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Abstract

While openness to trade is a well-recognized hallmark of the Asian growth model, another component of the model is a leapfrogging strategy—the use of policies to guide industrial structural transformation ahead of a country's factor endowment. Does the leapfrogging strategy work? Opinions vary but the evidence is scarce in part because it is more difficult to measure the degree of leapfrogging than the extent of trade openness. We undertake a systematic look at the evidence both across countries and subregions within a large regional Asian economy to assess the efficacy of such a strategy. We conclude that there is no strong and robust evidence that this strategy works reliably.

Keywords: growth, trade openness, leapfrogging

JEL Classification: O20, O40

1. Introduction

All countries want to achieve rapid, sustainable growth. Many Asian economies excel in this area. Following the lead of Japan after World War II, the "four little dragons"—Hong Kong, China; the Republic of Korea; Singapore; and Taipei,China—are by now familiar success stories. Many more economies in the region quickly followed, including Malaysia, Thailand, and Indonesia, all of which achieved higher growth rates than most other developing countries that had a comparable level of development in the 1960s. Since 2000, the People's Republic of China (PRC), India, and Viet Nam have been viewed as the new "growth miracles" for having achieved the same high growth rates as their neighbors over the last 20–30 years.[1] Naturally, this record invites admiration and scrutiny, and leads to several pertinent questions: What is the Asian growth model? Is it something that could be transplanted to Latin America, Africa, or elsewhere with the same remarkable results?

While the growth records of Asian economies are (mostly) uncontroversial, the factors responsible for the growth results are subject to debate. At the risk of over-simplification, we suggest that two aspects of the Asian growth model merit particular attention. First, almost all high-growing Asian economies embrace trade openness. Trade barriers are taken down or progressively reduced either at the start of the growth process or not long after the start of the process. Trade liberalization does not take only the narrow form of reducing tariff rates on imports, although that is often part of the process. It can also take the form of de-monopolizing and de-licensing, which include the right to import and export before liberalization is concentrated in a small number of firms through government regulations. Trade liberalization broadens the set of firms that can directly participate in international trade. Even holding tariff rates constant, or the "democratization" of trading rights, can dramatically increase a country's trade openness. This was a significant part of the PRC's trade liberalization process in the 1980s. Trade liberalization can also be accompanied by a reduction in entry barriers or an offer of incentives for foreign firms to help jumpstart the domestic export industry. This may be particularly important for those countries that have been isolated from global markets for an extended period of time. Sometimes, the Asian model is called an "outward-oriented strategy." However, this is not very accurate since many Asian economies do not simultaneously embrace capital account openness, at least not to the same degree as they embrace openness in the areas of cross-border portfolio equity and portfolio debt.

The second aspect of the Asian growth model is the use of government policies to promote high-tech and high-domestic-value-added industries, presumably beyond what an economy would naturally develop if left to its own devices. This aspect of the growth model may be labeled as a leapfrogging strategy. The PRC, Malaysia, and Singapore all have a variety of aggressive policies to promote certain high-value-added sectors. Other

[1] Myanmar has also consistently reported double-digit growth rates in real gross domestic product (GDP) growth every year since 2001, but international financial institutions and other observers are somewhat skeptical about the reliability of these statistics. The PRC's official growth rates are sometimes challenged for their veracity, although most scholars, economists of major international investment banks, and international financial institutions take the view that officially released figures are reliable, or, if there is a bias, the bias could be either positive or negative.

countries in the region do not wish to fall behind. For example, the Philippines' National Information Technology Council announced (1997) that "within the first decade of the 21st Century, the Philippines will be a knowledge center in the Asia Pacific: the leader in IT education, in IT-assisted training, and in the application of information and knowledge to business, professional services, and the arts" (NITC, 1997).

Are these two aspects responsible for Asia's successful growth model? The first aspect—the role of trade openness in economic growth—has been subject to extensive (and intensive) scholarly scrutiny. While there is notable skepticism (Rodriguez and Rodrik, 2000), most economists read the evidence as suggesting that trade openness does help to promote economic growth. Following and extending the work by Frankel and Romer (1999), in a recent paper Feyrer (2009) aimed to sort out causality from correlation to again show that greater trade openness causally leads to a rise in incomes. Using changes in infant mortality and life expectancy as an alternative measure of well-being, Wei and Wu (2004) present evidence that trade openness helps to improve social welfare beyond raising per capita income by reducing infant mortality and raising life expectancy. Based on the overwhelming amount of evidence, we lean strongly toward the position that trade openness has played a key role in the economic success stories of Asia as well as in most high growth episodes around the world.

What about the second aspect of the Asian growth model? Has a leapfrogging strategy played a key role as well? In comparison to the trade openness issue, there is far less scholarly work on the effectiveness of a leapfrogging strategy. In theory, if the production of sophisticated goods generates positive externalities via learning-by-doing, then there generally would be an under-investment among private economic agents relative to the socially optimal level. A leapfrogging strategy, such as a government-led industrial policy that tilts resource allocation to technologically sophisticated industries, could correct this market failure. The natural inference from this argument suggests that a country may benefit more from exporting sophisticated products than from exporting unsophisticated and low domestic value-added products, even if its comparative advantage at the current time is to produce the latter type of goods. Recent academic studies have reported evidence supporting this comparative-advantage-defying development strategy. In Hausman, Hwang, and Rodrik (2007) (henceforth, abbreviated as HHR), the authors suggest that some exported goods have higher spillover effects than others. They develop a measure of export sophistication and find that a positive relationship exists between their measure and the country's subsequent economic growth rate. However, there is no shortage of skepticism toward the leapfrogging growth strategy. On one hand, one might question the size of any such market failure in the real world if there were one. On the other hand, one might wonder whether the existence of a "government failure," if it were to pursue a leapfrogging strategy, could overwhelm whatever benefits a country might derive from correcting the market failure. In a series of papers, the World Bank's chief economist Justin Lin advocates strongly for development strategies that follow a country's comparative advantage and against what he calls "comparative advantage defying strategies," which include a leapfrogging industrial policy.

In this paper, we aim to test the validity of the leapfrogging hypothesis with fresh evidence both from a cross-country data set and variations across regions within the PRC. One bottleneck in testing this hypothesis is to identify which countries (regions) engage in such a growth strategy.[2] We employ four different measures, including a new indicator proposed in this paper, based on the proportion of identifiable high-tech products among a country's exports. Cross-country growth regressions are criticized for ignoring the role of culture, legal systems, and other institutions, as well as for their interactions with other regressors. Since we are mindful of this potential pitfall, we complement the cross-country regressions with evidence from comparing different regions within a single country—the PRC. Relative to cross-country comparisons, the legal, political, and other institutions are more similar within a single country. Therefore, this within-the-PRC investigation gives us complementary evidence on the efficacy of a leapfrogging strategy.

Our main results can be summarized as follows. First, across countries, there is no strong and robust evidence that a leapfrogging strategy contributes to a higher growth rate. Second, across different regions within the PRC, there is no such evidence either. Overall, the empirical investigation does not support the contention that a government intervention aimed at raising a country's technological sophistication beyond what is expected of its level of development can produce better growth results on a sustained basis.

The paper is organized as follows. Section 2 discusses our measures of leapfrogging. Section 3 examines the empirical connections between technological leapfrogging and economic growth rates. Section 4 concludes.

2. Measuring Leapfrogging

A key to this exercise is to assess whether a country pursues a leapfrogging strategy and, if it does, what the degree of leapfrogging is. Ideally, we would want to compare a country's actual production structure with what could have been predicted based on its factor endowment. There are two challenges. First, data on production structure by an internationally comparable classification are not available for most countries, especially developing countries for which evaluating the efficacy of a leapfrogging strategy is most pertinent. Second, even when internationally comparable production data are available, there is only a relatively coarse classification, with less than 100 sectors. Many differences in economic structure do not reveal themselves at such an aggregate level. For example, many countries have electronics industries, but different types of electronic products may have very different levels of skill content. We address these challenges by looking at trade data instead. Generally speaking, a country's export structure closely resembles its production structure. Trade data are available for a much larger set of economies (over 250 in the World Integrated Trade Solution [WITS] database). At the most detailed and still internationally comparable level (Harmonized System [HS] 6-digit), there are over 5,000 products a country can export (or import). To control for the "normal" amount of sophistication based on a country's factor endowment, we include a country's income and education levels as controls in a growth regression framework.

[2] A literature review of previous tests of the hypothesis will be added in the next revision.

In the rest of this section, we review two existing measures of export sophistication in the literature and propose two additional measures to address some any shortcomings of the existing measures. We then describe the data that we use to implement the measures. Finally, we conduct some simple "smell checks" to see how well these measures capture those countries that are commonly reported as having a leapfrogging industrial policy.

2.1 Measures of a Country's Industrial Sophistication Based on Export Data

While it is difficult to directly measure a country's industrial sophistication, in part because the standard industrial classification is too coarse for this purpose, the existing literature has considered proxies based on data on a country's export bundles. The idea being that, with the exception of non-tradable goods, the structure of the export bundle should mimic that of production. One measure is the level of income implied in the export bundle, introduced in HHR. This measure builds on the concept that the degree of sophistication in a country's exports can be inferred by the income level of each good's exporter. The second measure is the Export Dissimilarity Index (*EDI*), introduced by Schott (2007) and adopted by Wang and Wei (2008), which gauges the distance between a country's export structure and that of high-income economies such as Japan, the United States (US), and the European Union (EU15). Both measures assume that higher-income countries, on average, produce more sophisticated products. One can avoid making this arbitrary assumption and focus on the degree of technological sophistication of the product itself based on a classification of high-tech advanced technology products (ATP) that comes from the Organisation for Economic Co-operation and Development (OECD) and the US Census Bureau.

Income implied in a country's export bundle (EXPY)

This indicator of export sophistication is a measure of the typical income associated with a given country's export basket. For every good, one can compute the "typical income" (*PRODY*) of the countries that export the good, or the weighted average of the income levels of the exporters of this good, with weights proportional to the value of the exports by countries. For any given exporter, one can look at its export basket and compute the weighted average of the typical income levels across all products in the basket, with the weights proportional to the value of each good in the basket. The key underlying assumption here is that advanced countries produce more sophisticated goods and poorer countries produce less sophisticated goods.

$$PRODY_i = \sum_k^n \frac{s_{ik}}{\sum_j s_{ij}} \bullet Y_k \quad (1)$$

$$EXPY_k = \sum_i s_{ik} \bullet PRODY_i \quad (2)$$

Where s_{ik} is the share of country k's exports in product i and Y_k is country k's per capita gross domestic product (GDP). Table 1 displays the summary statistics for the *EXPY* over the period 1992–2006.

There are two major merits of this index. First, it does not require one to tediously sift through and classify goods as sophisticated goods or high-tech products. Second, it can be computed easily with data in trade flows and GDP per capita. But it also has several weaknesses. First, the key assumption underlying *PRODY*, that more advanced countries produce sophisticated goods, may not be true. Advanced countries often produce a larger set of goods than poor countries. Furthermore, larger countries also often produce a larger set of goods than smaller countries. These features suggest that the *PRODY* index may over-weight advanced and large countries. Second, the index may conceal diversity in the quality and type of goods within a product category. Third, the index fails to capture the processing trade, where a country imports sophisticated product parts to produce the final sophisticated product. This is the case in the PRC, where a significant share of sophisticated exports is based on the processing trade. Given the weaknesses of the *EXPY* index, we construct the following index in hopes of avoiding some of its pitfalls.

Unit value adjusted implied income in the export bundle—Modified EXPY

In this modified version of the *EXPY* index, we discount the *PRODY* of each good by the ratio of the unit value of the exporter to the mean unit value of the same goods in the following G3 countries: Germany, the United Kingdom, and the US.

$$PRODY_i = \sum_k^n \frac{s_{ik}}{\sum_j s_{ij}} \bullet Y_k \bullet \frac{v_{ik}}{v_{iG3}} \quad (3)$$

The modified *EXPY* is computed similarly as in the original *EXPY* index in equation (2).

The motivation of this modification is our belief that the unit value data adds an additional layer of differentiation among goods of different quality or varieties. This can take account of the diversity within the 6-digit HS category. The assumptions behind this modification are that (i) unit values proxy quality and (ii) G3 countries export higher quality goods.

Since we only have unit value of products at the 6-digit HS level across the world for 2005, we apply the same unit value discount factor to the *PRODY* during our whole sample period. Table 2 shows the summary statistics of this modified *EXPY*.

Distance to the export bundle by high-income countries

We define an index for a lack of sophistication by the dissimilarity between the structure of a country's (city's) exports and that of the G3 economies or the export dissimilarity index *(EDI)* as:

$$EDI_{rft} = 100(\sum_i abs(s_{irt} - s_{i,t}^{ref})) \quad (4)$$

$$s_{irt} = \frac{E_{irt}}{\sum_i E_{irt}} \qquad \text{where} \tag{5}$$

where s_{irft} is the share of HS product i at the 6-digit level in country (city) r's exports at year t, and $s_{i,t}^{ref}$ is the share of HS product i at the 6-digit level exports of G3 developed countries. The greater the value of the index, the more dissimilar the compared export structures are. If the two export structures were identical, then the value of the index would be zero; if the two export structures were to have no overlap, then the index would take the value of 200. We regard an export structure as more sophisticated if the index takes a smaller value. Alternatively, one could use the similarity index proposed by Finger and Kreinin (1979), and used by Schott (2006) (except for the scale):

$$ESI_{rft} = 100\sum_i min(s_{irft},\ s_{i,t}^{ref}) \tag{6}$$

This index is bound by zero and 100. If country (city) r's export structure had no overlap with that of the G3 developed countries, then ESI would be zero; if the two export structures had a perfect overlap, then the index would take the value of 100. It can be verified that there is a one-to-one linear mapping between ESI and EDI:

$$ESI_{rft} = \frac{200 - EDI_{rft}}{2} \tag{7}$$

Share of Advanced Technology Products in total exports— ATP share

Besides the measures already in the literature, we also propose a new measure on the share of high-tech products in a country's exports bundle that does not require assuming that richer countries automatically export more sophisticated products.

$$ATPSH_{it} = 100\frac{EXP_{it}^{ATP}}{EXP_{it}^{TOT}} \tag{8}$$

where EXP_{it}^{ATP} is exports of ATP of country i at time t and EXP_{it}^{TOT} is total exports of country i at time t. This measure of export sophistication requires us to specifically define what is meant by "high-tech exports," thus it sacrifices $EXPY$'s simplicity.

To compute this measure, one needs an expert definition of which product is high-tech. Two lists of expert definitions are well-respected. One was developed by the US Census Bureau, which identified about 700 product categories as advanced technology products (ATP) from about 20,000 10-digit HS codes used in the US. The other was developed by the OECD, which identified 195 product categories from 5-digit SITC codes as high-tech products. Because the HS classification is more detailed and is cross-country comparable at the 6-digit level, we harmonize both lists into 6-digit HS product categories. We convert the OECD high-tech product list to 328 6-digit HS codes based on concordance between SITC (rev3) and HS (2002) published by the United Nations (UN) Statistical Division.

To condense the US Census ATP list from 10-digit HS to 6-digit HS, we first calculate the ATP value share in both US imports from the world at the HS-6 level based on US trade statistics in 2006, bearing in mind that within each HS-6 heading some of the US HS-10 lines are considered to be ATP and others are not. We choose two separate cutoff points. For a narrow ATP definition, we select the 6-digit HS categories in which the ATP share is 100% of total US imports from the world according to the US Census ATP list, which resulted in 92 HS-6 lines. For a wider ATP definition, we select the 6-digit HS categories in which the ATP share is at least 25% of total US imports from the world, which resulted in 157 HS-6 lines. We use the 6-digit HS code in which all products are in the US Census ATP list and also in the OECD high-tech product list as our narrow definition of ATP. For a wider ATP definition, we deem an HS-6 line as ATP when either it is in the OECD high-tech product list or if at least 25% of its value is ATP products in US imports from the world according to the US Census ATP list.

The recent literature also documents significant variations within the same product. Although both developed and developing countries may export products under the same 6-digit HS code, their unit value usually varies significantly, largely reflecting the difference in quality between their exports. To allow for the possibility that a very large difference in the unit values may signal different products (that are misclassified in the same 6-digit category), we take unit value for all products from Japan, the EU15, and the US (G3) in our narrow ATP definition as reference, and any products with a unit value below the G3 unit value minus five times standard deviation will not be counted as ATP. This results in our third definition of ATP.

2.2 Data and Basic Facts

The $EXPY$ measure requires data on trade flow and GDP per capita. We computed $EXPY$ for both a short and long sample. For the short sample, dating from 1992 to 2006, the data on country exports come from the UN's COMTRADE database, downloaded from WITS. The data from 1992 to 2006 is at the 6-digit HS level (1988/1992 version) covering 5,016 product categories and 167 countries. For the long sample, dating from 1962 to 2000, the trade flow data is taken from the National Bureau of Economic Research (NBER)-UN data compiled by Feenstra et al., which can be downloaded from the NBER website. The data is at the 4-digit SITC level, revision 2, covering 700–1000 product categories and 72 countries. The GDP per capita data on purchasing power parity (PPP) basis is taken from the Penn World Table.

The modified $EXPY$ measure requires additional data on unit value. The data were obtained from Ferrantino, Feinberg, and Deason (2008) and the UN's COMTRADE database. The data is only for the year 2005 and is cleaned of products that lack well-defined quantity units and consistent reporting, and have a small value or a unit value belonging to the 2.5% tail of the distribution of the product's unit values. In total, the resulting unit value dataset covers 3,628 6-digit HS subheadings.

The other two export sophistication indices—*EDI* and *ATP* share (narrow, broad)—are computed excluding HS Chapters 1–27 (agricultural and mineral products) as well as raw materials and their simple transformations (mostly at the HS 4-digit level) in other HS chapters. A list of excluded products is reported in Appendix Table 1. Each country's *ATP* exports' share is computed by the country's ATP exports divided by its total manufacturing exports. Our sample of countries is listed in Appendix Table 2.

The other explanatory variables included in the growth regressions are human capital, GDP per capita, and institutional quality. The human capital variable in the cross country regressions uses the average school year in the Barro–Lee education database. GDP per capita is on a PPP basis and taken from the Penn World Table. The institutional quality variable is proxied by the government effectiveness index downloaded from the World Bank and Transparency International websites.[3]

Data on the PRC's exports were obtained from the China Customs General Administration at the 8-digit HS level. The data report the geographic origin of exports (from more than 400 cities in the PRC), firm ownership, and transaction type (whether an export is related to processing trade as determined by customs declarations) for the period from 1996 through 2006. Each PRC city's *EDI* is computed by the difference between a PRC city's manufacturing export structure and the combined manufacturing export structure of G3 countries. Each PRC city's *ATP* exports share is computed by dividing the city's ATP exports by its total manufacturing exports. Similar to the cross-country exports, we only consider manufactures. We link this database with a separate database on PRC cities—covering gross metropolitan product (GMP) per capita, population, percent of non-agricultural population in the total population, and college enrolment—downloaded from China Data Online, which is a site managed by the University of Michigan's China Data Center. Unfortunately, the coverage of this second database is more limited (270 cities from 1996 through 2006), which effectively constrains the sample size used in our regression analyses. In these cities, only about 210 cities have complete records for 10 years or more. About 11 cities have records for only 3 years or less. Therefore, we deleted these 11 cities from the sample. There are also eight major cities that re-drew their administrative area during the sample period: Nanning, LiuZhou, Fuyang, Haikou, Chongqing, Kunming, Xinning, and Yinchuan. The total number of cities in our data set is 259 and these are listed in Appendix Table 3. Since we do not have data on the consumer price index (CPI) at the city level, we use provincial CPI to deflate cities in a particular province to obtain real GMP. The base year we chose is 2002.

[3] http://www.worldbank.org/wbi/governance/govdata/ and http://ww1.transparency.org/surveys/index.html #cpi

3. Do Leapfroggers Grow Faster? An Examination of the Evidence

3.1 The Elusive Growth Effect of a Leapfrogging Strategy

Since Hausman et al. (2007) is the most recent and best known study providing an empirical foundation for the proposition that a leapfrogging strategy, as measured by a country's export sophistication, delivers a faster economic growth rate, we start our statistical analysis by taking a careful look at their specifications and checking the robustness of their conclusion. In particular, we follow their econometric strategy, regressing economic growth rates across countries on a leapfrogging measure and including other control variables typically used in empirical growth studies. After replicating their regressions with $EXPY$ as the leapfrogging proxy, we use the alternative measures discussed above—modified $EXPY$, EDI indicator, and the ATP shares.

Table 1 shows our replication of the HHR's cross-section regressions for the short sample 1992–2003, which corresponds to HHR's Table 8. The controls include human capital and a measure of institutional quality. Since the source of their rule of law index is not clearly stated, we use four other well-known institutional variables: corruption, government effectiveness, regulation quality, and CPI. In the ordinary least squares (OLS) regressions, the coefficients for the first three institutional measures are significant. In particular, the coefficient for regulation quality (0.013) is close to HHR's coefficient for their rule of law index (0.011). Columns 1, 2, 7, and 8 in Table 1 can be compared to the corresponding regression in HHR's Table 8; the coefficients for the initial GDP per capita and human capital variables are basically the same as HHR's. While the coefficients on log initial $EXPY$ have different magnitudes than HHR's results for the same sample period 1992–2003, they are all statistically significant (though not as strong, depending on the institution variable) and are positive as HHR's. A possible explanation for this difference in the size of the coefficients is that trade data for the countries in the 1992–2003 sample has been revised since their usage. The bottom line from this replication exercise is that their results can be replicated.

In the next step, we replace the $EXPY$ variable with alternative measures of export sophistication—modified $EXPY$, EDI, and the ATP shares—and re-estimated the regressions. The results for each of these respective variables are displayed in Tables 2–5. In Table 2, the coefficient for the modified $EXPY$ is statistically insignificant in all but the first specification with only human capital as control, even as the direction of the coefficients and significance on initial GDP per capita, human capital, and institutional variables remain the same as in Table 1. This observation extends to the case where either EDI or the broad definition of ATP is used as the export sophistication measure, as shown in Tables 3 and 4. However, the coefficient on the ATP share using a more stringent definition is positively significant across all specifications. We will show in the next section that even this result is not robust.

To summarize, the positive association between a country's export sophistication and economic growth rate is not a strong and robust pattern of the data. In particular, alternative measures of export sophistication often produce statistically insignificant coefficients. For example, a reasonable adjustment to the HHR measure of sophistication that accounts for possible differences in unit values when computing the implied income in an export bundle would cause the positive association to disappear. Therefore, we infer that that it may be too early to conclude that pursuing a leapfrogging strategy would accelerate a country's growth rate.

4. Further Investigations

4.1 Does Growth in Sophistication Lead to Growth in Income?

It is possible that the level of a country's export sophistication may not successfully capture policy incentives or other government actions. In particular, if a country happens to have an unusually large pool of scientists and engineers, its level of export sophistication may surpass what can be predicted based on its income or endowment. A useful empirical strategy is to look at the growth of a country's export sophistication. Holding constant the initial levels of export sophistication, would those countries that have an unusually fast increase in sophistication also have an unusually high rate of economic growth?

In Table 6, we rank the 49 countries in our sample by descending order in terms of the growth of export sophistication. As a smell test, we pay particular attention to the rankings for Ireland and the PRC using this metric since both countries are often viewed as practical examples of extensive government programs used to promote industrial transformation toward high-tech industries. All five measures are able to capture the PRC as having experienced a high level of change in its export sophistication. But only the modified $EXPY$ variable is able to capture both the PRC and Ireland as having undergone a significant change in export sophistication during the period. This further strengthens our confidence in the relative adequacy of the modified $EXPY$ against the original $EXPY$ in capturing leapfrogging in industrial structure.

Table 7 displays the regression results with this specification for all five export sophistication measures and their changes over the period 1992–2003. The initial GDP level, human capital, and institutional variable all have the correct signs. None of the export sophistication growth variables enters significantly into the regression. But the most conspicuous observation involves the initial export sophistication measures: all but the $EXPY$ variable are insignificant with this specification. In contrast to the previous specification, the ATP share is no longer significant either. This once again shows that when export sophistication is constructed in alternative ways, it no longer indicates significant impact on growth.

To summarize, these results raise skepticism of the view that leapfrogging leads to higher growth.

4.2 Non-normality and Non-linearity

If the effect of leapfrog policies is not linear on log productivity, a potential omission bias will occur. Rodriguez (2007) shows that a linear regression of a nonlinear data generation process will only produce an average policy effect if the data generating process of the policy variable —in other words, the leapfrogging measure —is distributed according to a normal distribution. We, therefore, test the normality of leapfrogs. Observe that export sophistication can be decomposed into a function of factor endowments, leapfrog policies, and other factors:

Export sophistication = *f*(factor endowments, leapfrog policies, other factors).

The growth regression specification is:

$$\begin{aligned} \mathrm{Ln}\,GDPc_{it} - \mathrm{Ln}\,GDPc_{it-1} = \alpha_0 + \alpha_1 \mathrm{Ln}\,GDPc_{it-1} + \alpha_2 ExpSophis_{it-1} \\ + \alpha_3 HumanCap_{it-1} + \alpha_4 Institution_{it-1} + \omega_{it} \end{aligned} \tag{9}$$

The interpretation of α_2 can be taken as the average impact of leapfrogging policies since it represents the variation on export sophistication that is unexplained by human capital, institutional variable, and the initial level of development, all three of which are already included as covariates in the regression. These covariates successfully capture the factor endowment and other factor aspects of export sophistication. We reformulate the procedure to isolate the part of export sophistication that is not attributable to factor endowment and other factors as leapfrog policies.[4]

Stage 1: Isolate the variation due to leapfrogging. We interpret ε_i as the portion of export sophistication attributable to a government's leapfrog policy:

$$ExpSophis_{it} = \beta_0 + \beta_1 \mathrm{Ln}\,GDPc_{it} + \beta_2 HumanCap_{it} + \beta_3 Institution_{it} + \xi_{it} \tag{10}$$

Stage 2: Growth regression

$$\mathrm{Ln}\,GDPc_{it} - \mathrm{Ln}\,GDPc_{it-1} = \gamma\xi_{it-1} + \nu_{it} \tag{11}$$

γ is interpreted as the impact of leapfrogging on growth. It is the equivalent of α_2 estimated from equation (1). We then set out to test the normality of the leapfrog variable. Table 8 displays the results from the Shapiro-Wilk and skewness/kurtosis tests of normality of variables. Normality in the distribution of $EXPY$ and the ATP share variables would be comfortably rejected in both tests. On the other hand, the modified $EXPY$ and EDI passed the normality test. We take away two messages from this exercise: (i) a linear regression may not give a meaningful interpretation for the $EXPY$ coefficient, even if it otherwise correctly captures the degree of leapfrogging; and (ii) the modified $EXPY$ appears to be a better regressor to use in the linear model from a pure statistical sense.

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4 The results from the normality test would be the same regardless of whether one used the isolated leapfrog variables or the export sophistication variables. We reformulate the variable here for clarity.

4.3 Panel Regressions with Instrumental Variables

The cross section regressions assume that productivity growth is the same for all countries except for the differences in their respective leapfrog policies. As an extension that relaxes this assumption, we turn to a panel analysis with separate country-fixed effects. New challenges emerge with the panel analysis as one has to deal with shorter time intervals and must have instrumental variables with meaningful time series variations.

We propose to use the professional background and educational preparedness of political leaders as variables that may affect their choice of economic strategy. Dreher, Lamla, Lein, and Somogyi (2008) constructed a database of the profession and education for more than 500 political leaders from 73 countries for the period 1970–2002. One set of dummies codify the educational background for the chief executives: law, economics, politics, natural science, and other. Another set of dummies codify the professions of the chief executives before they take office: entrepreneur, white collar, blue collar, union executive, science, economics, law, military, politics, and others. We use this set of variables as instruments for export sophistication.

Table 9 shows the growth regression results for the long sample of 1970–2000 when using $EXPY$ and EDI as measures of export sophistication. Unfortunately, we cannot use the ATP shares as they are not available for the early years of the sample period. Panel A shows the results for using $EXPY$ as export sophistication. To compare with the analysis in Hausman et al., our sample starts a few years later (as opposed to 1962), yet our OLS estimation closely replicates their estimates: (i) the coefficient for initial GDP per capita is negative and significant at –0.001, (ii) the coefficient for initial $EXPY$ is positive and significant at 0.02, and (iii) the coefficient for human capital is positive and significant at 0.01. In the fixed effects and IV specifications, neither of the coefficients for initial $EXPY$ is significant, despite the improved Hansen-J statistics and our set of instruments. The R-squared of our regression for the OLS case is more than twice as large as the R-squared from the Hausman et al. study, despite the similarities in the estimates. Panel B shows the results for the same regression, but replacing $EXPY$ with EDI. None of the export sophistication variables are significant, while the initial GDP per capita and human capital variables are both significant. We conclude that in the panel regressions, there is no strong and robust support for the notion that a leapfrogging strategy promotes growth.

5. Comparing Cross-Regional Variations within a Single Country

Cross-country analyses could suffer from a serious omitted variable bias as countries differ in history, culture, legal systems, governance institutions, among myriad other factors. There are always some such variables that are not properly controlled for in cross-country regressions. If none of these variables were time-varying, then fixed effects in a panel regression would take care of them. If some of these variables were time-varying (and correlated with the export sophistication measures), then we cannot obtain a consistent estimate of the true effect of a leapfrogging strategy. Assuming these omitted country-level variables can be plausibly held constant within a country, one solution to this problem is to explore cross-regional variations within a single country. In our context, regions have to differ in their pursuit of a leapfrogging policy and the country has to be relatively large so that enough statistical power is available from a cross-regional analysis.

In this section, we conduct such an analysis across cities in the PRC. Specifically, at the city level, we compute the same set of export sophistication measures as before. In addition, we pay attention to the role of the processing trade and imported ATP inputs, which could not be included in a cross-country analysis. Recent international trade literature (Koopman, Wang, and Wei, 2008; Dean, Fung, and Wang, 2009; De La Cruz et al., 2009) provide evidence that export sophistication in developing countries such as the PRC and Mexico can be explained in large part by vertical specialization and global production fragmentation. The two ratios of ATP imports over ATP exports in a city provide a very rough lower and higher bound for a proxy measure of the foreign content embodied in a PRC city's total ATP exports, which may contribute directly to the sophistication of a city's exports.

By comparing the values of export sophistication measures against per capita GMP, we can infer which cities may be more aggressive in upgrading their economic structure (beyond their income level alone). The cities of Wuxi, Zhuhai, and Tianjian can be identified as having been ahead of other cities in 1996 in terms of exporting advanced technological goods. By 2006, Shenzhen, Xiamen, Dongguan, Shanghai, and Guangzhou were among the cities that had risen according to the leapfrog measure. How sensible is this leapfrog measure in identifying cities where the local government installed favorable industrial policies? All the aforementioned cities and other cities that had experienced a rise in their leapfrog measure, with the exception of Dongguan, were established as export processing zones between 2001 and 2002, and high-technology industry development areas between 1996 to 1997.[5] Overall, the leapfrog measures seem to be consistent with regional variations in public sector policies in favor of high-tech industries in local economies.

We now turn to a formal regression analysis.[6] The results are reported in Table 10. Most coefficients for export sophistication measures are not statistically significant, with the exception of the ATP (narrow) share and the modified $EXPY$. However, the coefficient for the modified $EXPY$ is negative. In other words, if a leapfrogging strategy has an effect on local growth, the effect is negative. In any case, the significance of the modified $EXPY$ variable disappears after adding the leapfrog growth as a covariate.

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5 Wang and Wei (2008) report the years of establishment of economic zones (e.g., special economic zone [SEZ], economic and technology development area, high-tech industry development area, export processing zone) in the PRC in their Appendix Table 2.

6 Eight major cities redrew their administrative area during the sample period. They are Nanning, LiuZhou, Fuyang, Haikou, Chongqing, Kunming, Xinning, and Yinchuan. Thus, we also re-estimated the regressions to include the interaction of these eight cities with the export sophistication variable on the right-hand side. But the general results did not change.

For both sets of regressions, there is no clear evidence of a conditional convergence, unlike the cross-country analyses reported in the earlier sections. The variation in growth across cities that can be explained is low. The R-squared ranges from 0.04 to 0.06 in Table 10. The Shapiro-Wilk tests of normality for the export sophistication measures reject normality for all of them, suggesting that some non-linearity is likely present in the data generating process. We also supplemented the cross section results with panel analysis for the period 1996–2005, sampling 3 years for each city and reporting the results in Table 11. The coefficients for the six leapfrog policy variables across three regression specifications are insignificant except for one specification for $EXPY$ and the IV specification for EDI. To summarize, there is no strong case supporting a robust and positive causal effect of leapfrogging on economic growth across cities in the PRC.

6. Conclusion

To be able to transform an economy's economic structure ahead of its income level toward higher domestic value-added and more sophisticated sectors is desirable in the abstract. Many governments have pursued policies to bring about such transformations. To be sure, there are examples of individual success cases, including the promotion of a certain industry by government policies resulting in an expansion of that industry. However, any such policy promotion takes away resources from other industries, especially those that are consistent with the country's factor endowment and level of development. On balance, the effect is conceptually less clear. Given the popularity of such leapfrogging strategies, it is important to evaluate empirically whether or not they are effective. Unfortunately, such an evaluation is difficult because it is not a straightforward process to quantify the degree of leapfrogging an economy may exhibit. Typical data on production structures are not refined enough and most relevant policies are not easily quantifiable or comparable across countries.

One way to gauge the degree of leapfrogging is by inferring from a country's detailed export data. This paper pursues such a strategy and develops a number of different ways to measure leapfrogging from revealed sophistication in a country's exports, recognizing that any particular measure may have both advantages and shortcomings.

After a whole battery of analyses, a succinct summary of our findings is that there is a lack of strong and robust support for the notion that a leapfrogging industrial policy can reliably raise economic growth. Again, there may be individual success stories. But there are also failures. If leapfrogging is a policy gamble, there is no systematic evidence to suggest that the odds for success are favorable.

We conclude by noting once again two distinct aspects of a growth model that embraces the world market. The first aspect is export orientation—an investment environment with few policy impediments to firms participating in international trade. While this paper does not reproduce the vast quantity of analysis on this, we do not doubt its validity. The second aspect is a leapfrogging strategy—the use of policy instruments to engineer a more rapid industrial transformation than what might emerge naturally based on an economy's stage of development and factor endowment. Our empirical findings have cast some doubt on the effectiveness of such strategies.

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Table 1: Replicating Hausman et al. Cross National Growth Regressions with Income Implied in a Country's Export Bundle (EXPY), 1992–2003

Dependent variable: growth rate of GDP per capita over 1992-2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
log initial GDP/cap	-0.011	-0.02	-0.025	-0.026	-0.03	-0.023	-0.009	-0.017	-0.025	-0.025	-0.024	-0.02
	[0.005]*	[0.007]**	[0.007]**	[0.006]**	[0.007]**	[0.007]**	[0.006]	[0.011]	[0.012]*	[0.010]*	[0.011]*	[0.012]
log initial *EXPY*	0.036	0.029	0.025	0.019	0.03	0.027	0.031	0.023	0.023	0.016	0.025	0.023
	[0.011]**	[0.011]*	[0.010]*	[0.010]	[0.010]**	[0.011]*	[0.014]*	[0.015]	[0.012]	[0.011]	[0.013]	[0.014]
log human capital		0.033	0.028	0.026	0.021	0.029		0.03	0.029	0.024	0.016	0.029
		[0.012]*	[0.012]*	[0.010]*	[0.010]*	[0.013]*		[0.017]	[0.015]*	[0.012]*	[0.012]	[0.016]
Corruption			0.008						0.008			
			[0.003]*						[0.004]			
government effectiveness				0.013						0.013		
				[0.003]**						[0.004]**		
regulation quality					0.021						0.018	
					[0.005]**						[0.006]**	
cpi score						0.002						0.001
						[0.001]						[0.002]
Constant	-0.193	-0.114	-0.023	0.041	-0.029	-0.066	-0.168	-0.079	-0.014	0.054	-0.019	-0.057
	[0.066]**	[0.072]	[0.065]	[0.074]	[0.061]	[0.070]	[0.078]*	[0.080]	[0.064]	[0.069]	[0.062]	[0.072]
Observations	52	42	42	42	42	42	52	42	42	42	42	42
R-squared	0.24	0.35	0.41	0.5	0.53	0.38						
Hansen J							0.93	1.69	1.61	0.82	0.35	1.95
Chi-sq p-value							0.33	0.19	0.2	0.36	0.56	0.16

Robust standard errors in brackets; instruments for IV regressions are log(population) and log(land); * significant at 5%; ** significant at 1%.

Table 2: Alternative Measure of Export Sophistication – Unit Value Adjusted Implied Income in the Export Bundle: Modified EXPY, 1992-2003

Dependent variable: growth rate of GDP per capita over 1992–2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
log initial GDP/cap	-0.004	-0.016	-0.02	-0.023	-0.022	-0.018	-0.005	-0.017	-0.032	-0.034	-0.031	-0.022
	[0.004]	[0.006]*	[0.006]**	[0.006]**	[0.007]**	[0.006]**	[0.005]	[0.011]	[0.017]	[0.012]**	[0.013]*	[0.016]
log initial modified *EXPY*	0.011	0.009	0.004	-0.001	0.004	0.006	0.012	0.01	0.006	-0.001	0.005	0.008
	[0.004]**	[0.006]	[0.006]	[0.006]	[0.007]	[0.006]	[0.004]**	[0.006]	[0.006]	[0.006]	[0.006]	[0.006]
log human capital		0.033	0.03	0.027	0.025	0.031		0.035	0.041	0.038	0.033	0.035
		[0.014]*	[0.013]*	[0.011]*	[0.012]	[0.014]*		[0.023]	[0.024]	[0.016]*	[0.018]	[0.024]
Corruption			0.009						0.013			
			[0.003]*						[0.009]			
government effectiveness				0.016						0.021		
				[0.004]**						[0.007]**		
regulation quality					0.019						0.024	
					[0.007]*						[0.010]*	
cpi score						0.002						0.002
						[0.002]						[0.003]
Constant	-0.024	0.037	0.123	0.195	0.144	0.077	-0.023	0.038	0.188	0.264	0.193	0.085
	[0.029]	[0.043]	[0.052]*	[0.061]**	[0.052]**	[0.050]	[0.029]	[0.048]	[0.125]	[0.103]*	[0.086]*	[0.089]
Observations	52	42	42	42	42	42	52	42	42	42	42	42
R-squared	0.17	0.28	0.34	0.45	0.4	0.3						
Hansen J							0.11	1.05	1.22	0.66	0.13	1.49
Chi-sq p-value							0.74	0.31	0.27	0.42	0.72	0.22

Robust standard errors in brackets; instruments for IV regressions are log(population) and log(land); * significant at 5%; ** significant at 1%.

Table 3: Cross National Growth Regressions with Advanced Technology Products (ATP) Share (narrow), 1992–2003

Dependent variable: growth rate of GDP per capita over 1992–2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
log initial GDP/cap	-0.002	-0.015	-0.021	-0.023	-0.022	-0.019	-0.008	-0.017	-0.033	-0.026	-0.03	-0.026
	[0.003]	[0.006]*	[0.007]**	[0.007]**	[0.007]**	[0.007]*	[0.006]	[0.015]	[0.019]	[0.014]	[0.020]	[0.020]
initial *ATP* share (narrow)	0.087	0.076	0.069	0.049	0.056	0.07	0.112	0.083	0.077	0.05	0.055	0.081
	[0.026]**	[0.027]**	[0.024]**	[0.027]	[0.023]*	[0.025]**	[0.034]**	[0.030]**	[0.022]**	[0.025]*	[0.022]*	[0.024]**
log human capital		0.036	0.03	0.027	0.026	0.031		0.041	0.042	0.03	0.035	0.039
		[0.014]*	[0.013]*	[0.011]*	[0.013]	[0.014]*		[0.032]	[0.023]	[0.018]	[0.023]	[0.026]
Corruption			0.009						0.015			
			[0.003]**						[0.009]			
government effectiveness				0.014						0.015		
				[0.004]**						[0.008]*		
regulation quality					0.018						0.024	
					[0.006]**						[0.015]	
cpi score						0.003						0.004
						[0.002]						[0.004]
Constant	0.054	0.098	0.164	0.181	0.172	0.129	0.105	0.112	0.241	0.198	0.225	0.173
	[0.030]	[0.036]**	[0.045]**	[0.043]**	[0.042]**	[0.044]**	[0.056]	[0.071]	[0.119]*	[0.088]*	[0.124]	[0.111]
Observations	52	42	42	42	42	42	52	42	42	42	42	42
R-squared	0.13	0.32	0.41	0.49	0.44	0.36						
Hansen J							0	0.59	0.16	0.02	0.07	0.72
Chi-sq p-value							0.97	0.44	0.69	0.88	0.78	0.4

Robust standard errors in brackets; instruments for IV regressions are log(population) and log(land); * significant at 5%; ** significant at 1%.

Table 4: Cross National Growth Regressions with Advanced Technology Products (ATP) Share (broad), 1992–2003

Dependent variable: growth rate of GDP per capita over 1992–2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
log initial GDP/cap	-0.002	-0.014	-0.021	-0.023	-0.023	-0.019	-0.007	-0.018	-0.033	-0.028	-0.03	-0.027
	[0.004]	[0.006]*	[0.007]**	[0.006]**	[0.007]**	[0.007]*	[0.006]	[0.014]	[0.017]	[0.013]*	[0.017]	[0.018]
initial *ATP* share (broad)	0.056	0.041	0.035	0.019	0.031	0.036	0.074	0.049	0.046	0.022	0.034	0.048
	[0.022]*	[0.026]	[0.023]	[0.023]	[0.020]	[0.024]	[0.028]**	[0.028]	[0.020]*	[0.020]	[0.020]	[0.022]*
log human capital		0.036	0.029	0.027	0.025	0.031		0.044	0.041	0.031	0.032	0.039
		[0.014]*	[0.013]*	[0.011]*	[0.013]	[0.014]*		[0.030]	[0.023]	[0.018]	[0.021]	[0.026]
Corruption			0.01						0.015			
			[0.003]**						[0.008]			
government effectiveness				0.015						0.017		
				[0.004]**						[0.007]*		
regulation quality					0.019						0.024	
					[0.006]**						[0.012]	
cpi score						0.003						0.004
						[0.002]						[0.003]
Constant	0.055	0.097	0.164	0.183	0.178	0.129	0.094	0.118	0.244	0.212	0.222	0.18
	[0.032]	[0.036]*	[0.045]**	[0.041]**	[0.043]**	[0.044]**	[0.049]	[0.067]	[0.108]*	[0.082]**	[0.104]*	[0.101]
Observations	52	42	42	42	42	42	52	42	42	42	42	42
R-squared	0.09	0.26	0.36	0.46	0.41	0.31						
Robust standard errors in brackets * significant at 5%; ** significant at 1%												
Hansen J							0.03	1.2	0.48	0.23	0.01	1.34
Chi-sq p-value							0.85	0.27	0.49	0.63	0.91	0.25

Robust standard errors in brackets; instruments for IV regressions are log(population) and log(land); * significant at 5%; ** significant at 1%.

Table 5: Cross National Growth Regressions with Export Dissimilarity Index (EDI), 1992–2003

Dependent variable: growth rate of GDP per capita over 1992–2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
log initial GDP/cap	-0.005	-0.017	-0.024	-0.026	-0.025	-0.021	-0.007	-0.02	-0.035	-0.034	-0.03	-0.031
	[0.004]	[0.007]*	[0.007]**	[0.006]**	[0.007]**	[0.007]**	[0.004]	[0.008]*	[0.010]**	[0.008]**	[0.011]**	[0.009]**
log initial *EDI*	-0.025	-0.011	-0.001	0.008	-0.007	-0.002	-0.029	-0.012	-0.011	0.002	-0.01	-0.011
	[0.012]*	[0.014]	[0.012]	[0.010]	[0.014]	[0.013]	[0.015]*	[0.017]	[0.014]	[0.011]	[0.015]	[0.015]
log human capital		0.038	0.029	0.027	0.026	0.03		0.044	0.043	0.036	0.031	0.044
		[0.014]**	[0.013]*	[0.011]*	[0.013]*	[0.014]*		[0.019]*	[0.017]*	[0.014]*	[0.016]	[0.018]*
Corruption			0.012						0.016			
			[0.004]**						[0.005]**			
government effectiveness				0.018						0.021		
				[0.004]**						[0.005]**		
regulation quality					0.019						0.023	
					[0.007]**						[0.010]*	
cpi score						0.004						0.005
						[0.002]*						[0.002]*
Constant	0.213	0.174	0.195	0.165	0.233	0.162	0.248	0.197	0.318	0.246	0.286	0.264
	[0.081]*	[0.104]	[0.095]*	[0.083]	[0.108]*	[0.097]	[0.103]*	[0.122]	[0.114]**	[0.085]**	[0.130]*	[0.111]*
Observations	52	41	41	41	41	41	52	41	41	41	41	41
R-squared	0.09	0.23	0.37	0.48	0.36	0.31						
Hansen J							0.97	1.36	1.26	0.39	0.15	2.08
Chi-sq p-value							0.33	0.24	0.26	0.53	0.7	0.15

Robust standard errors in brackets; instruments for IV regressions are log(population) and log(land); * significant at 5%; ** significant at 1%.

Table 6: Ranking Growth in Export Sophistication, 1992–2003

Ranking	Country	*EXPY*	Country	Modified *EXPY*	Country	*ATP* (narrow)	Country	*ATP* (broad)	Country	*EDI*
1	Hungary	3.14	Ireland	5.54	Malaysia	1.50	Malaysia	2.01	Australia	-2.32
2	Bangladesh	3.12	Hungary	4.44	Iceland	1.41	Hungary	1.93	Korea, Rep. of	-1.70
3	Kenya	3.05	Madagascar	4.38	PRC	1.20	PRC	1.88	Oman	-1.56
4	Madagascar	2.78	Kenya	3.55	Singapore	1.09	Finland	1.31	Hungary	-1.50
5	Korea, Rep. of	2.10	Ecuador	3.41	Netherlands	0.88	Singapore	1.10	Mexico	-1.46
6	Thailand	2.07	Indonesia	3.22	Hungary	0.56	Korea, Rep. of	1.09	Kenya	-1.45
7	PRC	2.03	South Africa	3.12	Indonesia	0.50	Iceland	1.08	Greece	-1.42
8	Trinidad and Tobago	1.96	Bangladesh	3.04	Thailand	0.49	Netherlands	1.04	Thailand	-1.40
9	Paraguay	1.89	Singapore	3.01	Korea, Rep. of	0.40	Indonesia	0.95	Indonesia	-1.38
10	Singapore	1.83	PRC	2.98	Mexico	0.33	Mexico	0.93	Turkey	-1.35
11	Turkey	1.82	Brunei Darussalam	2.98	Portugal	0.33	Thailand	0.70	Portugal	-1.28
12	Colombia	1.50	Turkey	2.91	St. Lucia	0.20	Greece	0.64	Ecuador	-1.09
13	Iceland	1.40	Malaysia	2.87	Tunisia	0.16	Croatia	0.61	PRC	-1.02
14	Malaysia	1.37	Thailand	2.61	Switzerland	0.15	Switzerland	0.59	India	-1.00
15	Cyprus	1.30	Korea, Rep. of	2.29	Australia	0.15	Brazil	0.54	Spain	-0.98
16	Bolivia	1.24	Greece	2.05	Finland	0.15	Denmark	0.49	Saudi Arabia	-0.96
17	Portugal	1.24	Portugal	1.96	Bolivia	0.13	Portugal	0.45	Malaysia	-0.79
18	Croatia	1.16	Cyprus	1.94	Sweden	0.13	St. Lucia	0.42	Colombia	-0.73
19	Greece	1.15	Colombia	1.78	Greece	0.11	Australia	0.39	Sweden	-0.63
20	Finland	1.12	Tunisia	1.75	Kenya	0.09	New Zealand	0.39	Denmark	-0.59
21	India	1.08	Croatia	1.70	Croatia	0.09	Paraguay	0.30	Paraguay	-0.55
22	Ecuador	1.01	Mexico	1.67	India	0.08	Tunisia	0.26	New Zealand	-0.54
23	Mexico	0.99	Iceland	1.41	New Zealand	0.08	Sweden	0.24	Romania	-0.51
24	Indonesia	0.90	Sri Lanka	1.35	Denmark	0.07	Romania	0.21	Iceland	-0.50
25	Sri Lanka	0.86	New Zealand	1.24	Cyprus	0.05	Kenya	0.20	St. Lucia	-0.48
26	South Africa	0.86	St. Lucia	1.15	Romania	0.05	India	0.15	Brazil	-0.46

Ranking	Country	*EXPY*	Country	Modified *EXPY*	Country	*ATP* (narrow)	Country	*ATP* (broad)	Country	*EDI*
27	Switzerland	0.65	Australia	1.06	Algeria	0.04	Bolivia	0.14	Cyprus	-0.46
28	Australia	0.63	India	1.06	Saudi Arabia	0.03	Algeria	0.14	Japan	-0.43
29	New Zealand	0.54	Netherlands	1.04	Paraguay	0.03	Saudi Arabia	0.10	Tunisia	-0.42
30	Oman	0.52	Switzerland	0.98	Ecuador	0.03	Turkey	0.08	South Africa	-0.40
31	Ireland	0.31	Finland	0.93	Peru	0.01	Chile	0.05	Croatia	-0.39
32	Brazil	0.27	Denmark	0.91	Chile	0.01	Spain	0.03	Sri Lanka	-0.37
33	Tunisia	0.27	Bolivia	0.88	Turkey	0.01	Peru	0.02	Canada	-0.36
34	Denmark	0.27	Paraguay	0.80	Bangladesh	0.00	Japan	0.02	Peru	-0.31
35	Japan	0.25	Spain	0.67	South Africa	0.00	Bangladesh	0.01	Singapore	-0.25
36	Sweden	0.25	Peru	0.66	Belize	0.00	Belize	0.01	Bolivia	-0.22
37	Netherlands	0.20	Brazil	0.24	Trinidad and Tobago	0.00	Trinidad and Tobago	0.00	Algeria	-0.07
38	St. Lucia	0.20	Japan	0.24	Brunei Darussalam	0.00	Canada	0.00	Brunei Darussalam	-0.01
39	Spain	0.20	Sweden	0.17	Jamaica	0.00	Brunei Darussalam	0.00	Bangladesh	-0.01
40	Canada	0.17	Algeria	0.11	Spain	-0.01	Jamaica	-0.01	Netherlands	0.00
41	Chile	0.07	Chile	0.09	Japan	-0.01	Ecuador	-0.02	Chile	0.00
42	Algeria	0.01	Macao	-0.22	Colombia	-0.02	Madagascar	-0.02	Switzerland	0.01
43	Brunei Darussalam	-0.03	Canada	-0.37	Madagascar	-0.02	Sri Lanka	-0.03	Belize	0.02
44	Saudi Arabia	-0.07	Belize	-0.42	Brazil	-0.03	Cyprus	-0.05	Trinidad and Tobago	0.04
45	Jamaica	-0.25	Saudi Arabia	-0.50	Sri Lanka	-0.04	Colombia	-0.05	Finland	0.11
46	Macao	-0.40	Oman	-0.51	Macao	-0.06	Ireland	-0.08	Madagascar	0.14
47	Romania	-0.68	Romania	-0.91	Ireland	-0.15	South Africa	-0.10	Jamaica	0.16
48	Peru	-0.84	Trinidad and Tobago	-2.74	Canada	-0.24	Macao	-0.13	Ireland	0.34
49	Belize	-1.09	Jamaica	-3.17	Oman	-0.25	Oman	-0.23	Macao	0.48

Table 7: Cross National Growth Regression, with Growth in Export Sophistication

Dependent variable: growth in real GDP per capita, 1992–2003	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Log initial GDP per capita	-0.028	-0.02	-0.02	-0.02	-0.02
	[0.005]**	[0.005]**	[0.005]**	[0.005]**	[0.005]**
Human Capital	0.016	0.021	0.022	0.019	0.023
	[0.010]	[0.011]	[0.010]*	[0.010]	[0.011]
Regulation quality	0.018	0.015	0.015	0.016	0.018
	[0.006]**	[0.007]*	[0.006]*	[0.006]*	[0.007]*
Log initial *EXPY*	0.032				
	[0.009]**				
Growth in log *EXPY*	0.252				
	[0.240]				
Log initial modified *EXPY*		0.005			
		[0.005]			
Growth in log modified *EXPY*		0.081			
		[0.153]			
initial *ATP* share (narrow)			0.04		
			[0.031]		
Growth in *ATP* share (narrow)			0.891		
			[0.567]		
initial *ATP* share (broad)				0.026	
				[0.023]	
Growth in *ATP* share (broad)				0.731	
				[0.388]	
initial log *EDI*					-0.001
					[0.015]
Growth in log *EDI*					-0.003
					[0.407]
Constant	-0.06	0.12	0.16	0.162	0.17
	[0.070]	[0.052]*	[0.033]**	[0.033]**	[0.095]
Observations	41	41	41	41	39
R-squared	0.51	0.36	0.44	0.43	0.33

Robust standard errors in brackets; * significant at 5%; ** significant at 1%.

Table 8: Test for Normality

Shapiro–Wilk W Test for Normal Data

Variable	Obs	W	V	z	Prob>z
log *EXPY*	42.00	0.94	2.41	1.86	0.03
log Modified *EXPY*	42.00	0.96	1.47	0.81	0.21
ATP (narrow)	42.00	0.76	9.86	4.83	0.00
ATP (broad)	42.00	0.87	5.34	3.53	0.00
log *ATP*	41.00	0.99	0.59	-1.13	0.87

Skewness/Kurtosis Tests for Normality

Variable	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
log *EXPY*	0.028	0.192	6.09	0.0475
log Modified *EXPY*	0.131	0.894	2.44	0.2946
ATP (narrow)	0	0.004	19.43	0.0001
ATP (broad)	0.001	0.074	11.16	0.0038
log *ATP*	0.491	0.926	0.5	0.78

Table 9: Long Sample, Panel Regressions with Fixed Effects

A. *EXPY*

5-year panels	**(1)**	**(2)**	**(3)**
	OLS	FE	IV
log initial GDP/cap	-0.0103	-0.0479	-0.0113
	[0.0027]**	[0.0060]**	[0.0104]
log initial *EXPY*	0.0208	0.0027	0.0223
	[0.0055]**	[0.0091]	[0.0423]
log human capital	0.0116	-0.0102	0.0088
	[0.0027]**	[0.0065]	[0.0078]
Constant	-0.059	0.3688	-0.0573
	[0.0379]	[0.0788]**	[0.3033]
Observations	640	640	369
R-squared	0.39	0.47	
First stage F stat			1.35
Hansen J-statistics (p-value)			0.186

B. *EDI*

5-year panels	**(1)**	**(2)**	**(3)**
	OLS	FE	IV
log initial GDP/cap	-0.0065	-0.0517	-0.0097
	[0.0026]*	[0.0062]**	[0.0054]
Initial log *EDI*	-0.0117	0.004	-0.0271
	[0.0071]	[0.0191]	[0.0180]
log human capital	0.0128	-0.0256	0.0081
	[0.0030]**	[0.0079]**	[0.0041]*
Constant	0.1555	0.4266	0.2709
	[0.0473]**	[0.1136]**	[0.1222]*
Observations	475	475	314
R-squared	0.43	0.59	
First stage F stat			3.08
Hansen J-statistics (p-value)			0.089

* Significant at 5%; ** significant at 1%; robust standard errors in brackets; instruments are the professions and educational background of political leaders from Dreher, Lamla, Lein, and Somogyi (2008).

Table 10: Cross-Section Growth Regressions, Cities in the People's Republic of China (1997–2006)

Dependent variable: growth rate over 1997–2006	(1)	(2)	(4)	(6)	(8)	(10)
	OLS	OLS	OLS	OLS	OLS	OLS
log initial GDP/cap	0.0089	0.0095	0.0103	0.0096	0.0094	0.0065
	[0.0050]	[0.0051]	[0.0049]*	[0.0051]	[0.0050]	[0.0057]
initial Human Capital	0.1505	0.1372	0.153	0.135	0.1624	0.1045
	[0.1501]	[0.1484]	[0.1489]	[0.1488]	[0.1468]	[0.1528]
SEZdummy	-0.0053	-0.0046	-0.0028	-0.0039	-0.0036	-0.0068
	[0.0080]	[0.0079]	[0.0079]	[0.0081]	[0.0078]	[0.0089]
log initial *ATP* share (narrow)	0.0549					
	[0.0215]*					
log initial *ATP* share (broad)		0.0103				
		[0.0158]				
log initial *ATP* share (G3)			-0.0354			
			[0.0248]			
log initial *EXPY*				-0.0073		
				[0.0077]		
log initial modified *EXPY*					-0.0084	
					[0.0030]**	
log initial *EDI*						-0.0556
						[0.0623]
Constant	0.0257	0.0197	0.0145	0.0867	0.0972	0.339
	[0.0426]	[0.0434]	[0.0418]	[0.0845]	[0.0536]	[0.3527]
Observations	209	209	208	208	208	208
R-squared	0.04	0.04	0.06	0.04	0.06	0.04

Robust standard errors in brackets; * significant at 5%; ** significant at 1%.

Table 11: Panel Growth Regressions, Cities in the People's Republic of China (1996–2005)

3-year panels	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
	OLS	**FE**	**IV**	**OLS**	**FE**	**IV**	**OLS**	**FE**	**IV**
log initial GDP/cap	0.0042	-0.2007	0.0337	0.0044	-0.2013	-0.0004	0.0038	-0.2038	0.0107
	[0.0049]	[0.0228]**	[0.0205]	[0.0048]	[0.0227]**	[0.0064]	[0.0049]	[0.0227]**	[0.0187]
human capital	0.0373	0.0316	-0.5121	0.0415	0.0363	0.0952	0.0477	0.0374	-0.951
	[0.1240]	[0.1947]	[0.3847]	[0.1228]	[0.1946]	[0.1271]	[0.1231]	[0.1946]	[1.4628]
initial *ATP* (narrow)	-0.0158	-0.0426	-1.5058						
	[0.0325]	[0.0733]	[0.9376]						
initial *ATP* (broad)				-0.0188	-0.0096	0.113			
				[0.0160]	[0.0225]	[0.1406]			
initial *ATP* (G3)							-0.0036	0.0041	0.777
							[0.0022]	[0.0037]	[1.1354]
Constant	0.0653	1.972	-0.1181	0.0644	1.9778	0.1432	0.0681	1.9997	0.0224
	[0.0424]	[0.2051]**	[0.1616]	[0.0419]	[0.2047]**	[0.0532]**	[0.0428]	[0.2043]**	[0.1673]
Observations	662	662	662	662	662	662	661	661	661
R-squared	0.32	0.55		0.32	0.55		0.32	0.55	
Number of id		256			256			256	
Hansen J (p-value)			0.307			0.05			0.855

3-year panels	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
	OLS	FE	IV	OLS	FE	IV	OLS	FE	IV
log initial GDP/cap	0.004	-0.2072	0.0075	0.0044	-0.2056	0.0068	0.0022	-0.2019	0.044
	[0.0049]	[0.0226]**	[0.0089]	[0.0049]	[0.0227]**	[0.0055]	[0.0058]	[0.0231]**	[0.0213]*
human capital	0.0431	0.0418	0.0865	0.066	0.051	0.1945	0.0292	0.0368	0.3632
	[0.1231]	[0.1937]	[0.1218]	[0.1211]	[0.1946]	[0.1468]	[0.1282]	[0.1960]	[0.2083]
initial log *EXPY*	-0.0028	0.0343	-0.1094						
	[0.0117]	[0.0151]*	[0.1574]						
initial log Modified *EXPY*				-0.008	0.0086	-0.0482			
				[0.0041]	[0.0055]	[0.0260]			
initial log *EDI*							-0.0307	0.0116	0.7304
							[0.0531]	[0.1680]	[0.3678]*
Constant	0.0928	1.71	1.0948	0.1353	1.9377	0.5175	0.2439	1.9219	-4.0894
	[0.1205]	[0.2362]**	[1.3989]	[0.0615]*	[0.2059]**	[0.2194]*	[0.3080]	[0.9396]*	[2.1198]
Observations	661	661	661	661	661	661	661	661	661
R-squared	0.32	0.56		0.33	0.55		0.32	0.55	
Number of id		256			256			256	
Hansen J (p-value)			0.048			0.289			0.516

All regressions include time dummies and special economic zone (SEZ) dummies.
Standard errors are in brackets. The instruments are log(land) and log(population); * significant at 5%; ** significant at 1%.

Appendix Table 1: HS Products Excluded from Export Data

HS Code	Description	HS Code	Description
01-24	Agricultural products	25-27	Mineral products
4103	Other raw hides and skins (fresh, o	8002	Tin waste and scrap.
4104	Tanned or crust hides and skins of	8101	Tungsten (wolfram) and articles the
4105	Tanned or crust skins of sheep or l	8102	Molybdenum and articles thereof, in
4106	Tanned or crust hides and skins of	8103	Tantalum and articles thereof, incl
4402	Wood charcoal (including shell or n	8104	Magnesium and articles thereof, inc
4403	Wood in the rough, whether or not s	8105	Cobalt mattes and other intermediate
7201	Pig iron and spiegeleisen in pigs,	8106	Bismuth and articles thereof, incl
7202	Ferro-alloys.	8107	Cadmium and articles thereof, incl
7204	Ferrous waste and scrap; re-melting	8108	Titanium and articles thereof, incl
7404	Copper waste and scrap.	8109	Zirconium and articles thereof, inc
7501	Nickel mattes, nickel oxide sinters	8110	Antimony and articles thereof, incl
7502	Unwrought nickel.	8111	Manganese and articles thereof, inc
7503	Nickel waste and scrap.	8112	Beryllium, chromium, germanium, van
7601	Unwrought aluminum.	8113	Cermets and articles thereof, incl
7602	Aluminum waste and scrap.	9701	Paintings, drawings and pastels, ex
7801	Unwrought lead.	9702	Original engravings, prints and lit
7802	Lead waste and scrap.	9703	Original sculptures and statuary, i
7901	Unwrought zinc.	9704	Postage or revenue stamps, stamp-po
7902	Zinc waste and scrap.	9705	Collections and collectors' pieces
8001	Unwrought tin.	9706	Antiques of an age exceeding one hundred years
530521	Coconut, abaca (Manila hemp or Musa	811252	Beryllium, chromium, germanium, van

Appendix Table 2: Countries (165) Included in the Sample Used in Cross Country Regression

Code	Reporting Country	No. Year reported	Code	Reporting Country	No. Year reported	Code	Reporting Country	No. Year reported
ABW	Aruba	5	GBR	United Kingdom	14	NCL	New Caledonia	8
AIA	Anguilla	6	GEO	Georgia	11	NER	Niger	11
ALB	Albania	11	GHA	Ghana	10	NGA	Nigeria	8
AND	Andorra	12	GIN	Guinea	8	NIC	Nicaragua	14
ARG	Argentina	14	GMB	Gambia, The	12	NLD	Netherlands	15
ARM	Armenia	9	GRC	Greece	15	NOR	Norway	14
AUS	Australia	15	GRD	Grenada	14	NPL	Nepal	5
AUT	Austria	13	GRL	Greenland	13	NZL	New Zealand	15
AZE	Azerbaijan	11	GTM	Guatemala	14	OMN	Oman	15
BDI	Burundi	14	GUY	Guyana	10	PAK	Pakistan	4
BEL	Belgium	8	HKG	Hong Kong, China	14	PAN	Panama	12
BEN	Benin	8	HND	Honduras	13	PER	Peru	14
BFA	Burkina Faso	10	HRV	Croatia	15	PHL	Philippines	11
BGD	Bangladesh	12	HTI	Haiti	6	PNG	Papua New Guinea	6
BGR	Bulgaria	11	HUN	Hungary	15	POL	Poland	13
BHR	Bahrain	7	IDN	Indonesia	15	PRT	Portugal	15
BHS	Bahamas, The	6	IND	India	15	PRY	Paraguay	15
BIH	Bosnia and Herzegovina	4	IRL	Ireland	15	PYF	French Polynesia	11
BLR	Belarus	9	IRN	Iran, Islamic Republic of	10	QAT	Qatar	7
BLZ	Belize	15	ISL	Iceland	15	ROM	Romania	15
BOL	Bolivia	15	ISR	Israel	12	RUS	Russian Federation	11
BRA	Brazil	15	ITA	Italy	13	RWA	Rwanda	10
BRB	Barbados	10	JAM	Jamaica	13	SAU	Saudi Arabia	14
BRN	Brunei Darussalam	9	JOR	Jordan	12	SDN	Sudan	12
BTN	Bhutan	4	JPN	Japan	15	SEN	Senegal	11
BWA	Botswana	7	KAZ	Kazakhstan	7	SER	Yugoslavia	11
CAF	Central African	13	KEN	Kenya	11	SGP	Singapore	15

Code	Reporting Country	No. Year reported	Code	Reporting Country	No. Year reported	Code	Reporting Country	No. Year reported
	Republic							
CAN	Canada	15	KGZ	Kyrgyz Republic	9	SLV	El Salvador	13
CHE	Switzerland	15	KHM	Cambodia	5	STP	Sao Tome and Principe	8
CHL	Chile	15	KIR	Kiribati	6	SUR	Suriname	6
CHN	PRC	15	KNA	St. Kitts and Nevis	13	SVK	Slovak Republic	13
CIV	Cote d'Ivoire	12	KOR	Korea, Rep. of	15	SVN	Slovenia	13
CMR	Cameroon	10	LBN	Lebanon	8	SWE	Sweden	15
COK	Cook Islands	4	LCA	St. Lucia	15	SWZ	Swaziland	6
COL	Colombia	15	LKA	Sri Lanka	9	SYC	Seychelles	11
COM	Comoros	10	LSO	Lesotho	5	SYR	Syrian Arab Republic	6
CPV	Cape Verde	10	LTU	Lithuania	13	TCA	Turks and Caicos Isl.	6
CRI	Costa Rica	13	LUX	Luxembourg	8	TGO	Togo	12
CUB	Cuba	8	LVA	Latvia	13	THA	Thailand	15
CYP	Cyprus	15	MAC	Macau, China	14	TTO	Trinidad and Tobago	15
CZE	Czech Republic	14	MAR	Morocco	14	TUN	Tunisia	15
DEU	Germany	15	MDA	Moldova	11	TUR	Turkey	15
DMA	Dominica	13	MDG	Madagascar	15	TWN	Taipei,China	10
DNK	Denmark	15	MDV	Maldives	12	TZA	Tanzania	10
DZA	Algeria	15	MEX	Mexico	15	UGA	Uganda	13
ECU	Ecuador	15	MKD	Macedonia, FYR	13	UKR	Ukraine	11
EGY	Egypt	13	MLI	Mali	11	URY	Uruguay	13
ESP	Spain	15	MLT	Malta	13	USA	United States	15
EST	Estonia	12	MNG	Mongolia	11	VCT	St. Vincent and the Grena	14
ETH	Ethiopia (excludes Eritrea)	11	MOZ	Mozambique	7	VEN	Venezuela	13
FIN	Finland	15	MSR	Montserrat	8	VNM	Viet Nam	6
FJI	Fiji	6	MUS	Mauritius	14	WSM	Samoa	5
FRA	France	13	MWI	Malawi	13	ZAF	South Africa	15
FRO	Faeroe Islands	11	MYS	Malaysia	15	ZMB	Zambia	12
GAB	Gabon	13	NAM	Namibia	7	ZWE	Zimbabwe	6

Appendix Table 3: Cities in the People's Republic of China Included in the Sample Used in Cross-City Regressions (259 cities)

Code	City	Province	No. Year reported	Code	City	Province	No. Year reported	Code	City	Province	No. Year reported
1100	BeijingCY	Beijing CY	11	3404	Huainan	Anhui	11	4311	Chenzhou	Hunan	11
1200	TianjinCY	Tianjin CY	11	3405	Maanshang	Anhui	11	4313	Huaihua	Hunan	10
1301	Shijiazhuang	Hebei	11	3406	Huaibei	Anhui	11	4401	Guangzhou	Guangdong	11
1302	Tangshan	Hebei	11	3407	Tongling	Anhui	11	4402	Shaoguan	Guangdong	11
1303	Qinhuangdao	Hebei	11	3408	Anqing	Anhui	11	4403	Shenzhen	Guangdong	11
1304	Handan	Hebei	11	3409	Huangshan	Anhui	11	4404	Zhuhai	Guangdong	11
1305	Xingtai	Hebei	11	3410	Fuyang	Anhui	11	4405	Shantou	Guangdong	11
1306	Baoding	Hebei	11	3411	Suxian	Anhui	9	4406	Foshan	Guangdong	11
1307	Zhangjiakou	Hebei	11	3412	Chuxian	Anhui	11	4407	Jiangmen	Guangdong	11
1308	Chongde	Hebei	11	3413	Liuan	Anhui	8	4408	Zhanjiang	Guangdong	11
1309	Changzhou	Hebei	11	3414	Xuancheng	Anhui	7	4409	Maoming	Guangdong	11
1310	Langfang	Hebei	11	3415	Chaohu	Anhui	8	4412	Zhaoqing	Guangdong	11
1311	Hengshui	Hebei	11	3416	Chizhou	Anhui	7	4413	Huizhou	Guangdong	11
1401	Taiyuan	Shanxi	11	3501	Fuzhou	Fujian	11	4414	Meizhou	Guangdong	11
1402	Datong	Shanxi	11	3502	Xiamen	Fujian	11	4415	Shanwei	Guangdong	11
1403	Yangquan	Shanxi	11	3503	Putian	Fujian	11	4416	Heyuan	Guangdong	11
1404	Changzhi	Shanxi	11	3504	Sanming	Fujian	11	4417	Yangjiang	Guangdong	11
1405	Jincheng	Shanxi	11	3505	Quanzhou	Fujian	11	4418	Qingyuan	Guangdong	11
1406	Suozhou	Shanxi	11	3506	Zhangzhou	Fujian	11	4419	Dongguan	Guangdong	11
1408	Xinzhou	Shanxi	7	3507	Nanpin	Fujian	11	4420	Zhongshan	Guangdong	11

Code	City	Province	No. Year reported	Code	City	Province	No. Year reported	Code	City	Province	No. Year reported
1410	Jinzhong	Shanxi		73508	Ningde	Fujian	7	4421	Chaozhou	Guangdong	11
1411	Linfen	Shanxi	7	3509	Longyian	Fujian	11	4424	Jieyang	Guangdong	11
1412	Yuncheng	Shanxi	7	3601	Nanchang	Jiangxi	11	4501	Nanning	Guangxi Zhuan AR	11
1501	Hohhot	Inner Mongolia AR	11	3602	Jingdezhen	Jiangxi	11	4502	Liuzhou	Guangxi Zhuan AR	11
1502	Baotou	Inner Mongolia AR	11	3603	Pingxiang	Jiangxi	11	4503	Guilin	Guangxi Zhuan AR	9
1503	Wuhai	Inner Mongolia AR	11	3604	Jiujiang	Jiangxi	11	4504	Wuzhou	Guangxi Zhuan AR	10
1504	Chifeng	Inner Mongolia AR	11	3605	Xingyu	Jiangxi	11	4505	Beihai	Guangxi Zhuan AR	11
1507	Holunbeir	Inner Mongolia AR	6	3606	Yingtan	Jiangxi	11	4506	Yulin	Guangxi Zhuan AR	10
2101	Shenyang	Liaoning	11	3607	Ganzhou	Jiangxi	8	4507	Baise	Guangxi Zhuan AR	5
2102	Dalian	Liaoning	11	3608	Yichun	Jiangxi	7	4508	Hechi	Guangxi Zhuan AR	5
2103	Anshan	Liaoning	11	3609	Shangrao	Jiangxi	7	4509	Qinzhou	Guangxi Zhuan AR	11
2104	Fushen	Liaoning	11	3610	Ji'an	Jiangxi	7	4512	Fangchenggang	Guangxi Zhuan AR	4
2105	Benxi	Liaoning	11	3611	Fuzhou	Jiangxi	7	4516	Hezhou Area	Guangxi Zhuan AR	5
2106	Dandong	Liaoning	11	3701	Jinan	Shandong	11	4601	Haikou	Hainan	11
2107	Jinzhou	Liaoning	11	3702	Qingdao	Shandong	11	4602	Sanya	Hainan	11
2108	Yingkou	Liaoning	11	3703	Zibo	Shandong	11	5000	Chongqing	Chongqing	10
2109	Fuxin	Liaoning	11	3704	Zaozhuang	Shandong	11	5101	Chengdu	Sichuan	11
2110	Liaoyang	Liaoning	11	3705	Dongying	Shandong	11	5103	Zigong	Sichuan	11
2111	Panjin	Liaoning	11	3706	Yantai	Shandong	11	5104	Panzhihua	Sichuan	11
2112	Tieling	Liaoning	11	3707	Weifang	Shandong	11	5105	Luzhou	Sichuan	11

Code	City	Province	No. Year reported	Code	City	Province	No. Year reported	Code	City	Province	No. Year reported
2113	Chaoyang	Liaoning	11	3708	Jining	Shandong	11	5106	Deyang	Sichuan	11
2201	Changchun	Jilin	11	3709	Taian	Shandong	11	5107	Mianyan	Sichuan	11
2202	Jilin	Jilin	11	3710	Weihai	Shandong	11	5108	Guangyuan	Sichuan	11
2203	Sipin	Jilin	11	3711	Rizhao	Shandong	11	5109	Suining	Sichuan	11
2204	Liaoyuan	Jilin	11	3713	Dezhou	Shandong	11	5110	Neijiang	Sichuan	9
2205	Tonghua	Jilin	11	3714	Liaochen	Shandong	9	5111	Leshan	Sichuan	10
2209	Baicheng	Jilin	11	3715	Linyi	Shandong	11	5114	Yibin	Sichuan	10
2301	Harbin	Heilongjing	11	3716	Heze	Shandong	7	5115	Nanchong	Sichuan	11
2302	Qiqihar	Heilongjing	11	3720	Laiwu	Shandong	11	5116	Daxian	Sichuan	8
2303	Jixi	Heilongjing	11	4101	Zhengzhou	Henan	11	5117	Yaan	Sichuan	7
2304	Hegang	Heilongjing	11	4102	Kaifeng	Henan	11	5201	Guiyang	Guizhou	11
2305	Shuangyashan	Heilongjing	11	4103	Luoyang	Henan	11	5202	Liupanshan	Guizhou	10
2306	Daqing	Heilongjing	11	4104	Pindinshan	Henan	11	5203	Zunyi	Guizhou	10
2307	Yichun	Heilongjing	11	4105	Anyang	Henan	11	5207	Anshun	Guizhou	7
2308	Jiamusi	Heilongjing	11	4106	Hebi	Henan	11	5301	Kunming	Yunnan	11
2309	Qitaiher	Heilongjing	11	4107	Xinxiang	Henan	11	5303	Zhaotong	Yunnan	6
2310	Mudanjiang	Heilongjing	11	4108	Jiaozhuo	Henan	11	5304	Qujing	Yunnan	10
2311	Heihe	Heilongjing	11	4109	Puyang	Henan	11	5306	Yuxi	Yunnan	9
2314	Suihua	Heilongjing	7	4110	Xuchang	Henan	11	5312	Baoshan	Yunnan	7
3100	Shanghai CY	Shanghai CY	11	4111	Luohe	Henan	11	5314	Lijiang	Yunnan	5
3201	Nanjing	Jiangsu	11	4112	Sanmenxia	Henan	11	6101	Xi'an	Shanxi	11
3202	Wuxi	Jiangsu	11	4113	Shangqiu	Henan	10	6102	Tongzhou	Shanxi	11

Code	City	Province	No. Year reported	Code	City	Province	No. Year reported	Code	City	Province	No. Year reported
3203	Xuzhou	Jiangsu	11	4114	Zhoukou	Henan	7	6103	Baoji	Shanxi	11
3204	Changzhou	Jiangsu	11	4115	Zhumadian	Henan	7	6104	Xianyang	Shanxi	11
3205	Suzhou	Jiangsu	11	4116	Nanyang	Henan	11	6105	Weinan	Shanxi	11
3206	Nantong	Jiangsu	11	4117	Xinyang	Henan	9	6106	Hanzhong	Shanxi	11
3207	Lianyungang	Jiangsu	11	4201	Wuhan	Hubei	11	6107	Ankang	Shanxi	7
3208	Huaiyin	Jiangsu	7	4202	Huangshi	Hubei	11	6108	Shangluo	Shanxi	6
3209	Yancheng	Jiangsu	11	4203	Shiyan	Hubei	11	6109	Yanan	Shanxi	9
3210	Yangzhou	Jiangsu	11	4205	Yichang	Hubei	11	6110	Yulin	Shanxi	8
3211	Zhenjiang	Jiangsu	11	4206	Xiangfan	Hubei	11	6201	Lanzhou	Gansu	11
3212	Taizhou	Jiangsu	11	4207	Ezhou	Hubei	11	6202	Jiayuguan	Gansu	11
3217	Suqian	Jiangsu	11	4208	Jingmen	Hubei	11	6203	Jinchang	Gansu	11
3301	Hangzhou	Zhejiang	11	4209	Huanggang	Hubei	11	6204	Baiyin	Gansu	11
3302	Ningbo	Zhejiang	11	4210	Xiaogan	Hubei	11	6205	Tianshiu	Gansu	11
3303	Wenzhou	Zhejiang	11	4211	Xianning	Hubei	8	6206	Jiuquan	Gansu	5
3304	Jiaxing	Zhejiang	11	4212	Jingzhou	Hubei	9	6207	Zhangye	Gansu	5
3305	Huzhou	Zhejiang	11	4215	Suizhou	Hubei	7	6208	Wuwei	Gansu	6
3306	Shaoxing	Zhejiang	11	4301	Changsha	Hunan	11	6211	Pinliang	Gansu	5
3307	Jinhua	Zhejiang	11	4302	Zhuzhou	Hunan	11	6212	Qingyang	Gansu	5
3308	Quzhou	Zhejiang	11	4303	Xiangtan	Hunan	11	6301	Xining	Qinghai	11
3309	Zhoushan	Zhejiang	11	4304	Hengyang	Hunan	11	6401	Yinchuan	Ningxia Hui AR	11
3310	Lishui	Zhejiang	7	4305	Shaoyang	Hunan	11	6402	Shizuishan	Ningxia Hui AR	11

Code	City	Province	No. Year reported	Code	City	Province	No. Year reported	Code	City	Province	No. Year reported
3311	Taizhou	Zhejiang	11	4306	Yueyang	Hunan	11	6501	Urumqi	Xinjiang AR	11
3401	Hefei	Anhui		114307	Changde	Hunan	11	6502	Kelamayi	Xinjiang AR	10
3402	Wuhu	Anhui	11	4309	Yiyang	Hunan	11				
3403	Bangbu	Anhui	11	4310	Loudi	Hunan	8				

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Does a Leapfrogging Growth Strategy Raise Growth Rate? Some International Evidence

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