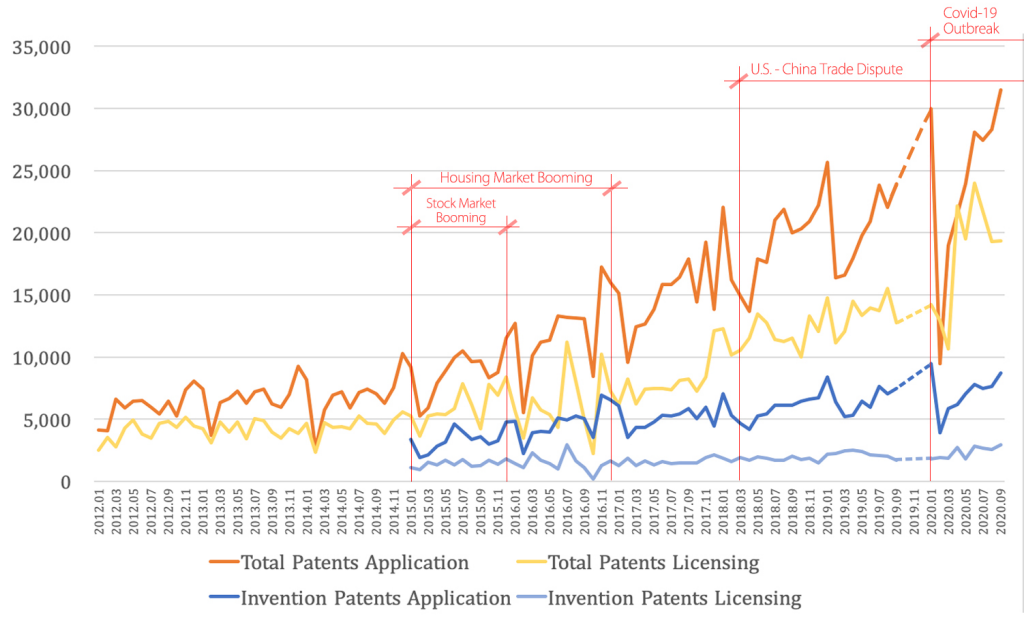

Figure 7.1: Patents Application and Licensing in Shenzhen, 2012-2020[6]

[6] Figure 7.1 is plotted based on patent data obtained from the website of Shenzhen Administration for Market Regulation/Shenzhen Intellectual Property Administration (2020).

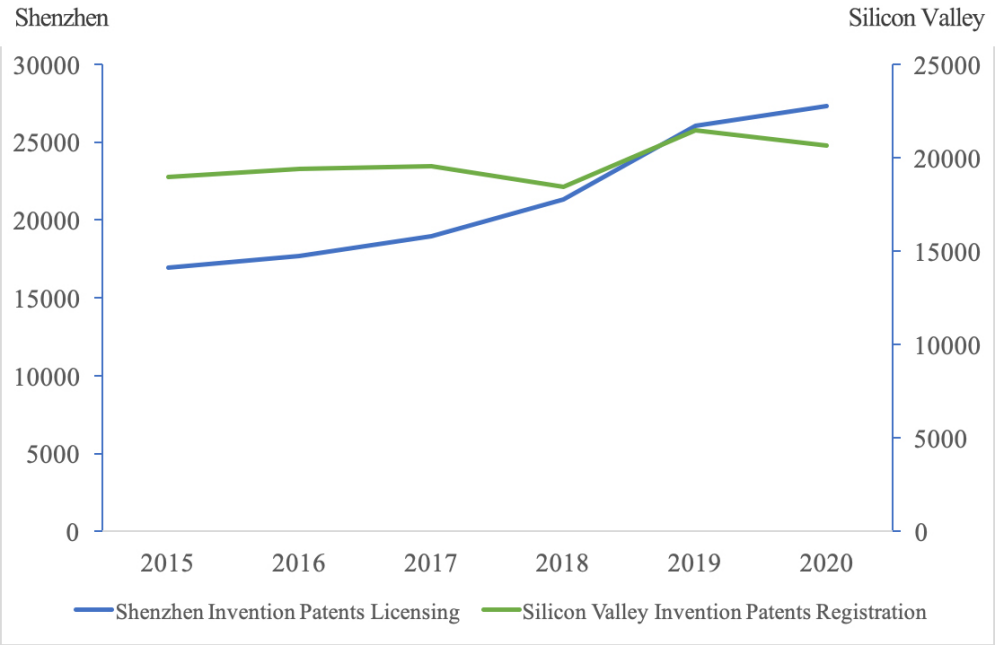

Figure 7.2 Growth of Invention Patents: Shenzhen vs Silicon Valley[7]

Patent data from 2012 - 2020 is used (see Figure 7.1) to visualize the innovation performance of Shenzhen over that time period. Different from R&D input/employment data, which are only available to the public on a yearly basis, patent data can be obtained monthly so there is higher temporal resolution; plus, this data gives us a first look at the innovation dynamics until September, 2020. There are three types of patents in China: Industrial Design, Utility Model, and Invention. The first two types are more about the application of, and the incremental improvement of, certain technologies, while the latter one recognizes more fundamental innovations. Figure 7.1 compares the temporal change

[7] Figure 7.2 is plotted based on patent data obtained from Shenzhen Statistical Bureau (2020) & Administration for Market Regulation/Shenzhen Intellectual Property Administration (2020) and Silicon Valley Institute for Regional Studies (2021). For Silicon Valley data, invention patents are measured by the number of "utility patents". Due to different definitions of patents, the "utility patent" in US is similar to the invention patent in China.

of application and licensing levels for the total of all three types *versus* just the invention patent. In addition, Figure 8.1 presents disaggregated data on Invention patents, both applications and licensing.

One issue with the patent data is that there is no category to precisely capture patents in the electronics industry; patent metrics are for all fields. However, these numbers still, to a great extent, roughly reflect innovation related to electronics, considering that electronics and information accounts for 90% of Shenzhen's high-tech sectors in terms of output value in 2019 (Shenzhen Science and Technology Innovation Commission, 2020). Of course, as is well known, patent measurement fails to capture the commercialization element in the notion of innovation since most patents are not commercialized. At the same time, in the Shenzhen case, simply relying on patent data would lose grassroots innovations featured by open-sourced innovation practice and informality, much of which has commercial application. Despite these caveats, patent data used in Figure 7.1 is the best option available yet to quantify changes in the innovation atmosphere in Shenzhen.

Timelines of major events are added in Figure 7.1 to better show how Shenzhen's innovation dynamic changes within different environments. In Shenzhen, the housing and stock market boom periods are defined by the following parameters: (i) Average housing price had doubled within just two years from the end of 2014 to 2016; (ii) The stock market reached its historical peak in 2015, in terms of both newly opened accounts and securities trading volume in Shenzhen Stock Exchange (Statistics Bureau of Shenzhen municipality, 2020). (iii) The U.S.-China trade war is considered to start on March 8th 2018 when US

President Trump approved tariffs on aluminum and iron products, which later resulted in retaliatory tariffs by China in early April. Although the phase one trade deal was signed in January 2020, the tension continues as the U.S. keeps adding Chinese firms and institutes, especially those from Shenzhen, to its entity list[8]. (iv) The Covid-19 pandemic first broke out in China in late January 2020, resulting in hard restrictions on traveling behavior. Production in Shenzhen largely resumed in late March 2020 but it is still (early 2020) impacted by disruptions to global industrial chains, as the pandemic later became increasingly out-of-control in other countries. However, the caveat should be made that the study is not aimed to statistically examine the correlation between external impacts and innovation performance by controlling other socio-economic changes in economic growth, population, local policy thrusts, etc. The visualization in Figure 7.1 is only exploratory, more critical evidence might need to be gained from regression analysis.

Since there is a few months' or even up to a couple of years' lag between the initial application and the final grant of a given patent, application numbers are taken as a more instant reflection of Shenzhen's innovation atmosphere. From Figure 7.1, the growth rate of patent numbers started to obviously increase during and after the booming of the housing and stock markets. It could be interpreted that a better innovation atmosphere is associated with market confidence related to economic prosperity. Taking the periodic fluctuation of patent data into account, patent applications only experienced strong unexpected drops in

[8] The Entity List is a trade blacklist published by the United States Department of Commerce's Bureau of Industry and Security, consisting of certain foreign persons, entities or governments that engaged in actives sanctioned by the State Department and activities contrary to U.S. national security and/or foreign policy interests. Listed entities are subject to U.S. license requirements for the export or transfer of specified items, such as some U.S. technologies.

March and April 2018 after the launch of the trade war but then rebounded to even a higher growth rate. The Covid-19 outburst in early 2020 appears to have accentuated the expected seasonal periodic drop of patent application in February more. Giving the highly turbulent external context, especially from 2015 onwards, the innovation atmosphere in Shenzhen shows no sign of decaying and continues to prosper but does display momentary shocks. Compared to the substantial surge of total patent numbers, the growth of invention patents is less significant. It doesn't necessarily mean Shenzhen has been reinforcing the culture favoring incremental innovation over fundamental innovation. The disparity of growth speed could be normal due to the nature of different patents. First, incremental innovation (measured by utility and design patents) is much easier to be made than fundamental innovation (measured by invention patents) which requires more inputs. Second, numerous incremental innovations can proliferate based on one fundamental innovation. A different benchmark is needed to explain the changing dynamics of fundamental innovation in Shenzhen. Figure 7.2 compares invention patents between Shenzhen and Silicon Valley. Since the standard and definition of patents are different between China and the US, I only focus on comparing the growth trend rather than the absolute number of patents. Over the last five years, fundamental innovation has grown more drastically in Shenzhen than in Silicon Valley – the world's most innovative place. It could be identified that Shenzhen's enthusiasm towards innovation, in terms of both the rapidly iterating incremental innovations and the time-consuming fundamental innovations, keeps increasing even under conditions of external turbulence.

7.2 Shenzhen's Innovation Culture under Changing Environments

Notwithstanding the strong inertia in the bias toward incremental innovation in Shenzhen described above, this Section describes ways in which the attitude to innovation appears to be changing related to the Covid-19 pandemic, U.S.-China trade war, and financial & property economy fevers, as these forces impact Shenzhen both separately and jointly.

7.2.1 The impact of Covid-19 pandemic

There are two main ways that the pandemic influences firms. Supply chain shocks caused by the pandemic make firms (Interviews A8; A9) realize the value of being resilient to crises resulting in higher productivity, while pandemic environments also force more conservative R&D operations to create back-up cashflow for six months to handle the ripple effects of pandemic events. All firms reported that a month's delay of work resumption after the spring break cuts their revenue[9], which is also a potential factor behind more conservative R&D activities. But some firms (Interviews A2; A4; A10) found that higher-end, and more automated, manufacturing lines were less influenced by the labor shortage during the pandemic, thus highlighting the need for adopting innovative production technologies.

Media reports also reveal both positive and negative impacts of the pandemic. The global pandemic led to shrinking imports of key materials and components form other countries, e.g., silicon wafers from Japan and display panels from Korea, which is thought to have stimulated the localization of such production in Shenzhen (ICWise, 2020). Meanwhile,

[9] The pandemic broke out around the spring festival holiday of 2020. Due to the restriction on traveling and production activities, the operation of most firms remained closed until late March and Early April.

huge opportunities in pandemic-related product businesses tend to distract firms from innovating in electronics, e.g., BYD, China's largest electric vehicle maker, became the world's largest mask maker (SZNEWS, 2020).

7.2.2 The impact of U.S.-China trade war

On the one hand, the trade dispute is associated with more awareness of the importance of innovation, especially fundamental innovation. Some firms (Interviews A4; A10) considered higher productivity brought by innovations in manufacturing processes as the solution to higher tariffs imposed by US. Given America's ban on exporting key electronics components (represented by semiconductor chips) to selected Chinese entities, firms (Interviews A1; A3; A6; A7) prioritized independent R&D on chip-making and shifted more to domestic suppliers for sourcing and improving chips, consistent with the rising public attention to overcoming China's weakness in fundamental innovation. Correspondingly, there was a 63.5% revenue growth in Shenzhen's integrated circuit sector in 2019 compared to 2018 (Sohu, 2020b).

On the other hand, the enthusiasm for chip-making caused bubbles. It is observed by firms (Interviews A4; A9; A10) that many unqualified firms entered the field to obtain subsidies and investment by riding the wave of semiconductor demand, by either selling concepts without being ready for actual R&D and production, or entering oversupplied lower-end chip-making (e.g., radio frequency chips) instead of urgently needed cutting-edge fields (e.g., GPU and CPU). China and Shenzhen are still decades' behind the world's latest technological standards, the current "great leap forward" emotion could decentralize and

dilute financial and labor resources that should have been concentrated to overcome real fundamental technological barriers.

7.2.3 The impact of financial & property economy fever

The "great leap forward" emotion associated with semiconductor chips is highly related to the financial market behind it, as the capital market's preference for quick returns is not compatible with fundamental innovation's nature of high upfront investment and slow return. Interviewed firms repeatedly mentioned the case of Goodix Co., Ltd. in Shenzhen, a firm producing chips for touch panel and fingerprint sensors. This firm has seen its share price increase six times in two years by taking advantages of the chip fever, but the share price then dropped 60% in just half a year due to the lack of progress in solving difficult technological issues. A Shenzhen-based multinational (Interviews A3; A6; A7) considered that not being listed can let the firm better concentrate on fundamental innovation without being disturbed by the fickle stock market.

Despite media's concern that the booming real estate market in Shenzhen would pull investment away from innovation (ifeng.com, 2016), interviewed firms were more positive on the role of the property economy. Many firms (Interviews A2, A3, A4, A6) admitted their involvement in the real estate business with the excuse of providing dormitories or discounted commodity housing to employees, and claimed it did not distract their emphasis on R&D regardless of theirs property development involvement. Other firms (Interviews A1; A7; A10) even think the booming property economy drives higher inputs to innovation because i) the appreciation of asset value increases the loan (credit) limits of the firm and

ii) profits gained from real estate contribute to the survival of firms, especially when they are under stress.

7.2.4 Resiliency of Shenzhen's innovation culture

When asked about the overall evolving direction of Shenzhen's attitude to innovation, firms generally identified the strong momentum to retain its existing character regardless of any external impact. Firms quickly adapted to challenges caused by domestic and international incidents operationally and psychologically. Some tricks by business organization are taken by firms to get around U.S. sanctions (Interviews A3; A7). Anxiety and nervous moods emerged among firms when the trade war first broke out, but soon disappeared with the stabilization of new market circumstances and business models (Interviews A4; A5; A9). Moreover, changes in the wider environment didn't initiate, but only highlighted, the inherent elements in local business culture. Constantly dealing with fierce peer competition, fast emergence of new technologies, and complex supply chains in the industry Shenzhen electronic firms have been always facing, the pandemic or trade war is just one of the challenges and uncertainties that have been faced over the years, bringing pressure to innovate. The distraction and market bubble caused by external impacts just reflect the preference towards quick profit in Shenzhen's innovation culture (Interviews A2; A4; A8; A10).

Nevertheless, there are some notable things on the resiliency of Shenzhen's innovation culture. A firm (Interview A5) admitted that no serious thought has been given to this issue, and is concerned about no significant change in the local business atmosphere. Another

firm (Interview A1) thought it might be too early to come to conclusions regarding the cultural changes caused by recent incidents, as uncertainties on the market impact remain to be further assessed. This point is also elaborated by some firms (Interviews A2; A6; A10) that by saying "no change" in Shenzhen's innovation culture, they didn't mean Shenzhen is stuck in a culture of imitation and incremental innovation, but refer to the unchanged cultural trajectory of evolving to a better atmosphere encouraging to radical and fundamental innovation. For example, the local authority is putting more emphasis on working with industry leaders to identify and prosecute IP infringements. Such claim is also supported by figure 7.2, indicating Shenzhen's innovation culture features increasing emphasis on more fundamental innovation, and such evolving direction remains resilient under external turbulences.

According to all firms interviewed, it is widely agreed that the local policy environment, rather than external impacts, is more relevant to the making of Shenzhen's attitude to innovation. Lower institutional costs, e.g., regulation, taxation,support to business, in Shenzhen facilitate innovation activities. Given the humble and efficient images of the Shenzhen government which contrasts sharply with the embellished bureaucratic culture in interior regions, firms find it much easier to be treated with equity and dignity when dealing with authorities. As the leading pilot zone for the institutional reforms during the "Opening Up" period in the late 20th Century, Shenzhen fostered risking-taking spirit in the local business community through its loose regulation, a situation which continues.

Like anywhere else in China, there are countless subsidy and loan policies at provincial, municipal, and district levels available in Shenzhen to invest in innovation, cover losses from the pandemic and trade war, and incentivize R&D activities in certain fields. But these policies have limited effects and often favor big corporations over small- and medium-sized firms (Interviews A5; A8; A9). In fact, Shenzhen is more rational regarding such policy actions thus having a healthier innovation environment. In some other Chinese cities, too heavy subsidies or even direct investment from the public sector very likely result in scams, e.g., the failure of SMIC's (Semiconductor Manufacturing International Corporation) 100 billion Yuan semiconductor project in Wuhan. It is widely believed by firms that the attractiveness of Shenzhen lies in the government's respect for firms' freedom of choice rather than heavy incentives to designated sectors. Firms will always have confidence in Shenzhen's innovation culture, as long as Shenzhen maintains the service-oriented governance it has gradually formed for the last forty years since the establishment of the most important of the original Special Economic Zones.

7.3 Endogeneity and Path-dependency of Shenzhen's Innovation Culture

Shenzhen's innovation culture, features not only its historical enthusiasm for incremental innovation but also the increasing emphasis on fundamental innovation, is resilient to the impacts of changing domestic and global environments. The Covid-19 pandemic, U.S.-China trade war, and Real Estate and Finance fever may spur firms' adaptive operational responses, often reinforcing inherent advantages and disadvantages of Shenzhen's innovation culture, while the culture itself is not essentially transformed. The logic of local policy is not based on using policy tools to offset a certain external impact but in fostering

the resiliency of innovation culture through Shenzhen's bottom-up policy practice. Generally, as long as Shenzhen remains China's flagship pilot zone, the innovation culture in Shenzhen's electronics cluster is not likely to change significantly.

Stability in the face of changing external environments reflects the endogeneity dimension of cluster culture. Cluster culture is rooted in the regional culture which is the accumulation of history, social custom, and relations within a certain area. Perception and codes of behavior, as part of a culture, are formed through, and accepted by, long time interactions between individuals or entities therein. Stories on endogeneity can be found in other case studies. The 2008 global financial crisis didn't change Shantou toy cluster's inter-firm cultural ties based on a network of mutual help that was formed as a buffer against negative economic impacts (Ouyang and Li, 2014). In Longgang's printing industry cluster, the transition towards modern management culture only occurred when newly introduced external talents were embedded inside the local business community (Zhu and Lv, 2010). The importance of endogenous factors behind cluster culture is also reflected in Saxenian's (1994) focus on local dynamics in her comparative cultural study between Silicon Valley and Route 128, despite criticisms by scholars like Florida (1994) and Gertler (1995) that she neglects nation-state and global dimensions.

The resiliency of Shenzhen's innovation culture also aligns with path-dependency notions in cluster culture. A regional economy's path-dependent evolution is fundamentally rooted in its distinctive culture that extends and reinforces the competitive advantages afforded to the region by its initial concentration of firms in a given sector (Nelles et al, 2005). Culture

tends to change slowly, as a sclerotic milieu can remain in a region even after the industrial structure to which it belonged already has disappeared (Hassink, 2005). For industrial clusters in the southern Brazilian state of Santa Caterina, the non-cooperative culture of internalizing as many activities as possible within firms didn't change easily even under the new external conditions of an opening market and increasing competitive pressure (Meyer-Stamer, 1998). A similar story line happened in Bulgaria: the business culture remains averse to entrepreneurial activity despite the nation's institutional transition from the socialist regime to the open market (Williams and Vorley, 2015).

The discussion above appears not in line with the perspective of multi-level institutional interaction represented by the concept of "institutional void" (Schrammel, 2013), i.e., cluster institutions are influenced by deficiencies in higher-level institutions. To solve this conceptual contradiction, the development stage of a cluster needs to be considered. The multi-level model is more suitable to analyze institutional interactions that happened during the initial generation stage of that cluster. For example, in Santa Caterina industrial clusters, the non-cooperative culture exists because it was rational in Brazil's closed market of the past (Meyer-Stamer, 1998). However, once a cluster has been basically established, path-dependency means its culture cannot be altered easily no matter how external environments change, as illustrated by the cultural dynamic of Shenzhen's electronics cluster. Cluster culture is not impossible to change slowly if certain catalysts can induce endogenous changes, e.g., a role model pursuing alternative paths within the cluster (Meyer-Stamer, 1998).

In conclusion, changing external environments are not able to significantly change the culture of a fully established cluster due to endogeneity and path-dependency. The interaction between cluster level and supra-cluster level institutions might be more apparent during the emergence stage of the cluster.

CHAPTER 8

BUILT ENVIRONMENT DIMENSION COMPONENT FINDINGS

8.1 The Xinweizai Urban Village Case

8.1.1 Emergence and Gentrification of Urban Villages in Shenzhen

Just like other urban villages in Shenzhen, the emergence of Xinweizai village is a process of how the informality of the land institution responds to the rapidly growing agglomeration. In Shenzhen, the urban village is an unintentional outcome but is acknowledged and tolerated by the local government due to the ownership dichotomy between urban (state-owned) and rural (collective-owned) land. When a village was enveloped by the urbanization process, the government took most of the farmland and vacant land but left the built-up village part and a small amount of buildable land for the village's own use. Villages got considerable autonomy to use their land since the collective-owned land is not clearly subject to planning regulations. Driven by the demands from rapidly inflowing migrants, urban villagers tore down their original village houses and build modern apartment-style rental housing as much as they can to maximize the usage of their land, especially in those well-located villages. The land is also put into manufacturing use, especially in peripherally located villages.

Due to concerns about safety risks, low environmental quality, and facility shortage resulting from unplanned construction, the renewal of urban villages has long been the priority of urban planning in Shenzhen. Among three approaches of urban renewal in Shenzhen, i.e., demolition-rebuilding, renovation (remaining the same

use), and renovation (switching to different uses), demolition-rebuilding is the approach most frequently adopted. Demolition-rebuilding would lead to radical changes in villages in terms of the physical environment and tenant composition. Informal settlements are wholly converted to high-rise residential communities or even urban complexes with offices, hotels, shopping malls, and apartments; lower-income white-collars and migrant workers are wholly replaced with higher-income white-collar & gold-collar workers as well as business owners & entrepreneurs (Deng, 2015; Zou and Wang, 2020). Living in urban villages nearby employers provides a good balance between affordability and convenience for labor forces who earn thin salaries but are essential for the electronics industry. Massive displacement caused by demolition-rebuilding is thought to harm the competitiveness of Shenzhen.

8.1.2 Half-gentrified Xinweizai Village

Xinweizai village is chosen as a case study to exemplify the gentrification dynamics impacting affordable housing for workers in Shenzhen's electronics cluster. Due to the location of Xinweizai village near both labor-intensive manufactures (Foxconn and KTC), the innovation leader – Huawei, and startups in an innovation district called Tian'an Cloud Valley, rental housing in Xinweizai has been being fully occupied by the diverse labor force in the industry, from rural migrant workers to well-educated talent. The village covers the area of 0.067 sq.km and has 226 residential buildings and about 9,260 residents (Luo, 2018). Each residential building, self-built by a local villager family, normally has five to ten floors with six units per floor to be rented out. Local villager families normally live on either the first or the top floor of their own building, leasing out units in the rest of floors.

The developer, Vanke, initiated the Xinweizai renovation project in August 2017. Since every building is independently owned and needs to be negotiated separately, Vanke proceeded with the renovation and operational transformation building by building, rather than transforming the whole village at once. By the end of 2020, 38 buildings (17% of all village housing) have been turned into Vanke apartments, and the project has stagnated with no more buildings under renovation, which doesn't meet Vanke's original plan of renovating 60%-80% of all villager housing. On the west periphery of the village, there are also other individual brand apartments renovated from old dormitories of collectively owned factories (not within Vanke's renovation plan). See figure 8.1.

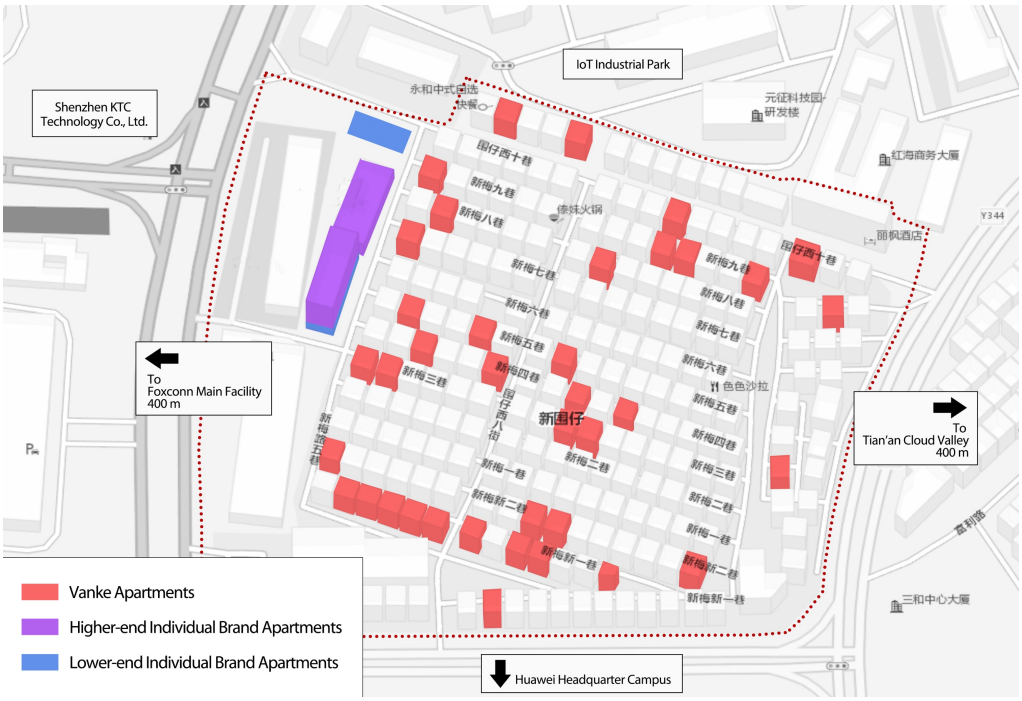

Figure 8.1: Distribution of Renovated Apartments in Xinweizai Village, Shenzhen[10]

[10] Figure is drawn by the author

To attract homeowners to get involved, Vanke offers a 12 years' contract, leasing each building at a price 10% higher than the current market price and with an annual rent increase of 3%. After obtaining the right to use, Vanke transforms housing units into modern apartment products before subleasing them for a premium price. Floorplans are rearranged to accommodate more units per floor, with smaller area per unit. Both interior and exteriors are redecorated for better lighting, ventilation, and aesthetics. Utilities including water and gas pipes, electric and telecommunication wires, as well as security and firefighting equipment are upgraded to meet official safety standards. The comparison on the exterior between renovated and unrenovated building is shown in figure 8.2.

Figure 8.2: Vanke Renovated Apartment (left) and Villager Housing (Right)[11]

[11] Photos taken by the author

Renovation brings significant housing rent premiums in Xinweizai village. Taking the studio floorplan as an example: the conventional villager rental housing costs 1,000-1,300 Yuan per month; the price range is up to 2,000 Yuan per month for apartments renovated by Vanke; renovated apartments of lower-end individual brands costs 1,500 Yuan or more per month; the rent for a higher-end individual brand apartment is 2,000-2,500 Yuan per month. Different from conventional villager rental housing, renovated apartments charge approximately 200 Yuan for a monthly management fee, further increasing actual costs. The Renovation Premium reportedly spills over to surrounding housing that has not been renovated (Shenzhen Government, 2018). Conventional villager housing rents have also increased rapidly in recent years: the monthly cost of a studio was only about 650 Yuan in 2017, but this had increased to 700-900 yuan in 2018 (China Real Estate Business, 2018). For reference, in the electronics industry, the normal monthly income for migrant manufacturing works is ￥3,000 – 5,000, while there are huge variations on how much well-educated talents make in different types of firms and positions, ranging from ten thousand to tens of thousands per month (Interview BG1; BG2).

8.2 Drivers behind Renovation, Renovation Premiums, and Displacement

8.2.1 Renovation Dynamics in Xinweizai

A series of policy documents promoted the launch of renovation program in Xinweizai. “Implementation Opinions on Fostering and Developing Rental Housing Market” (Shenzhen Government, 2017) and “Administrative Measures for Arranging Talent and Public Housing” (Housing and Construction Bureau of Shenzhen Municipality, 2020)

identify urban villages as the major source of near-term rental housing supply. Correspondingly, "Shenzhen Urban Village General Plan (2019-2025)" (Planning and Natural Resources Bureau of Shenzhen Municipality, 2019) shifts the planning approach for urban villages from demolition-rebuilding to renovation for faster urban renewal, indicating that all villages not demolished by 2020 should be included in the renovation plan. It greatly accelerates the urban renewal process, because renovation can be launched immediately after signing the leasing contract with a few property owners. while demolition needs consent from almost all villagers which could remain unsolved for many years (because of "hold outs" and high costs in China's contemporary property institutional environment. Moreover, "Shenzhen Rental Housing Pilot Work Plan" (Urban Planning, Land and Resources Commission of Shenzhen Municipality, 2017) indicates that every district should have one pilot project of branded house renting in an urban village by the end of 2017. Responding to these policy thrusts, Vanke promotes the gentrification of Xinweizai as its flagship for the renovation-subleasing business model (Interview B5).

However, the progress of Xinweizai renovation is hindered by most of the homeowners' unwillingness to collaborate with Vanke. Villager property owners (Interviews B1; B2; B3) resisted the renovation policy because they i) have higher expectations for rent increases than the 3% annual rate promised by the developer; ii) are very concerned about losing discretionary power to manage their own properties; and iii) still hope for their properties to be demolished for huge compensation (tens of millions or even hundreds of millions yuan) at a later date. Public safety issues caused by unregulated construction is one of the major concerns underlying policies and subsidized programs for urban villages to be

renovated (if not rebuilt). But bottom-level policies on minor infrastructure fixes make integrated renovation less urgent (Interview B5). I observed two examples: under district- and street-level government subsidies, the municipal gas piping can be installed in villager housing for just 1/6 of the market price; the community committee routinely spots potential risks in buildings, and posts on the announcement board force responsible personnel to fix problems (see figure 8.3).

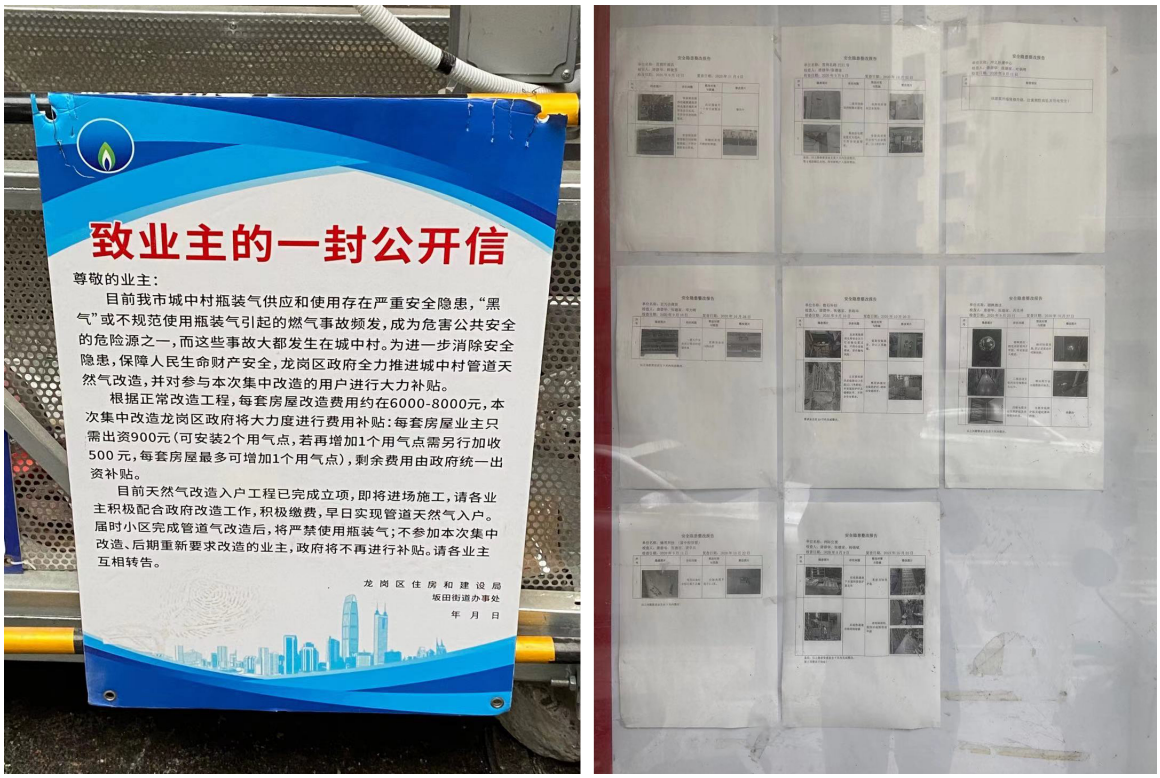

Figure 8.3: Announcement of Gas Infrastructure Fix Policy (Left) and Announcing Board of Spotted Safety Risks (Right)[12]

[12] Photos taken by the author

8.2.2 Premium Dynamics in Xinweizai

For conventional urban villager housing, rents are normally 50% lower than that of commodity housing, but the affordability advantage largely diminishes after renovation which brings up to a 100% premium in Xinweizai. Even so, according to the manager of a renovated apartment (Interview B6), the profit for the developer is still wafer-thin given the high cost of running the renovated apartment, including paying various taxes previously evaded by villager landlords, the premium price paid to property owners, as well as renovation and maintenance costs. A news commentary (Chen and Guo, 2020) noted that renovating apartments is not viewed as a sustainable business. Developers can earn much higher profits in alternative investments; however, an attraction of the renovation model to developers is that they obtain cash flow from tenants' deposits - capital that can be used. There is a rumor that Vanke has already suspended renovation projects in Shenzhen and is considering withdrawing from this type of activity due to financial losses from this business model (Interviews B4; B5). Overall, the rent increases resulting from renovation is inevitably high due to the nature of this business and could be possibly higher in the future if the business model is to be sustainable.

Potentially, as a measure to remedy renovation premium issues, "Opinions on Regulating Rental Housing Market and Stabilizing Housing Rents" (Shenzhen Government, 2019b) announces that the government will intervene in the rental market by establishing an official platform where all transactions are recorded for monitoring and rent control. Specifically, tax exemption will be given to leasing activities that are enrolled in the official platform and follow the guide price. However, such a policy is ineffective in controlling

the rent of renovation apartments because specific measures on how to determine the guide price are never addressed by follow-up documents such as *"Regulations on Shenzhen Rental Housing Management"* (Shenzhen Government, 2019c). It makes no sense to put a hard limit on rents of renovated apartments because 1) premium mainly comes from the high costs of running the renovation-subleasing business in expensive Shenzhen rather than speculative behaviors of developers; 2) if the guide price is pushed too low to keep the necessary profitability, developers can easily get around it by increasing utility and administrative fees while keeping rents no higher than the criterion (Interview B4; B6). In addition to formal renting activities of renovated apartments, informal renting activities of other conventional villager housing is also difficult to be included in price controls, for fear of leaking their rental income and being taxed, landlords don't want to formalize their trading activities by joining the official rental platform (Interview B1; B2; B3). However, as indicated by the local real estate agent (Interview B4), despite the sharp premium generated by renovated apartments, the rent of other conventional villager housing in Xinweizai, under the invisible hand of the market, is always at a pricing point that most landlords and tenants can accept.

8.2.3 Displacement Dynamics in Xinweizai

The renovation of villager housing would displace manufacturing worker tenants due to the price premium, as migrant workers employed in nearby major manufacturing factories are not willing to/can't afford to spend more on housing given their 3,000 - 5,000 yuan monthly income (Interview BG1). And more importantly, renovated apartment products (by both Vanke and other individual brands) are designed for Millennial and Gen Z white-

collar workers; they are unfriendly to migrant worker families. Within renovated buildings, features such as public spaces for social interaction (e.g., gym facilities) and small single-room studio floor plans without kitchens correspond to the lifestyles of the young and single (upper-)middle class (see figure 8.4). The importance of multi-room and kitchen features in affordable rental housing is highlighted by the current trend of family-based rural to urban migration. In Chinese first-tier cities, over 80% of urban village dwellers live together with their spouses, and 50% of families have their children with them (Wu, 2016). According to my observation, migrant manufacturing workers prefer the outdoor public square for leisure activities, different from young knowledge workers who uses gym and event space within renovated apartments for social activities. Manufacturing worker tenants indicated they have little voice in, and even don't know much about, the renovation process in Xinweizai; some of their neighbors had to move out of the village as the tenancy was forcedly discontinued when the property owner signed renovation contract with Vanke (Interview BG1). Former Xinweizai tenants' dissatisfaction with Vanke can be also found on online forums (Leju, 2017). Migrant workers kicked out of a building could neither come back to the same but gentrified building nor move to other affordable villager housing in Xinweizai which are almost fully occupied throughout the year. Therefore, migrant manufacturing workers are displaced by the renovation which have happened in 17% of villager residential buildings in Xinweizai. However, as the renovation project stagnates due to reasons discussed earlier, there are a considerable proportion of migrant manufacturing workers who are not displaced and still living in unrenovated villager housing. As far as I observed, retail outlets, restaurants, and consumer services in the

villages remain affordable, indicating that demand from the lower-income group has not faded (figure 8.5).

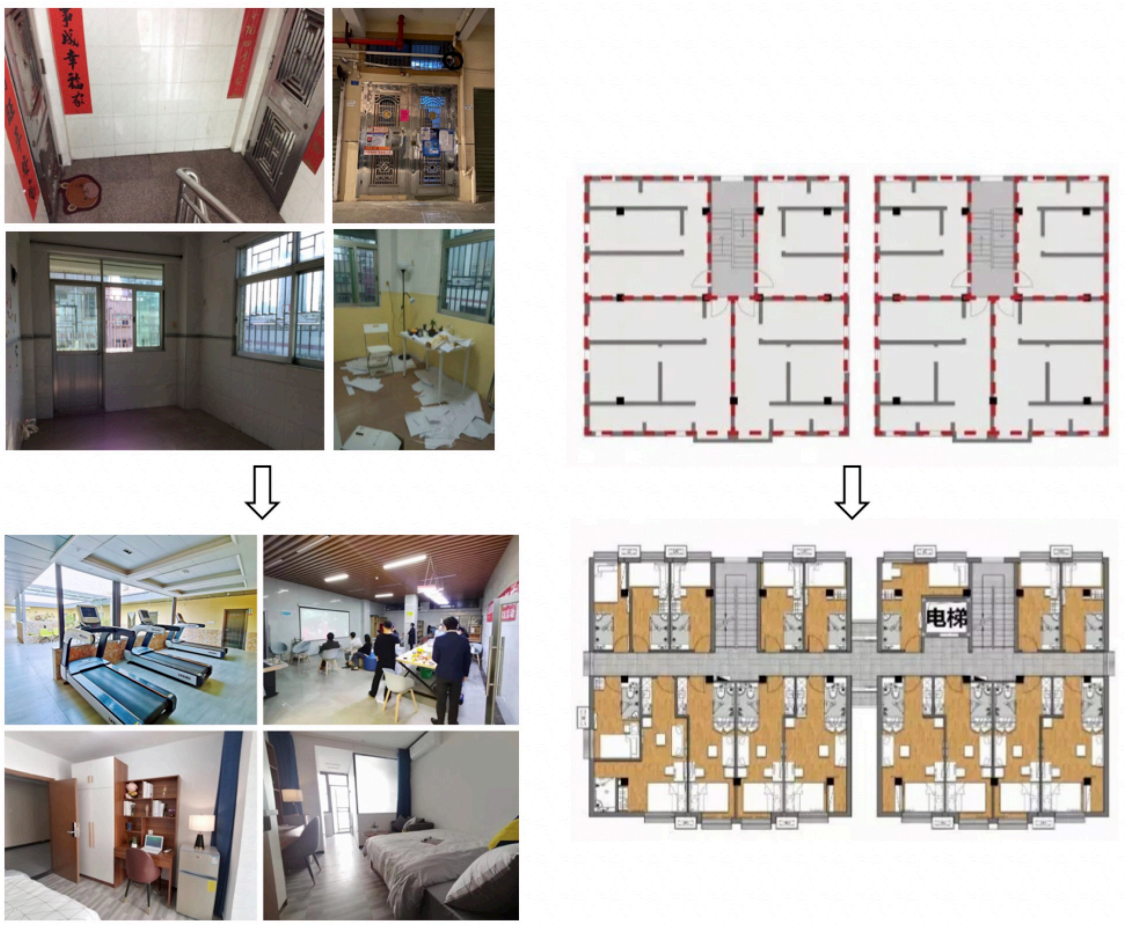

Figure 8.4: The Renovation of Interior Spaces[13]

[13] Source: photos taken by the author, Zhihu.com, Sohu.com

Figure 8.5: The Main Street with Affordable Retails, Xinweizai Village[14]

Earlier media reports even expressed concern as to whether young knowledge workers would regard the upgrade of their living environment worth the cost of the rent premium (Sohu, 2019). However, renovated Xinweizai village is in fact still attractive to higher-end talent in Shenzhen's electronics industry. Taking an individual branded renovated apartment as the example, despite rent higher than Vanke's, its manager claimed that the whole building has been mostly occupied since its opening only half a year ago, and 80%

[14] Photo taken by the author

of the tenants are well-paid engineers in the nearby headquarters of a Shenzhen-based multi-national (Interview B6). Based on interviews with this multi-national employer (Interview A3; A6) and tenants in renovated apartments (interview BG2), it turns out that with the relatively high salary, higher-end young knowledge workers have much more flexibility regarding their rental choice, because their real housing barrier is buying housing. They are satisfied with less expensive conventional villager housing, but they also would like to try new rental options provided by Vanke and other developers, which are still less expensive than renting conventional commodity housing or the company's own dormitories. As a result, a mixed and stratified landscape is formed in Xinweizai; that is, the village still mainly consists of affordable villager housing mostly occupied by migrant manufacturing workers, but this is interspersed with some renovated apartments occupied by young knowledge workers.

8.3 Gentrification Policies in Innovation Clusters

This sub-section of the dissertation looks at the renovation dynamic in Xinweizai village to exemplify how gentrification of urban villages in Shenzhen, driven by policy thrusts, economic development, and other drivers, impacts the labor force in the electronics industry. Given the difficulty of demolition-rebuilding in Shenzhen and the value of urban villages as a vital source of affordable housing, the focus of urban renewal policy has shifted to the renovation approach for less dramatic and smaller scale but quicker initiation of gentrification. Xinweizai village, as the pilot zone for this new gentrification approach, has only experienced a modest displacement despite the ineffectiveness of price control policies. The reasons are: (i) Renovation projects have stagnated with modest progress due

to most villager property owners' resistance and the low profit of the renovation-subleasing business; (ii) Renovated apartments with premium rents are welcomed by young knowledge-worker tenants in urban villages; (iii) Market forces determine the rent, at "fair" market rates of conventional villager housing which is not renovated. Overall, a mixed and stratified community urbanscape has formed in Xinweizai; that is, the village still mainly consists of affordable villager housing mostly occupied by migrant manufacturing workers but is interspersed with some renovated apartments occupied by young knowledge workers. And these two social groups are also segregated in terms of social activities in public spaces. Xinweizai is the urban village where Vanke prioritized its most ambitious urban renewal project among developers; thus, renovation elsewhere in Shenzhen by either Vanke and other smaller developers would likely be no more fruitful than in Xinweizai. It can be seen that the current renovation policies are going to bring modest gentrification to urban villages in Shenzhen, and displacement of labor forces in the electronics industry is not as large as expected.

It appears that gentrification policy may function across innovation clusters based on the Shenzhen case. In clusters where high-value activities are agglomerated, diseconomies such as high land and property prices actually retard the process of gentrification. It is hard to negotiate with property owners with high expectations for compensation, and it would be too expensive to massively proceed with demolition-based urban renewal. Meanwhile, more diverse tenants in affordable settlements include not only lower-skilled labor who are socially and economically disadvantaged but also considerable numbers of knowledge and white-collar workers with stronger consumption power, thus being less vulnerable to

displacement. Gentrification is therefore more likely to be promoted in a very incremental fashion in already congested high-value innovation clusters. This situation is not a result of policy success. Shenzhen's policies that remedy side effects of gentrification failed to take effect, similar to the previous experience of policy failure to neutralize gentrification (Shaw, 2008). The modest gentrification with small proportion of displacement in Shenzhen should be ascribed to the mix of policy thrusts (not necessarily successful), market forces, and stakeholder interests. However, my case study findings do not mean that there is no need to worry about gentrification in innovation clusters. Firstly, Shenzhen is unique in the way that the entwinement of China's dichotomous land ownership institutions, Shenzhen's rapid industrialization and urbanization, and pre-existing affordable informal settlements have preserved the status quo into the highly mature stage of the cluster. Secondly, there is not guarantee that the current balance of modest gentrification will continue. And other types of innovation clusters, e.g., a fast-growing cluster or one in the transitional stage may require different policy responses.

CHAPTER 9

CONCLUSION

9.1 Agglomeration Dimension Conclusion

The agglomeration dimension part addresses the following research question posed earlier: *How does firm heterogeneity affect the trade-off between agglomeration economies and diseconomies, as reflected in different locational behaviors of staying/leaving Shenzhen among firms and in intra-firm functions?*

It is found that at the scale of Shenzhen-Dongguan-Huizhou sub-region there is no significant distance-decay of Shenzhen's agglomeration economies; different firms therefore come to Dongguan and Huizhou pursuing either various forms of lower agglomeration diseconomies or rising agglomeration economies on peripheries. As a result, both big and smaller firms as well as manufacturing, R&D, and supporting service functions all spill out of Shenzhen.

Corresponding to the existing theoretical perception that agglomeration effects are asymmetric when being moderated by firm heterogeneity, the trade-off between distance-decaying agglomeration economies and diseconomies also exhibits variations across different types of firms. However, due to other mechanisms involved, such asymmetric "borrowed size" doesn't simply lead to differentiated spillover behaviors. First, there are interactions between firms' locational behaviors, i.e., the "borrowed size" behavior of leading firms would later induce the spillover of other firms. Second, different motivations could result in the same locational behavior. Therefore, findings in the agglomeration dimension contribute to the understanding of cluster growth/expansion at the sub-regional

scale, indicating asymmetry in "borrowed size" doesn't necessarily mean asymmetric spillover behaviors.

Policy implications can be learned from the findings discussed above. If a local government wants to develop the economy by receiving the industrial spillover from the core city within the same sub-region, planning & policies should be made to accommodate all types of firms along the supply chain, because heterogonous firms will ultimately co-locate with each other in the new location. However, priority should be given to attract large firms which hold the central role in the industrial network. The landing of such firms can induce the spillover of smaller firms in their eco-systems, thus triggering the rise of local agglomeration advantages.

9.2 Institutional Dimension Conclusion

The institutional dimension part investigates the following research question posed earlier: *How are cluster institutions formed through multi-level interactions, as illustrated by the net impact Shenzhen's innovation culture receives from the wider contexts?*

The study found that while recent major external impacts, namely the Covid-19 pandemic, China-U.S. trade dispute, and financial and property economy fever, influence firms' innovation activities both positively and negatively, the overall attitude to innovation in Shenzhen remains more or less the same as before. The formation of Shenzhen's innovation culture is more ascribed to local business-friendly policy environment rather than multi-level institutional interaction.

In terms of the theoretical contribution, the relationship between recent external impacts and Shenzhen's innovation culture highlights the significant role of the local policy environment as a long-term moderating factor. Cluster culture and its resiliency are largely fostered by the local policy environment which has been there consistently for decades. Therefore, only focusing on the short-term interaction between the cluster and wider contexts is not enough to fully understand the formation of cluster institutions. There are other critical factors, e.g., local factors, long-term factors to consider when explaining cluster institutions.

In terms of the policy implications, for local government, cultivating innovation culture in a cluster is a long-term task, which requires the building of a favorable policy environment over many years or even decades. Given Shenzhen's status as the domestic role model city for innovation, other Chinese cities always want to copy Shenzhen's enthusiasm and facilitative environment for innovation. However, Shenzhen's innovation culture has been fostered within the local bottom-up policy environment for over forty years and shows certain resiliency to major short-term impacts. If other clusters want to have an innovation culture as dynamic as that of Shenzhen, the ideology of local governance needs to be essentially transformed so as to maintain consistent policy support.

9.3 Built Environment Conclusion

The built-environment part attempts to answer the question posed earlier: *How does the co-existence of policies promoting and controlling gentrification affect the pace and*

character of gentrification in Shenzhen's urban villages and What is the impact of gentrification on the displacement of labor in the electronics industry?

The study takes Xinweizai village as the example. Hindered by factors related to agglomeration diseconomies, namely rapid (or anticipated) increase in the value of property in Shenzhen, renovation-based gentrification policies only lead to the renovation of a modest proportion of residential buildings. When a residential building is renovated, migrant manufacturing worker living in that building are displaced from the village. Those renovated apartments, despite sharp lease premiums under ineffective price control policies, are accepted by young knowledge workers. As for other unrenovated units, which account for the majority of urban village housing, their rents remain relatively stable due to market forces and still affordable to village tenants, particularly migrant manufacturing workers. As a result, relative to the size of the labor force, the number of tenants displaced by the renovation project is not large that the current gentrification dynamics may not be greatly affect the activities of the cluster.

Theoretically, findings in this dimension exemplify the causality that cluster built environment not only causes, but is also influenced by, agglomeration effects. The current mainstream logic adopted in cluster built environment research is to conceive and prove the impact of certain built environment features on the clustering of firms and innovation, so as to justify these features when promoting cluster development. However, it has been overlooked that the built environment dimension could be reversely affected by the clustering phenomenon. A better understanding of the causality in this direction can inform the feasibility of promoting certain built environment features within the context of clusters.

When it comes to the policy-making for the built-environment in innovation clusters, more attention should be given to the implementation mechanism. Given the rise of place-based arguments to support local productivity growth globally and in China, and the top-down nature of Chinese city building, public intervention in terms of the built-environment becomes an easy starting point of cluster policy. However, complex stakeholder interests and strong market forces resulting from agglomeration diseconomies impede the implementation of built-environment initiatives. When facilitating innovation cluster through built-environment tools, policy studies need to focus more on feasibility study before acting, and policy-making needs to be more bottom-up.

9.4 Intertwining Three Dimensions

9.4.1 Theoretical Integration of Three Dimensions

Since the agglomeration dimension directly reflects the essence of clustering, the following will build on agglomeration economies as the benchmark and core of cluster theory and discuss if the institutional and built-environment dynamics share similar localization dynamics as agglomeration effects. In that way, the theoretical feasibility of meshing three dimensions together is probed.

Just like the emergence of agglomeration effects, the emergence of cluster institutions is a primarily local process. Shenzhen's innovation culture tends to remain stable regardless of recent impacts from wider environments, and its formation is more ascribed to the local policy environment and history. The institutional context also affects, and is affected by,

spillover and distance-decay when viewed from a conventional agglomeration effects perspective. Policy targets and actions are similar among Shenzhen, Dongguan, and Huizhou, causing fierce competition and increased industrial homogeneity across these three neighboring cities (Liu, 2011). Therefore, the emergence of cluster culture and policy can be viewed as additional types of agglomeration effects beyond the classical (more strictly economic) trinity of specialization, knowledge spillover, and labor pooling.

The cluster built environment, specifically a special form of housing in Shenzhen examined by the study, has a close relationship with agglomeration effects. Affordable rental housing in urban villages, which facilitates labor pooling in Shenzhen, cannot be easily gentrified due to factors derived from agglomeration diseconomies, i.e., high land value. Urban villages emerge from the interface between informality in local land institutions and industrial clustering and consequent migrant inflow, associated with Shenzhen's electronics cluster. Moreover, built environment quality is considered as one of agglomeration (dis)economies driving the spillover behavior of Shenzhen firms. Overall, it can be argued that just like cluster institutions and traditional agglomeration effects, the emergence of certain built-environment features, in this case the availability of affordable housing near electronics employment, is also the localized advantage associated with the clustering phenomenon.

Analytical integration of the agglomeration, institutional, and built-environment dimensions of the cluster concept can be fruitful in terms of theoretical conceptualization. But more importantly, new insights on cluster development could be derived from

analyzing disaggregated dynamics (specific processes) of different dimensions together, which will be discussed in the following section using the Shenzhen case.

9.4.2 Is the future of Shenzhen's innovation on the Periphery?

Integrating the dynamics of three dimensions, the spatial periphery of Shenzhen's electronics industry cluster seems to have a higher potential than Shenzhen Municipality (the core city) in terms of innovation. Study of agglomeration dynamics indicates that innovation activities are increasingly spilling out of the cluster core looking for higher quality space attractive to knowledge workers and compatible with intelligent manufacturing. According to the built-environment dynamics, high land value creates implementation obstacles to urban renewal within the cluster core, forces which have built up for many years. Comparatively, in the periphery with lower land value and more available land, it should be easier to create a newer built-environment favorable to innovation.

As different types of firms and functions all spills outwards, Shenzhen's innovation culture can be expected to diffuse to surrounding areas. The institutional dimension study shows no significant change in Shenzhen's innovation culture caused by recent external impacts. But in the periphery where Shenzhen firms' new starts meet a slightly different institutional environment, whether such resiliency in the innovation culture can stay the same remains a question. The periphery favors different policy approaches and has different strategic positioning than the core. As the location for expansion, the periphery is more likely to accommodate the firm's new factors of production. Therefore, compared to the long-

established core, the growing periphery might be more prone to leading significant adaptation in the innovation culture of the sub-region.

However, these probes on the innovation potential of the periphery is just the product of this preliminary assumption. Further research is needed, as suggested later in this Chapter.

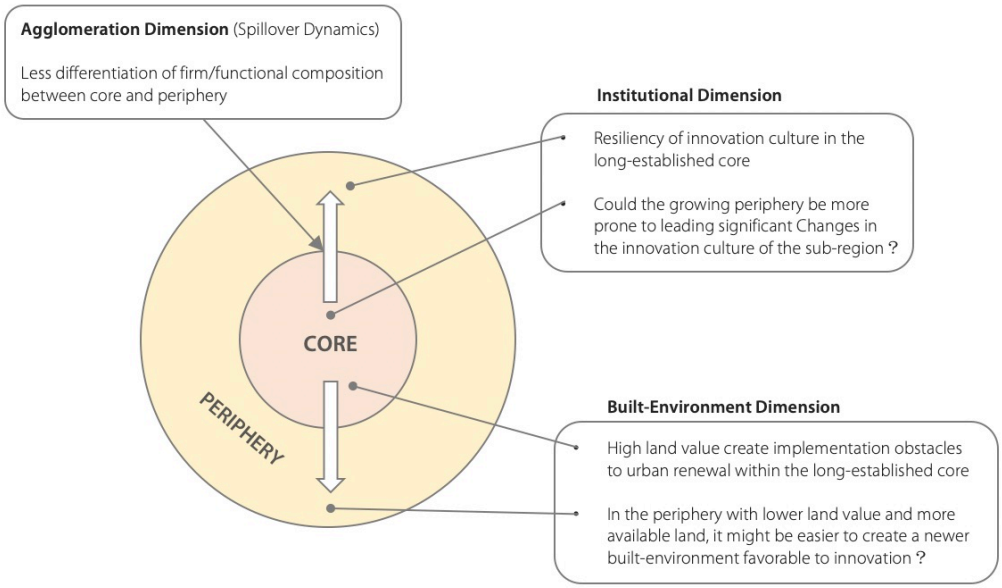

Figure 9.1: Innovation Potential of the Periphery

The strategic importance of the periphery is reflected in major regional development policies that emphasize the spatial dispersion of innovation. In the, *Guangzhou-Shenzhen Technological Innovation Corridor Plan*, peripheral innovation nodes are considered as the spatial connection between innovation nodes in Guangzhou and Shenzhen. In the, *Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area,* secondary cities and townships are planned to be integrated with core cities in the making of a world-

class regional innovation network. Infrastructure connectivity in the Greater Bay city cluster is to be greatly improved to facilitate the interaction between the core and the periphery.

Understanding the innovation potential of the periphery is an alternative way of conceptualizing innovation geography to the current urban-centered bias. It is undeniable that the urban core environment provides many favorable conditions for the clustering of innovation activities. However, the current urban-oriented arguments, concepts, and policies envision and interpret the periphery as a second choice for firms wanting to reap advantages from the urban core in an economical way. In fact, the periphery has its own unique innovation advantages and should be viewed more positively in theoretical and policy debates. Twenty years ago, the peri-urban fringe characterized by the mosaic of traditional manufacturing and agricultural land was the frontline of Chinese urban development in the era of labor-intensive economic growth. In today's China, by increasingly accommodating higher-value activities in well-organized spaces, the periphery is worth a revisit by both researchers and policymakers for its potential to shape the future of China's innovation-led growth.

Peripheries, potentially as the key area for future innovation in Shenzhen, should be given more policy significance. In recent years, the focus on innovation spaces has shifted from suburbs to downtowns. However, based on the study of the dynamics of agglomeration, institutional, and built-environment dimensions of cluster dynamics in Shenzhen, I argue that more potential for future innovation can be found on the periphery where cluster

expansion happens and new cluster dynamics emerge. I am not advocating the return of the traditional suburban economic development zone, but rather calls for policy efforts to facilitate creation of urban innovation platforms on peripheries suited to current requirements, from both technical and talent perspectives.

9.5 Future Research

In terms of the agglomeration dimension, since this dissertation only studies the growth of Shenzhen's electronics cluster through the lens of why Shenzhen-based firms spills outwards, there is a missing link on how and why firms newly enter the sub-region or how firms originating from Dongguan and Huizhou frame locational choices in the core *versus* the periphery of the Shenzhen-Dongguan-Huizhou sub-region. Future research needs to expand the sample selection beyond firms from Shenzhen to have a more holistic understanding of agglomeration advantages on the periphery.

To understand the innovation potential on the periphery from the institutional perspective, future studies can focus on whether and how innovation culture evolves differently between the core (Shenzhen) and the periphery (Dongguan, Huizhou). External influencing factors (pandemic and trade war) considered in the institutional part happened very recently; their longer-term impacts on Shenzhen's innovation culture still needs to be explored, despite no significant short-term cultural impact to be found so far.

In terms of the institutional dimension, findings on housing gentrification are based on one case study of Xinweizai village; the representativeness of this case should be further

validated by studying other urban villages relevant to Shenzhen's electronics industry. In addition to the living place, the working place, e.g., company campuses, innovation zones are also an important part of the electronics cluster built-environment that has not been examined by this dissertation. Future work can address the question on whether the renewal of old industrial zones in Shenzhen is as stagnated as that of urban village housing.

In conclusion, I argue that the periphery of Shenzhen's electronics cluster will become increasingly important, surpassing the importance of the current core area in determining the cluster's future. Future research on innovation clusters or relevant topics should pay more attention to the peripheral areas, so as to either support or refute this assumption. As case study research grows, comparative analysis and learning across different leading innovation zones worldwide will become possible. Last, this exploratory research was based on a small number of interviews; more highly funded research designs with extensive sampling and diverse analytical approaches (both qualitative and quantitative) would yield additional critical empirical evidence to test the validity of exploratory findings outlined in this dissertation.

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APPENDIX A

INTERVIEW QUESTIONS

For staff of firms in the electronics industry:

i) Could you please introduce the basic information of your firm?

ii) Have your firm spilled / considered spilling towards Shenzhen's surrounding areas? How and why?

iii) What changes have been brought to your firm's operation by the spillover? What are advantages and disadvantages of being (partly) on the periphery adjacent to Shenzhen?

iv) How Covid-19 pandemic, US-China trade war, and booming real estate & financial markets influence your firm's operation and innovation attitude? How have the innovation culture in Shenzhen changed recently?

v) How public policies affect your firm's operation and innovation attitude under recent domestic and global situations?

vi) Regarding issues we just talked about, what about your surrounding friend's firms, partners, or other firms in the industry you heard of?

For local villagers (homeowners) or village heads in two case urban villages:

i) Do you want to get involved in the renovation? How and Why?

ii) How tenants in this village have changed after the renovation began?

iii) How is the progress of renovation in this village? Are related policies effective?

For staff of developers involved in renovation projects at two case villages:

i) Could you introduce the basic information and timeline of this renovation project?

ii) How about the positioning of your rental housing products? Could you give a profile of major tenants of your products so far?

iii) How policies and regulations affect the operation of your renovation project?

For tenants of rental housing in two case urban villages:

i) Could you briefly introduce yourself?

ii) How living costs have changed after the renovation began? Have you considered moving out of this village? Why?

iii) As for what we just discussed, what about your friends, co-workers, or others you heard of who also live(d) in this village?

APPENDIX B

IRB APPROVAL DOCUMENTS

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Deirdre Pfeiffer
CLAS-SS: Geographical Sciences and Urban Planning, School of (SGSUP)
-
deirdre.pfeiffer@asu.edu

Dear Deirdre Pfeiffer:

On 9/28/2020 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	The Electronics Hardware Innovation Cluster in Shenzhen, China: Contemporary and Future Dimensions from an Agglomeration, Institutional, and Built-environment Context
Investigator:	Deirdre Pfeiffer
IRB ID:	STUDY00012365
Funding:	Name: Arizona State University (ASU)
Grant Title:	
Grant ID:	
Documents Reviewed:	• Interview Questions 26-08-2020.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Interview Questions 26-08-2020_Translated CN.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Interview Questions_back translation.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Jianyi Li Research Significance_V3.pdf, Category: Sponsor Attachment; • Jianyi Li_Completion Fellowship.pdf, Category: Sponsor Attachment; • Jianyi Li_Form-translation-certificate.pdf, Category: Translations; • Jianyi Li_IRB Social Behavioral Protocol.docx, Category: IRB Protocol;

	• Jianyi Li_Recruitment Script A.pdf, Category: Recruitment Materials; • Jianyi Li_Recruitment Script A_back translation.pdf, Category: Recruitment Materials; • Jianyi Li_Recruitment Script A_Translated CN.pdf, Category: Recruitment Materials; • Jianyi Li_Recruitment Script B.pdf, Category: Recruitment Materials; • Jianyi Li_Recruitment Script B_back translation.pdf, Category: Recruitment Materials; • Jianyi Li_Recruitment Script B_Translated CN.pdf, Category: Recruitment Materials; • Jianyi Li_short-consent A.pdf, Category: Consent Form; • Jianyi Li_short-consent A_Translated CN.pdf, Category: Consent Form; • Jianyi Li_short-consent B.pdf, Category: Consent Form; • Jianyi Li_short-consent B_Translated CN.pdf, Category: Consent Form; • Jianyi Li_short-constent A_back translation.pdf, Category: Consent Form; • Jianyi Li_short-constent B_back translation.pdf, Category: Consent Form; • Li Signed_Grad College Completion Fellowship-Confirmation Form, AY20-21.pdf, Category: Sponsor Attachment; • Pfeiffer CITI Certificate 2020.pdf, Category: Other; • Supporing documents 26-08-2020.pdf, Category: Other;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 9/28/2020.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

If any changes are made to the study, the IRB must be notified at research.integrity@asu.edu to determine if additional reviews/approvals are required. Changes may include but not limited to revisions to data collection, survey and/or interview questions, and vulnerable populations, etc.

Sincerely,

IRB Administrator

cc: Jianyi Li
Jianyi Li