Airports and Economic Growth

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1. Introduction

1.1. The environmental and financial justifications for a third runway at the Hong Kong International Airport (HKIA) have aroused heated debate among the public. Much work has been done in areas such as the engineering and logistic aspects of the infrastructure, viability of the financing, and the sustainability of the business model (see the Airport Authority Master Plan 2030); and a repetition of similar economic assessment would be unwarranted. The focus of this paper is, instead, on the statistical link between airport development and regional economic growth.

1.2. In conventional airport studies, economic impacts are assessed using either a bottom-up approach or input-output tables. The works of the Eurosystem and the World Bank cited in the reference offer examples of these. The former, for instance, evaluates the employment stimulus and economic benefits accrued to the air transport sector and calculates the spillover of such direct effect to other sectors in the economy.

1.3. We take a more macro view in this paper and check if the presence of airports constitutes a growth factor and a determinant of regional growth spillover. The sample comprises data of HKIA and another eleven busiest airports in the Mainland. Our findings confirm the significance of airports in enhancing growth but the spillover conjecture is in less accord with the data on hand.

2. Overview of the Airport Data

2.1. Chart 1 and 2 are plots that are commonly presented in airport studies.

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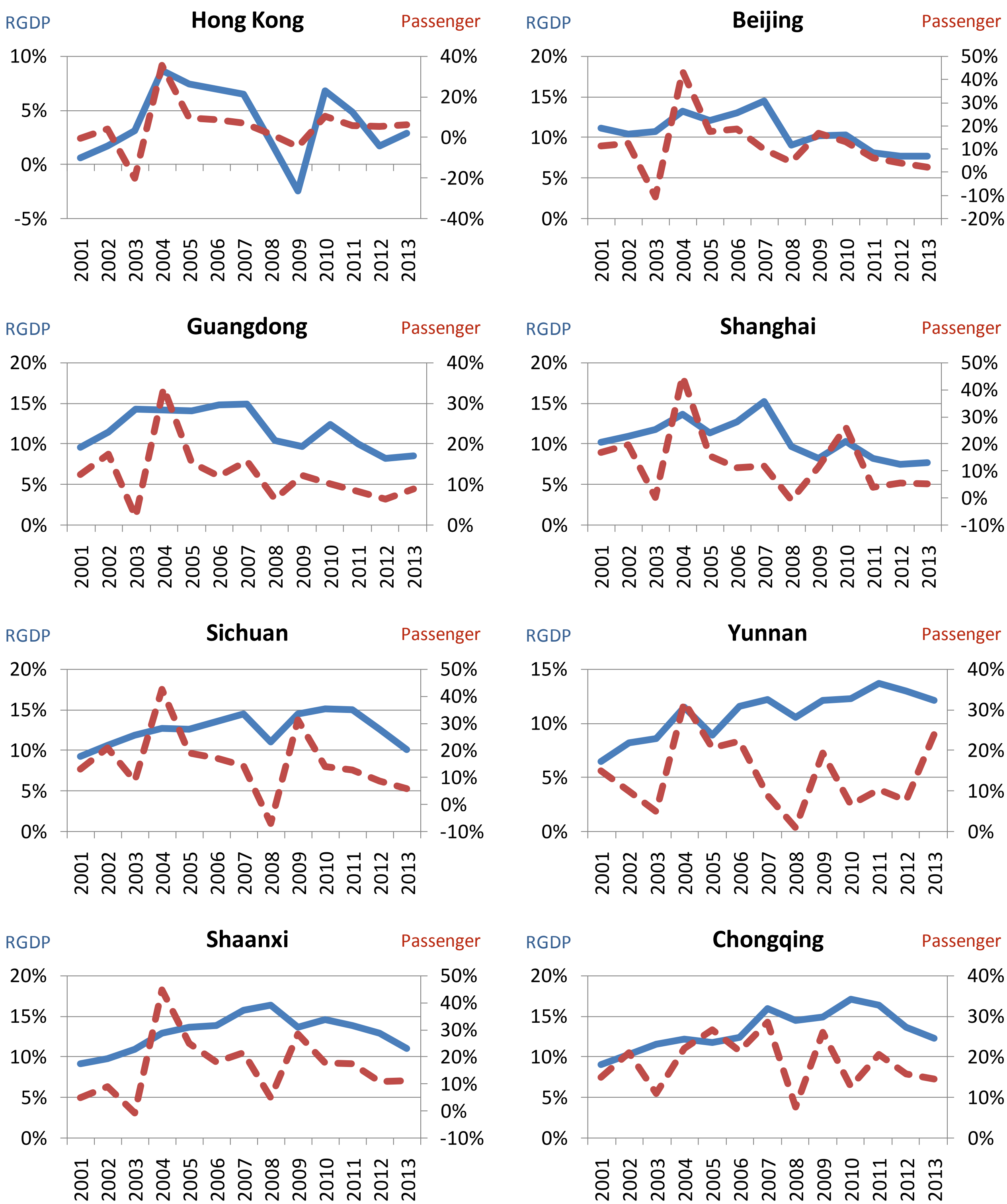
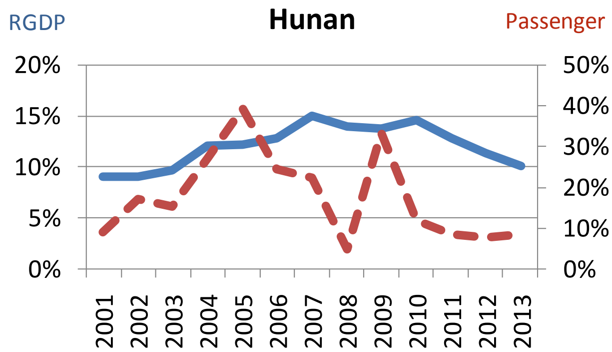
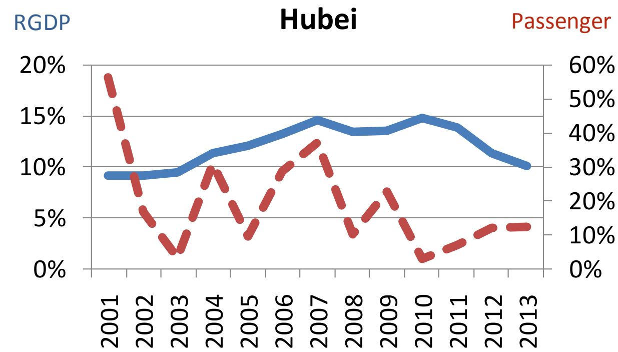
Chart 1. Growth in Air Passenger Traffic and Real GDP – Obvious only for a few Regions







2.2. Chart 1 compares the growth in air passenger traffic (red dotted line) of each of the studied region with their respective real GDP growth (blue solid line). The rankings of the airports in our sample by level of passenger traffic in 2013 are:

[1] Beijing Capital International Airport

[2] Hong Kong International Airport

[3] Guangzhou Baiyun International Airport

[4] Shanghai Pudong International Airport

[5] Shanghai Hongqiao International Airport

[6] Chengdu Shuangliu International Airport

[7] Shenzhen Bao'an International Airport

[8] Kunming Wujiaba International Airport

[9] Xi'an Xianyang International Airport

[10] Chongqing Jiangbei International Airport

[11] Changsha Huanghua International Airport

[12] Wuhan Tianhe International Airport

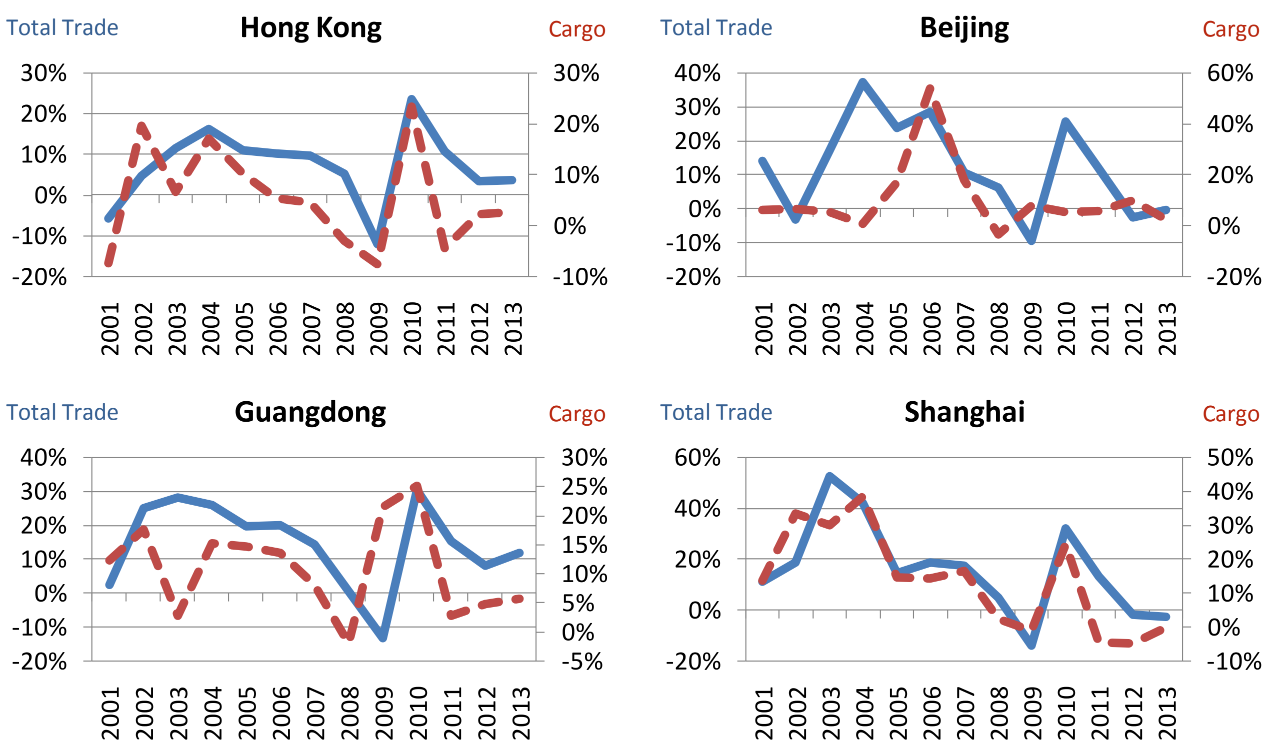
2.3. Since some provinces/areas have one set of economic data (that cannot be further disintegrated into sub-regions) but more than one airport, we aggregate the passenger throughput of different airports in the same geographical region to facilitate the comparison. This concerns

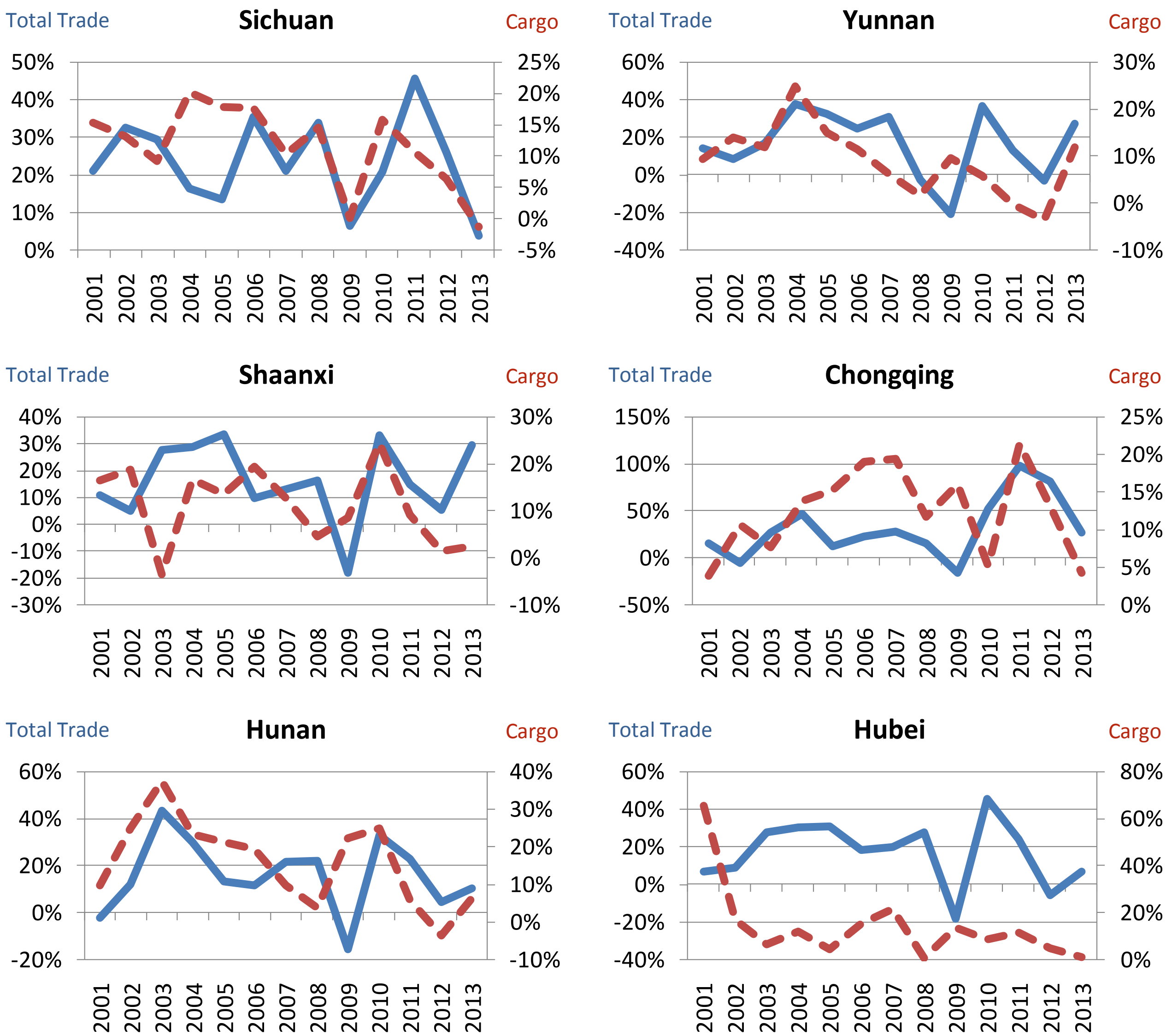
Shanghai, Guangzhou and Shenzhen. We can see that **with the exception of HK and, possibly, Beijing, air passenger growth is generally not highly correlated with economic growth for most of the regions**.

2.4. Chart 2 offers similar comparison between growth in cargo traffic and total merchandise trade growth. Again, HK recorded rather high correlation between the series, as was Shanghai. Despite the more obvious co-movements between cargo and trade in these diagrams, the correlation coefficients of their growth rates in most regions are not particularly high.

2.5. So apart from the three areas HK, Beijing and Shanghai, pairwise comparison of air traffic/trade/economic growth does not offer much clue to the growth impact of airports.

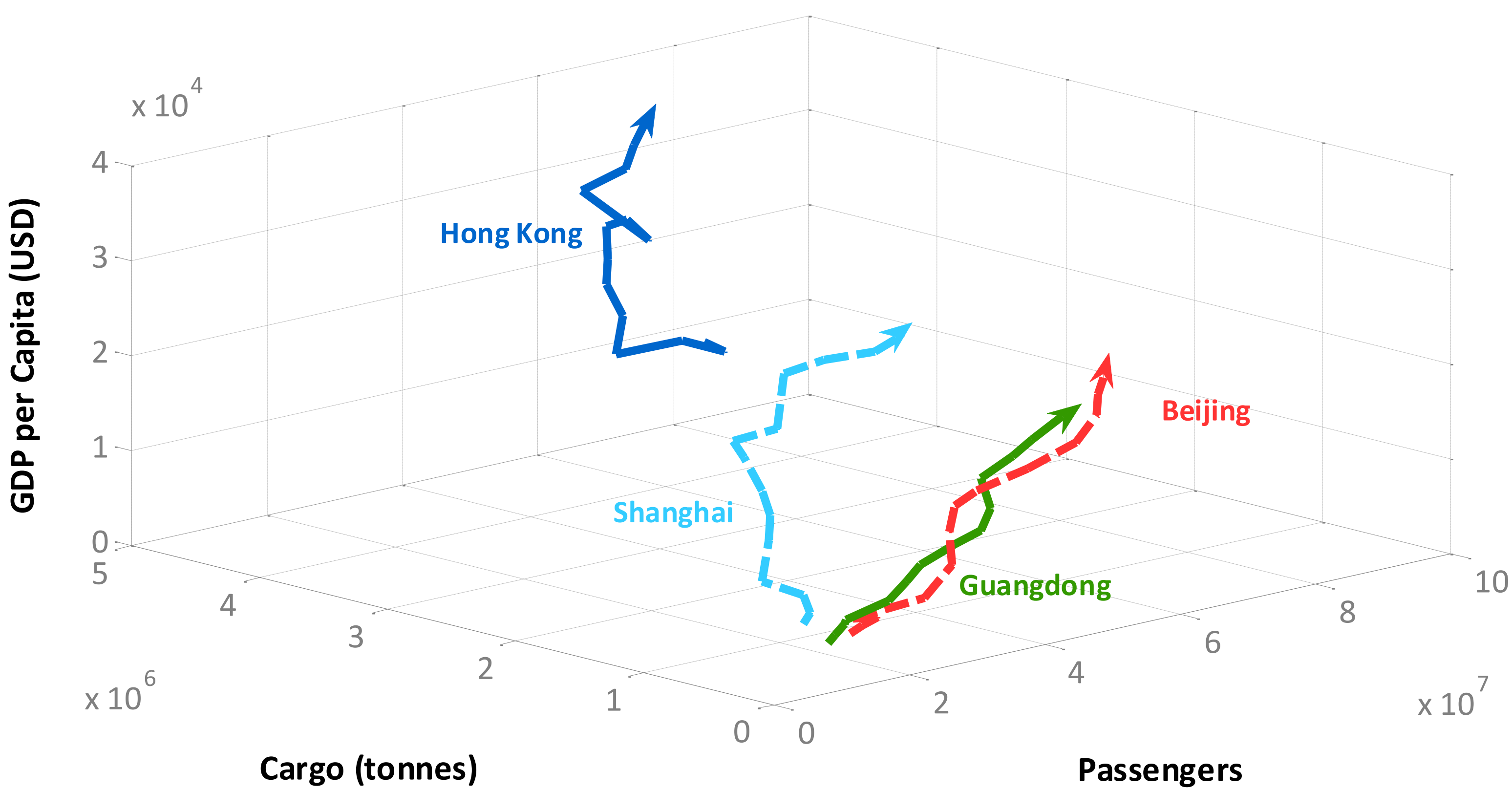
Chart 2. Growth in Air Cargo Traffic and Total Merchandise Trade – More Obvious Association





2.6. If growth rates indicate no clear-cut association, what would the situation be like if we consider the data in level terms? Chart 3 shows the evolution of air traffic with respect to regional income levels for domiciles of the busiest airports in our sample, namely, HK, Beijing, Guangdong and Shanghai. Income is measured by nominal GDP per head in USD term, so comparison across subjects is legitimate. The horizontal axes capture the amount of air passenger and air cargo traffic. If a suspended curve is tilted upwards as it moves away from the point of origin, there is a positive relationship between the three variables.

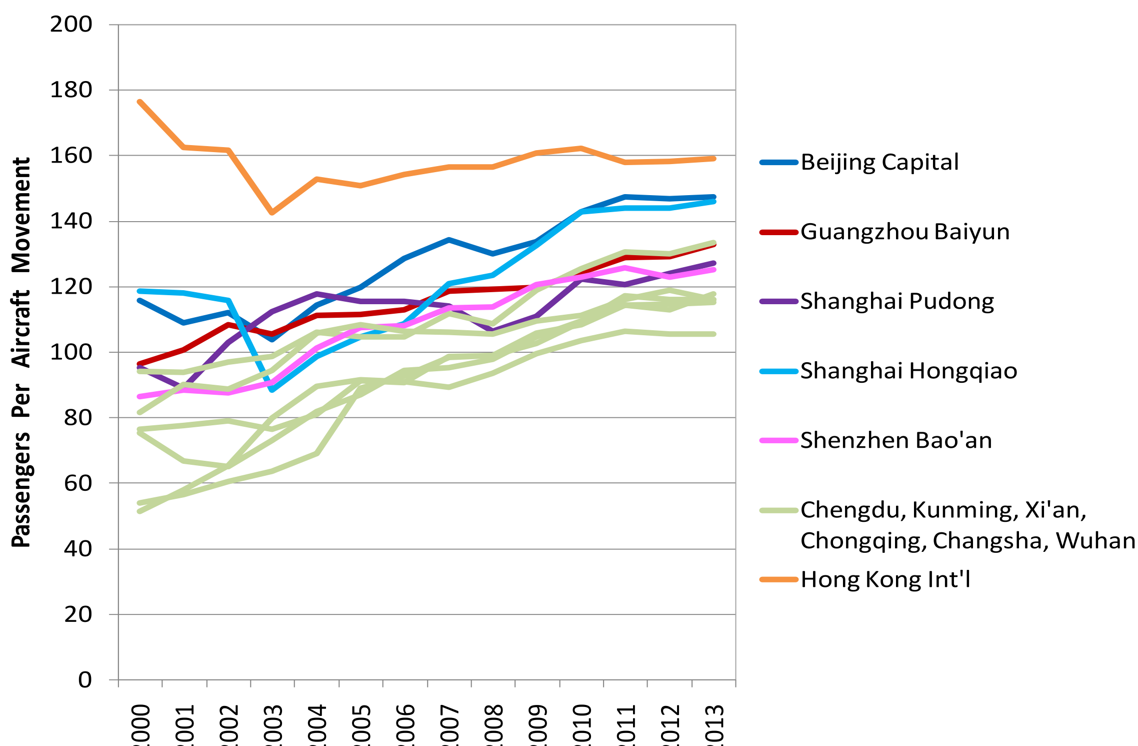
Chart 3. The Evolution of Passenger and Cargo Throughput against Nominal Income per Head: 2000-2013



2.7. **HK has a more balanced passenger/cargo mix whereas the Chinese counterparts' throughputs are weighted more heavily by passenger transport**. Note that HK started with a much higher income level in 2000 but the income gaps with the Chinese regions were reduced significantly over the 13 years surveyed. In sum, higher income *levels* are positively associated with larger air traffic throughputs although there is no way to gauge or control for spurious relationship just by visual inspection.

2.8. Next, we discuss the "quality" side of the airports being studied. The World Bank report (Serebrisky, 2012) suggests a few benchmarks for measuring airport efficiency. Some of these involve information of operating costs which are not available. We choose the measure No. of Passengers per Unit Aircraft Movement (PUAM). This is passenger throughput divided by the total number of aircrafts landed/taken-off. Other things being the same, the higher the value of this indicator, the more efficiency is implied for the airport concerned.

Chart 4. Airport Efficiency as Measured by Passengers per Aircraft Landed/Taken Off (PUAM)



2.9. For PUAM to be a valid indicator of efficiency, we need to avoid confusion between capacity constraint (congestion) and efficiency. For example, a strained airport capacity could hamper the growth in flights handled while witnessing an increase in the number of air passengers. So instead of an efficiency gain, the situation is more a problem of insufficiency. We cannot negate such a possibility but the evidence we have tend to imply a small risk of this happening. The correlations between the growth in air passenger and the growth in aircraft movement are extraordinarily high. For the twelve airports reviewed, the average correlation coefficient is larger than 0.85 which means that increases in passenger demand is largely accompanied by increase in services provided.

2.10. Chart 4 shows the efficiency indicators of the various airports. All, except HK, saw a general increase in the efficiency reading between 2000 and 2013. **Although HKIA still tops the batch in the *level* of airport efficiency, its supremacy seems to have narrowed over time**.

3. Econometric Analysis

3.1. In this section, we conduct a quantitative analysis of the growth impact of airports. The primary hypotheses are: (i) whether (an efficient) airport stimulates growth; and (ii) whether (an efficient) airport helps bring about spillover in economic growth to other regions. The analysis is performed using the 10-region-12-airport sample that runs from 2001 to 2013.

3.2. The dependent variable is naturally real GDP growth (GROWTH). All underlying real GDP figures/indices are in local currency terms[1]. The independent variables include growth in total merchandise trade (TRADE), CPI inflation (INFL), log population (POP), and the log tertiary sector's share of national output (TERT).

[1] The National Bureau of Statistics of China has not compiled real GDP series for Chinese provinces. We cannot therefore convert the figures into a common currency such as the USD.

3.3. An important element of the analysis is the airport variable. Many studies simply used passenger flows or cargo volumes to measure the relevance of an airport. It is well known that these variables are influenced by other factors like alternative means of transport available, income levels, etc.. The gross aircraft movement figures might be a suitable candidate as the amount of scheduled flights landing/taking off in an airport is supposedly less sensitive to short term changes in economic condition. Aircraft movement is thus a useful indicator of airport capacity. Even better, we can proxy the importance of airports using the efficiency indicator PUAM introduced earlier[2].

3.4. The first part of the exercise is a simple panel data analysis[3]:

$$GROWTH_{it} = \alpha_i + \beta_1 PUAM_{it} + \beta_2 TRADE_{it} + \beta_3 INFL_{it} + \beta_4 POP_{it} + \beta_5 TERT_{it} + \varepsilon_{it} \quad (1)$$

$$i = 1, \cdots, N, \qquad t = 2001, \cdots, 2013.$$

where α_i is a time invariant and subject-specific intercept capturing unobserved factors of the individual region. β_1 is the airport coefficient which is the parameter of interest. **Other things being the same, we would expect $\boldsymbol{\beta_1}$ to be a positive number under the null hypothesis** (i) in para. 3.1. Model (1) is estimated using the fixed-effect approach.

3.5. Based on our second hypothesis, an airport is more than a simple growth enhancing factor but also plays a part in regional growth spillover. This requires a model that has a built-in mechanism concerning growth spillover like the following:

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[2] PUAM is the main airport indicator in our analysis. We tried both the PUAM and total aircraft movement and the results showed little material difference. Another advantage of PUAM is that the ratio might neutralize potential feedbacks between economic growth and demand for air traffic.

[3] We did try to control for endogeneity using lags of inflation and trade growth as instruments. The effect of this on the airport coefficient is not substantial but the model fit is somewhat worse. We choose to stick to the original formulation described by (1).

$$GROWTH_{it} = \alpha_i + \rho \sum_j W_{ijt} \cdot GROWTH_{jt} + \beta_2 TRADE_{it} + \beta_3 INFL_{it} + \beta_4 POP_{it} + \beta_5 TERT_{it} + \varepsilon_{it} \quad (2)$$

$$i = 1, \cdots, N, \quad t = 2001, \cdots, 2013.$$

The difference here is the term $\rho \sum_j W_{ijt} \cdot GROWTH_{jt}$ which replaces the PUAM element in equation (1). The weight W_{ijt} assigns a fraction of the growth in region j to the growth in region i and the larger the value of W_{ijt} the larger the spillover effect. The parameter ρ dictates the sign of the spillover. A positive number indicates a growth sharing scenario whereas a negative number implies a growth competition situation. In this latter case, higher growth in region j will draw away growth impetus of region i resulting in a lower growth in i.

3.6. We explicitly model the role of airport in spillover by relating W_{ijt} and PUAM. Specifically,

$$W_{ijt} = 1/\left|PUAM_{it} - PUAM_{jt}\right|. \quad (3)$$

Intuitively, the size of the spillover is governed by the "closeness" of airport efficiency. Airports with similar efficiency levels are more likely to have growth spillover to/from one another. For instance, the link of economic growth between HK and Shanghai will be stronger than that between HK and Shaanxi (Xi'an). As time lapses, the magnitude of spillover, if exists, will also change according to the improvement in airport efficiency.

3.7. The estimation results are shown in Table 1. For the linear panel data model (1), we found an airport elasticity of 0.05 which is statistically significant. **In other words, a 1% improvement in airport efficiency as measured by PUAM will increase real output growth by about 5% point**. In the meantime, faster economic growth is also associated with faster growth in merchandise trade and higher inflation. Population and the share of tertiary sector output are, on the other hand, negatively related to real GDP growth. The linear model has an overall R^2 of 0.723 meaning that it explains 72% of the data variation (measured as deviations from the average growth rate across all provinces and all time periods).

Table 1. Estimation Results of the Panel Data Models

	Linear Panel Data		Spatial Panel Data	
Dependent Variable:	Real GDP Growth		Real GDP Growth	
No. of Subjects	$N = 10$		$N = 10$	
No. of Periods	$T = 13$		$T = 13$	
R^2 (Overall)	0.723		0.680	
R^2 (Within)	0.372		0.275	
Independent Variables:	Coefficient	p-value	Coefficient	p-value
Spillover	-	-	$\rho = 0.1356$	0.459
Log Airport Efficiency	$\beta_1 = 0.0514$	0.000	-	-
Total Trade Growth	0.0262	0.022	0.0228	0.061
CPI Inflation	0.2043	0.037	0.3180	0.002
Log Population	−0.1234	0.001	−0.0984	0.008
Log Share of Tertiary Production	−0.0130	0.748	−0.0223	0.605
Constant	0.8604	0.005	0.8718	0.009

3.8. The spatial panel data model (2) has a slightly smaller overall R^2 of 0.68. There is no airport elasticity as PUAM enters subtly by way of the weight specification (3). **The parameter ρ is positive indicating a positive spillover of growth to areas with similarly efficient airports. It is, however, not statistically significant**. The signs of other coefficients are the same as those found in the linear model.

4. Conclusion

4.1. This study provides evidence that pinpoints the positive role of an efficient airport in stimulating economic growth. While we cannot provide expert evaluation of the current capacity status of HKIA, our analysis suggests that if insufficient air traffic capacity imposes constraints on aircraft movement and possibly operational efficiency, there will be a negative effect on future economic growth.

4.2. The presence of an efficient airport may not necessarily help distribute growth among areas connected by air traffic networks. This spillover hypothesis is inspired by the better flows of people and cargo over areas linked by airport networks. The statistical evidence we have suggests the potential of a positive growth spillover between HK and major Mainland provinces, but the evidence is nevertheless not very strong.

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