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Made In China: Coastal Industrial Clusters and Regional Growth[1]

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Upon us is a new era where globalization is inevitable. With this, the global climate significantly changes with the level of economic influence emerging markets have. China is one such country. Though still considered an emerging market, the speed of its economic growth places it in direct competition with more mature economies, such as the United States and the European Union, both economically and politically. After wasting away its resources under a centrally planned system, China's economy made a turn towards free market activities in 1979. Its prodigious growth is in part the result of certain economical units acting as "hot spots" for regional development.

This study examines the effect of the development of industrial clusters on regional growth in China. As a form of industrial organization, it cannot be said with certainty whether such production proximity between firms will necessarily imply economies of scale or, as they are referred to in the urban economics literature, economies of urbanization or agglomeration. Clusters located in developed and developing nations often have different origins, organizational structures and competitive factors. Across industries, it is unsurprising that the effect of clustering varies greatly given the diverse nature of the industries themselves.

Clusters have been a significant component of the provincial economies of coastal China. Literature cites it as a new source of growth for non-metropolitan areas, enabling them to attract investment and resources that would otherwise be concentrated in major cities (Zhang et. al, 2004 Sonobe et. al, 2002). Empirical evidence and case studies in China have also found that clusters have increased standards of living in rural areas by enabling small amounts of capital to be integrated into a larger production chain. Our study contributes to this growing pool of knowledge by quantitatively examining whether such industry agglomerations are indeed the workhorse of the economy. We use an endogenous growth model as our theoretical framework. Empirical parameters are used to determine the presence of a cluster as well as any economic effects the cluster has on the overall economy. By using data from different size economies, we simulate the "ripple effect" of clusters to measure their economies of scale at different administrative levels.

I. Literature and Background

Industrial clusters in China have been developing over the last 20 years, beginning soon after the market reformation in 1979. China's rapid economic expansion is often attributed to the economy's shift from a centrally-planned system to an open, market-based economy (Borzensztein 1996). In addition to institutional development, expansion factors include the development of private and semi-private enterprises, improvement in higher education, international trade, and foreign investment (Chen 2000). In terms of regional growth, the eastern coastal regions of China have experienced a higher economic growth rate than their inland counterparts.

It is likely that the higher growth for China's coast can be attributed to the higher share of non-state-owned enterprises occupying the region. These enterprises, unlike state-owned enterprises, are better able to adapt to rapid market changes and survive within a more competitive market. (Chen 2000). On average, the share of non-state owned enterprises in the coastal provinces is 44.8 percent, more than twice the share in the inner provinces (Chen 2000).

Industrial clusters are most often defined in literature as the agglomeration of a number of enterprises with production linkage to each other within a concentrated geographical area (Wang

2002). Along with the growth factors listed above by Chen, Zheng (2004) notes that industrial clusters tend to form in regions where barriers to entry are very low in terms of capital and technology. Also, in these specific provinces, initially there was an abundant supply of cheap labor and open access to information and technology due to knowledge spill-over generated and circulated within the clusters, thus making rapid market development possible (Chen and Zheng, 2004). Most importantly, these coastal regions provided the opportunity for international trade in order for clusters to grow and develop in an international context (Zhang *et al.*, 2004). In middle and western provinces, the clusters are mainly urban-based economic agglomerations.

Like many clusters in developing countries, member firms in Chinese clusters consist mostly of small and medium enterprises (Schmitz and Nadvi, 1999). Recent studies (Zhou and Pu, 2003) (Zhu *et al., 2005)* identify industrial clusters as one of the most productive strategies in promoting sector and regional growth. In a cluster, firms benefit primarily through increased interaction and cooperation where resources are shared as "club goods". This includes more technology spillover, stronger social network and lower transaction cost. Clustering also builds up a skilled labor pool, lowering entrance barriers to an industry, and enabling small amounts of capital to be integrated into the production chain by specializing on a particular stage of production (Sonobe, Hu & Otsuka, 2002). In both domestic and international markets, clusters create a collective image for its member firms, strengthening their competitive advantage and marketing capabilities.

Despite the many advantages of clustering, there exist constraints that often hinder the long-term development of a cluster. In the Chinese context, lack of endogenous innovation and technological improvement, while allowing for a temporary competitive edge, makes for poor long-term integration into the local or international economy. Internally, this leads to intense price competition between firms which can, in many cases, eventually lead to deterioration in quality. Externally, these clusters are prone to become victims of external shocks, such as regulations on the international market. Firm migration becomes the inevitable result as these factors slowly wear out. Also, in terms of the cluster, disproportionate support for leading firms within a cluster leads to malnutrition for SMEs (small and medium-sized enterprises) in terms of resources, leading to a weak support network. (China City Competitiveness Report, 2005)

More specifically for China's middle and western provinces, another case is agglomeration by administrative mandate. In such cases, clusters are not formed by market forces but by local governments. This kind of cluster lacks interaction and connectivity between firms, producing inefficiency and waste of public resource. Finally, restriction on labor migration by the "Hukou" (house registration) system leads to inefficient allocation of labor and non-optimal city sizes. (Au and Henderson, 2004) This potentially limits cluster growth as they spread across administrative borders.

Among the previous efforts to analyze clusters, Hill and Brennan (2000) use mathematical cluster analysis and discriminant analysis to identify the driving industries for the clusters in the Cleveland area. Hierarchical cluster analysis is a mathematical procedure with no dependent variable and no meaningful descriptive statistics. It main objective is to identify various groups of industries that share economic base characteristics. They then use stepwise discriminant analysis to test for the statistical validity of such labeling based on data rather than industry names, which they believe maybe misleading. In their paper they use competitiveness, exports, centrality and employment specialization as their independent variables. Competitiveness is measured by: productivity proxy (estimated gross metropolitan product per hour), regional industry's change in national employment share, relative earnings (local average earnings to national average earnings) and change in relative earnings. Exports are measured by share of industry's output shipped out of the region and share of local exports accounted for by the industry. They measure centrality in terms of forward linkage (buy relationships), backward linkages (purchase relationships) and change in local employment share. Finally, location quotient and change in location quotient measure employment specialization in the Cleveland area.

This methodology is most efficient when identifying the leading industries of one region. In China however, industry competitiveness is usually identified using different measures, and in a regional rather than cluster context. We will come back to the effect of this difference later in the model section of our paper.

II. Data

For our study we use data from the *2005 China Statistical Yearbook* and the 2004 and 2005 *Statistical Yearbooks* of Zhejiang, Jiangsu and Guangdong provinces. These three provinces have an extensive presence of market-oriented clusters in both urban and rural areas. We eliminated coastal provinces that either lack a significant cluster presence (*i.e.*, Guangxi, Hainan) or are under special administrative influence. Specifically, we eliminated Hebei, where the capital Beijing is located, and Jilin, where its heavy industry is subject to substantial state influence and control. The years 2003 and 2004 are "normal years" in terms of economic development, with no substantial fluctuations, and therefore we take them as a representative sample of most of the years in cluster development history. They are also among the more recent years on which we can find more complete and consistent data across the three provinces.

Data collection on the cluster level proved difficult because no data at that level exist. Therefore, because clusters tend to locate on the city/county level with member firms locating in its administrative subordinates, we use cross sectional city/county level data for different variables to model the effects of clustering on the general economy. This includes all cities and counties in Zhejiang, Jiangsu and Guangdong. Our selection includes "county cities," which are cities on the same administrative level as a county. All clusters in our selected provinces are identified by official statistics as belonging to one city or county. This is partially due to the complications and red tape that firms have to face crossing borders. Later we will also elaborate on the effects of social networks in this matter.

In order to determine cluster influence upon a GDP growth, we collected statistics regarding a given city's foreign export, small enterprises, private firms, private employment, township enterprises, and road freight. We first measure the number of small enterprises within a region as a percentage of the total number of enterprises within the region. This percentage is then divided by the provincial percentage to generate a quotient which measures the concentration of small enterprises within a region. Since clusters are composed mainly of a large number of small firms relative to the number of larger firms, the proportion of small enterprises to the overall number of enterprises seemed a good proxy for the extent of cluster presence within a given area. Trade dependence is measured as the level of exports as a percentage of GDP for a given area. Given the geographic concentration of our study, the clusters examined were most likely to engage in international trade, thus increasing output and revenue. Thus, using trade dependency, we will be able to gauge the effect of export on per capita GDP. Last, for private firms, we measured the concentration of private firms located within a city or town, using the quotient technique described above. This is due in large part to the fact that, as stated by the supporting literature, privately owned firms are more likely to successfully cluster and contribute to overall output than the state owned enterprises. This allowed us to semi-accurately gauge the presence of a cluster within a region.

Though the abovementioned variables are good proxies for cluster presence, missing data, specifically for Zhejiang province, made us decide to estimate the presence of a cluster using trade dependence, private employment quotient and percentage of highway freight transportation as a percentage of total freight transportation. Private employment quotient was calculated using the technique described above. We chose private employment data to mirror the private enterprise data used for the remaining two provinces. For freight transportation, we used this variable in hopes of modeling the interaction between firms of a cluster. As the level of activity between components goods producers and final goods producers increases, we would expect that freight transportation will increase as well, thus freight correlates to the level of output of a cluster.

III. Theoretical Model

The theoretical model that we choose to represent the influence of industrial clusters is the endogenous growth model derived by Rivera and Romer (1990). In essence, the cluster is treated as a single firm, and through its activities engages in actions in order to increase and improve production capabilities. This occurs with the initiation of research and development within the cluster, therefore making what was once an uncontrollable exogenous shock an endogenous factor to the cluster. We begin with the equations representing the clusters output in terms of human capital (H), labor (L), and capital (K):

(1) $$Y = H^{a} L^{b} K^{1-a-b} \qquad (a + b \leq 1)$$

However, because the cluster actively improves their manufacturing process, the term (K) can be replaced with a function represented the most recently developed type of capital:

(2) $$K = \int_{0}^{A} x(i)di$$

Below, the substitution has been made:

(3) $$Y(H, L, x(i)) = H^{a} L^{B} \int_{0}^{A} x(i)^{1-a-b} di$$

The newly added integral represents the continuous process of capital innovation. The term x(*i*) represents the current level of capital stock, while the newest term *A* represents the quality factor of the good, not to be mistaken for the good itself. *A* can be thought of as the highest level of technology the company/cluster at which the company is operating. The solved integral therefore represents the most developed product that the company can produce given the improvements in capital stock. With these technological improvements, increases the overall level of output yielded from the most current level quality, *A*. The improved form of capital is represented by *K*; therefore, Equation (2) can be solved for and written as below:

(4) $$K = Ax(i)$$

Substituting and solving for the integral:

(5) $$Y = H^{a} L^{b} A(K / A)^{1-a-b}$$

Therefore:

(6) $$Y = H^{a} L^{b} K^{1-a-b} A^{a+b}$$

Equation (6) represents the cluster's ability now to engage in economic behavior that causes increasing returns to scale in terms of output. This increasing returns to scale should have a positive effect on the economy as a whole, as we hypothesize is the effect of clusters on overall economic growth.

In order to take growth into a "cluster context", when forming our empirical model, we make two refinements to the system based on conclusions drawn from existing literature. First, we make the assumption that technology is endogenous to a cluster but exogenous to its member firms based on the cluster-level economy of scale and member firm competition argument (Zhu et. al, 2005). This leads us to define *A* in the original model not as technology but as available channels to acquire technology. Technology affects an individual firm in one of two ways: as an exogenous shock or as advancement made by the firm itself. Large firms tend to have greater endogenous capabilities while small firms most often benefit from imitation and spillovers. This typology we found to be true for firms both in and out of a cluster. However, technology in a cluster is treated quite differently. Here technology is considered a "club good" which disseminates freely among its member firms whether with or without explicit permission from its inventor. Firms enjoy the benefit of clustering by learning from each other.

Second, we define *H* in the original model not as human capital but as a social network for the cluster that, in effect, creates an economic barrier to entry for potential competitors. We assume the principal, long term way for a firm to lower non-production costs is by establishing social networks, which enable it to establish long-term business relationships with other firms at a lower cost. Cheap labor in this case is regarded as a less general and more temporary condition. The linkage through family and friends, particularly at the small enterprise level, is in many ways a natural and invisible barrier that segments clusters according to administrative divisions. In some cases, clusters develop around social networks that act as a type of financial market, given the failure of the established financial market. However, for the purpose of this study, we are only concerned with firms that cluster on the basis of production.

IV. Empirical Model and Regression

Taking these assumptions into account, we form our empirical model. For our initial model, we aimed to solve for growth in per capita GDP (PCGDP) by using three different variables: location quotient (*LQ*), trade dependency (*TD*), and concentration of small enterprises (*SE*). In terms of the previous equation and our assumptions, the concentration of small enterprises represents the social network established within a cluster among the component producers, thus represents the level of human capital (*H)*. Likewise, this variable also represents the channels by which the cluster as a whole improves its technology; therefore this variable also represents the level of technology (*A)* the cluster is performing at. Trade dependency also represents the abovementioned variables, in terms of established social networks and technological channels. Lastly, the location quotient, which is also representative of the social network term described above, measures the degree of concentration of an industry in a region, and therefore, is the most important variable for this regression. Our empirical model is calculated below:

(7) $$\ln PCGDP = b_0 + b_1 LQ + b_2 TD + b_3 SE + e$$

As mentioned before, the location quotient is our most important variable in order to accurately predict the presence of a cluster within a region. This quotient measures the concentration of a given industry within a specific region (such as a city or province) relative to the industry concentration within an entire region. We calculate this as follows:

(8) $$LQ = \frac{REVENUE_{provincial} / GDP_{provincial}}{REVENUE_{national} / GDP_{national}}$$

Above, the revenue of a particular industry in a given city is taken as a percentage of the overall provincial GDP. Once calculated, this proportion is then taken as a percentage of the nationwide proportion of revenue from this same industry to national GDP. Therefore, one can calculate the overall strength of a given industry, be it textiles or electronics, and identify which particular region is stronger, in terms of production, in a particular region. To clarify, in terms of our project, the numerator represents a calculation based on statistics at the city and county level, while the denominator represents the entire province.

A location quotient larger than 1 indicates some degree of competitive advantage (assuming that the quotient is driven by market forces rather than state planning, and that advantages are stable over time – that is, that the high value does not reflect past and outdated history) and a quotient larger than 2 indicates a significant competitive advantage. We calculated the location quotient for 38 industries located in Zhejiang and Jiangsu according to the national industry segmentation. Certain heavy industries have a history of state planning and control, yet we believe that the market is the driving force behind the majority of these industry agglomerations. Our results correspond with the reported "pillar industries" in Zhejiang and Jiangsu. However, our quotients were calculated at a provincial level due to lack of data at the city level, which in turn made the results unusable due to a lack of a number of observations. Although the location quotient is a good measure of clustering, we were forced to choose a less accurate but a less limiting proxy for cluster strength in a given city or town.

We replaced the location quotient variable with the variable that measures the percentage of privately owned firms within a region. Because, as mentioned and outlined in related literature, firms within a cluster are mainly private enterprises and not state owned enterprises, we felt that this would be a sufficient replacement.

The final econometric model attempts to determine the growth of per capita GDP, given a city or town's trade dependence (*TD*), small enterprise quotient (*SEQ*), and private enterprise quotient (*PEQ*). Small enterprise quotient within a region is calculated using (8) to determine the concentration of small enterprises within a given city or town as compared to the entire province. Likewise, the concentration of private enterprises was calculated in the same manner, calculating the concentration of private enterprises within a given city or town as percentage of the provincial level. This model is illustrated below:

(9) $$\ln PCGDP = b_0 + b_1 TD + b_2 PEQ + b_3 SEQ + e$$

All three variables are expected to have a positive effect on the growth of GDP per capita. A detailed table of all variables and their expected values can be found in Appendix I of this paper.

While these variables are sufficient to model the presence of a cluster, due to missing data issues, we are again forced to examine different parameters to proxy the presence of clusters in Zhejiang province. In the absence of a private enterprise quotient and a small enterprise quotient, we instead used freight transportation percentage (*TRN*) and private employment quotient (*EMPQ*), along with trade dependence, to model per capita economic growth. Below is the regression equation for Zhejiang province:

(10) $$\ln PCGDP = b_0 + b_1 TD + b_2 TRN + b_3 EMPQ + e$$

Again, just like the previous model and as previously mentioned, all coefficients are expected to be positive.

While these regression models are sufficient in predicting cluster influence, we wish to further investigate the presence and the effect of clusters and, in order to expand our analysis, we included interaction terms as well as squared interaction variables in each model. Below is the regression model for Zhejiang:

(11) $$\ln PCGDP = b_0 + b_1 TD + b_2 TRN + b_3 EMPQ + b_4 Z + b_5 Z^2 + e$$

where

(12) $$Z = (EMPQ * TRN)$$

In the models above, we included the interaction term *Z* to demonstrate the relationship between private employment and freight transportation. The expected coefficient for *Z* is positive as well: an increase in the levels of employment for the region implies an increase in the number of firms operating or an increase in the operations and output of the firms. With this expansion, firms would then be expected to interact with other firms in the economy even more than before; therefore we would expect freight transport to increase as well. In terms of the cluster, because the cluster itself is growing, the volume of goods transported within the cluster (in terms of component goods and final goods) should also increase.

In terms of the model for Jiangsu and Guangdong provinces, we add dummy variables to gauge regional cluster influence. The following model includes interaction and quadratic terms for a provincial relationship (as indicated by the variable P_i) between the trade dependence, private enterprise concentration (as measured by the quotient) and small enterprise concentration (also measured by the quotient):

(13) $$\ln PCGDP = b_0 + b_1 TD + b_2 SEQ + b_4 (TD * P_{i)} + b_5 (PEQ * P_i) + b_6 (SEQ * P_i) + b_7 (PEQ * P_i)^2 + b_8 (SEQ * P_i)^2 + e$$

These terms are added in order to account for regional effects and for economies of scale on the presence of clusters. The interaction terms added are expected to have a positive value, while the quadratic terms are expected to be negative. Since these regions are now operating as a market economy, resources are being allocated efficiently, but there is a point in time where these resources will be exhausted. Therefore, these quadratic terms are modeling diminishing returns to scale.

As a result of these additions, a total of 8 different regressions are run. The first set of regressions, regressions 1 through 3, pertains to cluster effects in Zhejiang province alone. The second set of regressions (4-8) pertains to the cluster effects in Jiangsu and Guangdong. The empirical results can be found in Table 1 of Appendix 2 and the analysis that follows.

V. Empirical Results

For regressions 1 and 4 (columns 1 and 4 respectively), we regress only the standard variables on the rate of per capita GDP growth. In the first regression for Zhejiang (regression number 1), our predictions are confirmed and all coefficients were positive and significant. The employment quotient proved to be the most influential on economic growth having 0.31% effect on per capita growth. In simple terms, this means that for every 1% increase in the concentration of private employment within the region, the level of per capita GDP increases by 0.31. However, while freight percentage is significant, the effect on growth is only .068%, the least influential in the entire regression. All variables are significant, trade dependence and the employment quotient being significant at the 1% level, and freight percentage at the 5% level. Using these variables as indicators of a cluster, it seems that the presence of a cluster would indeed contribute to economic growth.

In the second regression, we now take into account the interaction between the employment quotient and freight percentage to truly represent the presence of a cluster. While our previous coefficients remained positive and significant, the interaction term between employment levels and transportation levels is negative and also significant at the 1% level. This is a surprise result. Previously, we assumed that an increase in employment would be the result of an increase in firm productivity, thus increasing output and use of freight transportation. However, because employment data are not exclusively from private manufacturing firms, an increase in employment in the private sector is not necessarily indicative of a specific increase in employment levels in the manufacturing sector. Because of this, we would have expected a rather weak effect on the independent variable, yet still positive. However, the coefficient is negative and highly significant, indicating that the proxies chosen for the Zhejiang province are not as accurate as we had hoped they would be.

In the third regression, we include the interaction term squared to address economies of scale. Contrary to our expectation, the coefficient of this variable is negative. However, because of the previous regression results, this further indicates that our chosen proxies are not accurate estimators of a cluster presence. Throughout the regression, trade dependency remains consistent in its effect on economic growth as well as significance in the regressions. When the interaction term between freight and private employment (Z) is added to the regression, both the employment quotient and freight traffic percentage at least double in magnitude. However, because the interaction term is the effect of transportation on employment, this is no surprise. Both remain significant at the 1% level for regression 2 and the employment quotient dropped in significance with the addition of a Z^2 term.

In the next set of regressions, per capita GDP growth is regressed on trade dependence, the concentration of private enterprises, and the concentration of small enterprises. Later, we include interaction terms between the two separate provinces and the three different variables.

Our prediction, like before, is that all of the coefficients would be positive (that the presence of a cluster would increase GDP).

The first regression for this set (regression number 4), once again confirms our hypothesis: the presence of a cluster causes economic growth. While all the coefficients are positive, we note the concentration of small enterprises does not play a significant role in the level of economic growth, as expected. In the literature, clusters are composed of relatively fewer large firms that produce final goods as compared to the higher number of smaller firms that produce component goods. What may be occurring is what we term a "ripple effect": the effect of small enterprises and potentially clusters become insignificant when placed in a larger economy such as a major city. For some of the small townships that we observed, the small enterprises that comprise the economy essentially *are* the economy, and therefore have greater significance. However, in our data, larger cities have a higher level of output and a smaller concentration of small enterprises as compared to the smaller cities observed, and therefore more weight on the level of output for a region. Therefore, we suspect that as the scope of an economy is widened (as we move from observing townships to observing cities) the less significant the presence of smaller enterprises may be in overall economic growth.

In the fifth regression (column 5), we add the interaction terms representing the relationship between Jiangsu province and the three previous independent variables. As in the previous regression, the significance levels remain consistent and the small enterprise variable is the only insignificant variable. In terms of the interaction variables, both Jiangsu's private enterprise concentration as well as the level of trade dependence calculated to be negative coefficients. However, in the sixth regression when controlling for economic returns, these signs changed.

In the sixth regression, squared terms are added. As expected, the coefficients are negative, demonstrating diminishing returns to scale in terms of possible cluster concentrations. After controlling for this effect, the coefficient of the interaction between the Jiangsu province and the private enterprise concentration variables from the fifth regression are now positive, a more expected result, and the magnitude of the coefficient increased dramatically as well. Furthermore, while the interaction between Jiangsu and small enterprise remains positive, there occurs a significant increase in the effect of this relationship on growth. With such a dramatic magnitude shift, we calculate that the effects of the potential clusters in Jiangsu province are greater than the other potential clusters in the other observed provinces. With this calculation, we estimate that this greater effect is due to a higher number of clusters within this specific province because of their principle industry: textiles. Another inference we make from this is, since there seems to be a high concentration of existing clusters, the region is approaching or has already approached the maximum level of clusters for the amount of resources that the market provides. Discussion on this follows shortly. This is significant for the study of industrial clusters. At this point, according to the current literature regarding cluster development, when the market can no longer support the addition of new clusters, the existing clusters themselves will engage in actions to improve output product quality and technological processes to remain competitive. In some cases we may see clusters merge in order to achieve economies of scale on a higher level. In other words, clusters engage in an endogenous growth process, confirming the theoretical model chosen for this study, and enter a second phase of cluster development. This is shown in our results, specifically regression (6). As stated above, Jiangsu is shown to have a high level of cluster concentration. In order to determine if the region has reached its peak, we take a partial derivative of regression 6 with respect to the private enterprise quotient. If new clusters are forming, we expect that the number of private enterprises increases first, then smaller firms concentrate around the anchor firm. The magnitude of this effect is as such:

$$(14) \qquad \frac{\partial PCGDP}{\partial PEQ} = 0.848 + 4.849(Jiangsu) - 11.562(Jiangsu * PEQ)$$

As seen above in equation 14, Jiangsu province has in fact reached its full cluster concentration. If a new cluster forms, the region will experience negative economic effects (possibly due to lack of resources). Therefore, clusters within this region are situated to begin the next stage of cluster development: endogenous growth.

In regressions seven and eight, interaction terms were introduced to model the relationship between Guangdong province and the three principle variables. In regression number 7, instead of being positive, the coefficient for small enterprise concentration became negative, now implying that all other small enterprises outside of Guangdong province have a negative impact on growth. The interaction term for small enterprises within Guangdong province demonstrates a positive economic impact. Since this term is larger in magnitude that of the coefficient for the aggregate, overall small business concentration does contribute to economic growth. In regression number 8, when controlling for the region, the concentration of small business continue to negatively affect economic growth. However, like in the previous regression, Guangdong small enterprises contribute positively to growth and are responsible for the overall positive effect. Also after controlling for diminishing returns, the coefficients appear as expected. The negative coefficient for aggregate small businesses, compared to the positive coefficient for small businesses within Guangdong province, confirms our previous inference regarding Jiangsu province that there is an exhaustion of resources for small business and the effect of diminishing returns for the other regions is taking effect.

Relating the two sets of regressions, between Jiangsu and Guangdong, it is easy to see that Guangdong is relatively less concentrated with clusters than Jiangsu and therefore, Guangdong as a region has not yet reached the second phase of cluster development. Also, interesting to note as well, is that the interaction between trade dependence and both provinces is negative, while trade dependency by itself contributes positively to the level of per capita GDP. While this can possibly be explained by the presence of trade tariffs and quality controls within clustering industries, it could also be that adding an interaction term for trade dependency is redundant, since trade dependency is measured using the same parameters from both provinces. Therefore, with any future extensions of this project, the trade dependency interaction term for both provinces will not be included in the regressions.

VI. Conclusion and Extensions

In conclusion, based on our data, we estimate that industrial clusters do encourage economic growth, but only up to a certain point. In our case, outside the boundary of a county city, the effect of clustering gradually diffuses into the larger economy. We estimate that the effect of clustering becomes gradually insignificant when placed in a larger economy, a phenomena we have called the “ripple effect”. For future study, we would like to compare our current results with those from data consisting of only small cities, completely removing larger metropolitan areas in order to test this theory and cluster influence on growth for these smaller areas.

Due to the nature of the data collected and our specified model, there is the potential for a multicollinearity problem associated with the small enterprise and private enterprise variables. A further extension of our work would be to address the effects of these proxies on growth independently, rather than in the same regression equation, thereby eliminating the problem. Even more, experimenting with different proxies for the presence of an industrial cluster would give us the ability to be more accurate in gauging the presence of a cluster, yet not with overlapping data. Lastly, expanding our data set to include more regions that are also experience a market shift may yield more general results.

In terms of the region as a whole, because China has shifted to a market economy in which most resources are no longer allocated by the government, cluster firms must engage in competition to ensure their market survival. Thus, China's clusters must undergo endogenous growth after the first phrase of cluster emergence and expansion, building their own knowledge pools and upgrading technology for long term growth. A further study that can be conducted based on our results concerns the effects of tariffs and quality control measures on the growth of an industrial cluster, especially one that is highly dependent upon international trade. This study specifically addresses the negative coefficient of the interaction term between trade and province, one that should have been positive. Another study to be conducted is the transition of clusters from the first stage of development to their next stage, undergoing endogenous growth. By observing a larger sample of clusters, and over a longer period of time, we can hopefully answer questions such as: How does a cluster's economic influence change in this second stage? How does the overall economy benefit from innovations at the cluster level?

Finally, it is important to note that clusters or agglomerations are only platforms for economic performance. They are a kind of organizing structure, a tool of the economy that does not generate productivity on their own. It is unreasonable to treat them as production units. Putting sand in a bag does not turn sand into stone. Nevertheless, in order to garner all productive capacities, it could be beneficial for a local economy to build an environment that is advantageous to the development of a cluster.

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VIII. Appendix

Table 1: Regression Results (Dependent Variable Per Capita GDP Growth)

Independent Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade Dependence	0.133 (5.52)***	0.130 (5.82)***	0.131 (5.88)***	0.140 (7.73)***	0.754 (3.56)** *	0.754 (3.75)** *	0.163 (7.64)***	0.163 (7.98)***
Freight Percentage	0.068 (2.52)**	0.388 (4.01)***	0.336 (3.06)***					
Employment Quotient	0.309 (2.82)***	0.602 (4.54)***	0.468 (2.49)**					
Z		-0.302 (3.42)***	-0.175 (1.14)					
Z-Squared			-0.006 (1.01)					
Private Ent. Quotient (PEQ)				0.540 (4.69)***	0.828 (5.49) ***	0.848 (5.92) **	0.712 (1.35)	0.714 (1.42)
Small Ent. Quotient (SEQ)				0.137 (1.41)	0.106 (1.17)	0.125 (1.45)	-0.231 (0.39)	-0.217 (0.38)
Guangdong PEQ							0.044 (0.08)	0.003 (0.00)
Guangdong SEQ							0.326 (0.56)	0.291 (0.51)
Guangdong Trade Depend.							1.585 (3.12)***	6.817 (4.72)***
Guangdong PEQ-Squared								-0.100 (0.27)
Guangdong SEQ-Squared								-5.336 (3.89)***
Jiangsu PEQ					-0.573 (0.98)	4.849 (0.64)		
Jiangsu SEQ					0.194 (0.31)	1.826 (0.20)		

Jiangsu Trade Depend.					-0.604 (2.84)***	-0.653 (3.20)***		
Jiangsu PEQ-Squared						-5.781 (0.79)		
Jiangsu SEQ-Squared						-0.963 (0.11)		
Obs	69	69	69	152	152	152	152	152
Constant	9.102 (95.43)**	8.829 (74.11)**	8.874 (69.76)***	8.673 (58.27)**	8.626 (62.40)**	8.587 (65.36)**	8.664 (62.84)**	8.646 (55.57)**
R2	0.59***	0.66	0.66	0.37***	0.48***	0.54***	0.48***	0.53***

Notes:
*Absolute value of t statistics in parentheses ** significant at 5%; *** significant at 1%

Definition of Variables and Expected Values

Dependent Variable	Explanation	Expected Value
ln(PCGDP)	Growth of per capita GDP	
Independent Variables		
TD	Percentage of Exports for the Region	(+)
PEQ	Concentration of Private enterprises	(+)
SEQ	Concentration of Small Enterprises	(+)
EMPQ	Concentration of Private Employment	(+)
TRN	Percentage of Freight Transportation in Region	(+)
Interaction Terms		
Z	The relationship between private employment and freight transportation	(+)
GUANTD	The percentage of trade for Guangdong province	(+)
GUANPEQ	The concentration of private enterprises for Guangdong province	(+)
GUANSEQ	The concentration of small enterprises for Guangdong province	(+)
JIANTD	The percentage of trade for Jiangsu province	(+)
JIANPEQ	The concentration of private enterprises for Jiangsu province	(+)
JIANSEQ	The concentration of small enterprises for Jiangsu province	(+)
Z-squared	Returns for the relationship between freight transportation and private employment	(+/-)
GUANTD-squared	Returns for trade in Guangdong province	(+)
GUANPEQ-squared	Returns for private enterprises located in Guangdong province	(+/-)
GUANSEQ-squared	Returns for small enterprises located in Guangdong province	(+/-)
JIANTD-squared	Returns for trade in Jiangsu province	(+/-)
JIANPEQ-squared	Returns for private enterprises located in Jiangsu province	(+/-)
JIANSEQ-squared	Returns for small enterprises located in Jiangsu province	(+/-)

IX. Endnotes

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