

Is China Disintegrating?

The magnitude of Chinese provinces' Domestic and International integration

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Abstract

In this paper, we apply the “border effects” method to study the impact of the economic reforms launched in China at the end of the 1970s in terms of international trade openness and domestic market integration, two of the main objectives of the reforms package. We rely on a new set of provincial trade flows to develop a model that analyzes and compares the magnitude and evolution of Chinese provinces' engagement in domestic and international trade by computing all-inclusive indicators of trade barriers. Our results underline the increasing international trade intensity of Chinese provinces between 1987 and 1997. Despite trade liberalization policies, barriers impeding international trade remain however extremely high. We find that Chinese provinces' greater involvement in international trade went together with a decrease in domestic trade flows intensity. Even if Chinese provinces still rely more on goods from the rest of China than on international imports, provincial borders appear to matter more and more inside the country in the sense that they imply greater discontinuities in the Chinese domestic market. This evolution underlines the failure of reforms to promote domestic integration and the growing division of Chinese domestic market into cellular sub-markets.

JEL Codes: F02, F14, F15, O52, R58.

Keywords: Chinese provinces, international trade, domestic integration, border effects.

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Résumé

Dans ce papier, nous appliquons la méthode des “effets frontière” pour étudier les avancées de la Chine en matière d’ouverture économique internationale des provinces et d’intégration du marché interne, deux des principaux objectifs des réformes économiques lancées à la fin des années 1970. Nous utilisons des données provinciales de flux commerciaux et développons un modèle qui analyse et compare l’ampleur et l’évolution de l’engagement des provinces dans le commerce international et inter-provincial en calculant un indicateur global de barrières aux échanges. Nos résultats soulignent la croissance de l’intensité des échanges internationaux des provinces entre 1987 et 1997 suite à la politique de libéralisation commerciale des autorités chinoises. Malgré le mouvement d’intégration internationale, les barrières pesant sur les importations demeurent à des niveaux prohibitifs attestant de l’isolement commercial persistant des provinces chinoises. Nos résultats soulignent que l’engagement croissant des provinces dans le commerce international s’est accompagné d’une réduction de l’intensité des flux d’échanges à l’intérieur de la Chine. En 1997, le marché chinois apparaît bien moins intégré que le marché européen. Si le reste du pays demeure de loin le principal fournisseur des provinces chinoises, les frontières entre les provinces chinoises induisent des discontinuités de plus en plus importantes à l’intérieur du pays, confirmant la pertinence des inquiétudes sur le mouvement de fragmentation interne du marché chinois depuis la mise en œuvre des réformes.

Codes JEL: F02, F14, F15, O52, R58.

Mots clés: Provinces Chinoises, commerce international, intégration des marchés, effets frontière.

1 Introduction

How integrated is China's domestic market? How does inter-provincial integration compare with international integration? These questions take on particular importance as China is entering into the World Trade Organization. Indeed, Chinese international opening can only be effective if free flow of goods inside the country is guaranteed.

A debate has however emerged about whether or not economic reforms have led to greater domestic integration. Several papers¹, among which Young's (2000) striking analysis, argue that over the past 20 years of economic reform China has devolved into "a fragmented internal market with fiefdoms controlled by local officials". Naughton (1999) takes a skeptical view of such a claim arguing that there are serious problems with the data used in these studies and their interpretation. Indeed, beside stories of provincial trade struggles² they consist of indirect and thus questionable analyses of market integration relying mainly on price and provincial economic structures data³. Naughton directly examines inter-provincial flows to show that inter-provincial trade is not only large but also dominated by intra-industry trade in manufactures in coherence with national economic integration. His study is however limited to the period 1987-1992, thus falling short of analyzing the evolution of impediments to trade within China since the deepening of the reforms. I aim at filling this gap with the exploitation of an updated version of the Naughton data for 1997.

In this paper, we apply the "border effects" method to study directly the reality of domestic market integration in China as well as of international trade openness of Chinese provinces for the years 1987, 1992 and 1997. Our model analyzes and compares the magnitude and evolution of Chinese provinces' engagement in domestic and interna-

¹Young (2000) and Naughton (1999) provide excellent overviews of this literature.

²Anecdotes about tariffs imposed on outside goods and price, investment and price discriminations are plenty. See Kumar (1994), *Chinese Economic Studies* (fall 1993) and Wedeman (2002) for descriptions of trade barriers in current China.

³Kumar led a World Bank report entitled "Internal Market Development and Regulation" (1994) in which she relied on data provided by the State Statistical Bureau to examine trends in inter-provincial retail purchases, finding evidence of a decline in interprovincial trade. However, as revealed by Young (2000), "unbeknownst to the World Bank mission, the data provided by the SSB included the value of interprovincial trade transactions with nonstate commercial departments in the value of intraprovincial purchases" thus making the interpretation of the declining "trade ratio" problematic.

tional trade by computing all-inclusive summaries of trade barriers. We measure the negative impact of Chinese provincial borders on import flows (from the ‘rest of China’ and from international partners) by calculating the proportion by which a province consumes more local goods than goods from the ‘rest of China’, on the one hand, and from international partners, on the other. We consider that each province is an integrated economy inside its boundaries but that its frontiers hinder trade flows with the outside. Chinese provinces’ international and domestic integrations are thus evaluated using the volume of intra-provincial flows as the reference⁴.

What is the magnitude of impediments to Chinese domestic integration in comparison with barriers to international trade? Can the Chinese domestic market be considered as integrated in the light of the territorial discontinuities induced by provincial boundaries? Did reforms enhance China’s domestic market integration?

This paper proceeds as follows: section II discusses domestic and international integration of Chinese provinces. Section III briefly reviews the literature on border effects. Section IV develops the empirical model used. The empirical application to Chinese provinces and the results are described in section V.

2 Domestic and international integration of Chinese provinces

Prior to the implementation of the economic reforms in 1978, China’s economy was characterized by an introverted development strategy. The political isolation of the country as well as the fears of foreign invasions legitimated, on the international side, the restriction of economic relations with the capitalist world and, on the domestic side, the pursuit of a strategy of regional self-sufficiency. Inside the country the accent was put on self-reliance, that is to say the ability for each province to support itself with its own resources. Inter-provincial trade was then considered only as a residual so that production completely neglected principals of comparative advantages, economies of scale and specialization.

The recognition of the economic inefficiencies and wastage of resources resulting from the introverted development policies led to the adoption of radical reforms starting in 1978. The pursuit of rapid

⁴The border effect measures the “excessive” trade volume observed within a province in relation with what would be expected from the gravity equation.

economic development not only entails the creation of markets, but also in a country as huge as China, their spatial integration. With this aim in view, the government progressively withdrew itself from the allocation, distribution and price setting of goods. Parallel to the reduction in the role of planning, the Chinese economy opened itself up. The promotion by the authorities of domestic openness alongside international openness was motivated by the search for dynamic and static gains resulting from increased competition, the diffusion of technological progress and the determination of production according to comparative advantages. Authors agree to recognize the successful promotion of Chinese provinces' international openness. The average trade openness rate of Chinese provinces more than doubled between 1987 and 1997, increasing from 14% to 37%⁵. Achievements in domestic integration are however more controversial. Despite measures to promote domestic market integration, not only have several studies concluded that inter-provincial trade in China is sub-optimal but also some authors (A. Young (2000)) have identified a move towards internal fragmentation since the beginning of the reforms. Some difficulties in the implementation of reforms (such as the decentralization process, launched in 1980, policies of import-substitution industrialization followed by the least developed provinces in order to put an end to perceived deprivation of profits relative to the coast as well as persisting price distortions) are held responsible for the renewal of the regional protectionism observed at the end of the 1980s. Kumar's World Bank report "Internal Market Development and Regulation" (1994) underlines the limited degree of regional specialization and the weak mobility of factors and goods in China. The author describes the numerous 'creative' actions taken by local governments to keep their production of scarce raw materials to themselves or prevent the inflow of goods produced in other provinces. Some struggles were so intense as to be called "wars" by observers. Local protectionism and impediments to the economic unification of the national market remain topical issues. At the annual session of the National People's Congress in March 2000, Wang Zhongfu, director of the State Administration for Industry and Commerce, pointed out that "administrative monopolies, forced deals and market blockades have become a cancer in China's market" (People's Daily July 1st, 2000). More recently, in April 2001, the State Council issued a directive to outlaw regional blockades in market activities.

⁵Trade openness is computed as imports plus exports divided by GDP.

Looking at inter-provincial trade data⁶, we observe as Naughton (1999) that inter-provincial trade is large relative to both GDP and total trade. Average Chinese inter-provincial imports amounted to 54, 50 and 38 % of GDP respectively in 1987, 1992 and 1997. These numbers are far higher than intra-regional trade figures for Western Europe, NAFTA or ASEAN⁷. On average inter-provincial trade accounted respectively for 88, 80 and 66% of Chinese provinces total trade in 1987, 1992 and 1997. Young (2000)'s argument about the decreasing domestic integration in China can however not be refuted. Inter-provincial trade relative to GDP or to total trade has significantly decreased between 1987 and 1997, especially since 1992.

We need to better understand the reasons behind the decline in inter-provincial intensity. Goods consumed in a given province have three potential different and complementary sources. They are goods produced locally (intra-provincial trade), goods produced in another Chinese province and imported (domestic trade) or foreign products imported from an international partner (international trade). Provincial total goods absorption is thus made up by these three types of goods. A decrease in one of the component automatically corresponds to the increase in at least one of the other sources. Total goods absorption is to be computed as the sum of local goods production and goods inflow (from the rest of China and international partners) minus outflow of locally-produced goods (to the rest of China or the rest of the world), that is goods produced locally but consumed outside.

In 1987, average provincial absorption of goods was composed as follows: 34% of goods produced in other provinces, 64% of locally made products and 2% of international imports. In 1992, the percentages were respectively 27, 68 and 5%. In 1997, the importance of locally-produced goods in provincial absorption further declined to 20% while the shares of locally-produced goods and foreign goods rose respectively to 72 and 8%. Figures A, B and C in Appendix 2 detail the evolution of the absorption composition by province. These data confirm a downward trend in the intensity of inter-provincial trade since the end of the 1980s. Declining importance of domestic goods in provincial absorption is compensated by growing shares of both inter-

⁶I obtained access to domestic trade flows from provincial Input Output tables for 1987, 1992 and 1997. See Appendix 1 for details.

⁷Intra-Western Europe imports reached 18% of GDP in 1999, intra-NAFTA imports were 5.6% of GDP in 1998 while the ratio of intra-ASEAN imports to GDP was 12% in 1998.

national and locally produced goods⁸. It thus seems that the reduction in inter-provincial trade flows intensity finds its roots not only in the internationalization process but also in the increase in intra-provincial trade intensity (greater autarchy or self-sufficiency of provinces).

3 The literature on border effects

The literature on border effects has developed since the pioneering article of McCallum (1995), who shows that in 1988, gravity-adjusted trade within Canada was more than twenty times larger than similarly adjusted cross-border trade with the US. Precisely, he finds that Canadian provinces traded twenty-two times more with each other than with American states after size and distance are controlled for⁹. In a study of the years through 1996, Helliwell (1998) finds that the US-Canadian border effect declines over time, though it remains significantly large and positive.

These measures of the US-Canadian border effect were however facilitated by the exceptional availability of Canadian inter-provincial trade flow statistics. In order to extend these studies to other countries and to compensate for the unavailable trade data, Wei (1996) develops an imaginative method to approximate infra-national trade flows. He computes the trade of each country “with itself” by subtracting the country’s total exports (to foreign partners) from its total production¹⁰. This difference measures the share of national production that is “exported” to national consumers. The border effect is measured by the coefficient on the dummy variable that equals 1 for intra-national observations (and 0 otherwise). Wei considers the border effect as a global indicator of trade barriers that includes the impact not only of tariff and non-tariff barriers on trade but also of all the factors that differentiate intra-national trade (supposed to be free) from international trade and that are not controlled for in the regression.

There exist two kinds of applications of the border effects method.

⁸Guangdong, Tianjin and Yunnan are the noticeable exceptions to this trend. For these provinces, the increase in the importance of international goods in the province’s consumption went parallel with the reduction of the shares of both local and national goods.

⁹This result was confirmed by other researches. Using an updated version of the McCallum data, Helliwell (1997) estimates a similar border effect in the years 1989 and 1990.

¹⁰Total production that remains within the local boundaries (not exported) is at the same time equal to imports “from itself” and exports “to itself”. Infra-national trade is thus to be calculated as: gross value of goods production minus international exports of goods.

The first one measures internal fragmentation within a single country and thus relies on trade flows between sub-national territorial units. The second type concerns the measure of the integration of a country with its international partners. In both cases Wei's method enables to compute the 'internal trade' (of the sub-national region or of the country) that will be used as the reference level to evaluate the impediments to trade implied by the existence of a frontier between the two partners.

To measure the Canadian internal fragmentation, Helliwell (1997) uses Wei's procedure to generate Canadian provinces' trade with "themselves". The author finds a provincial border effect of 2.1, which is to be added to the national border effect of 22 to obtain the global border effect. The latter measures the extent to which inhabitants of a given province consume more local goods than goods from an unrelated American state, given size and distance.

American domestic market integration is analyzed by Wolf (1997). Despite protections guaranteed to inter-state trade by the American constitution¹¹, exchange rate fixity as well as cultural and institutional homogeneity between states, Wolf finds border effects between 3 and 4.5 depending on the specification.

The second type of study that analyzes the commercial integration between trade partners has been conducted mainly to evaluate the impact of preferential trade agreements. The Single European Act has been widely investigated. Head and Mayer (2000) focus on the magnitude of fragmentation and its causes in the European Union between 1978 and 1995. They are the first to work at a disaggregated industry-level. Their paper constitutes an innovation in that they abandon the gravity model and develop a theoretical model integrating NTBs (Non Tariff-Barriers) and heterogeneity in consumer preferences as explanatory factors of border effects¹². Their model, which we will use in this paper, is based on the monopolistic competition model of trade introduced by Krugman (1980). The authors find that European border effects decreased over time from 21 at the end of the 1970s to 11.3 in the years 1993-95. Their results confirm the positive impact of the Single Market Programme in reducing national borders effects.

¹¹In article 6 of the US constitution, the Interstate Commerce clause specifically forbids inter-state trade impediments.

¹²Formal tariff barriers (quotas and customs dues) are not taken into account since they are forbidden inside the Union since 1968.

4 The model

We follow the model used by Head and Mayer (2000) who apply the border effects method to the European countries. These authors adopt a monopolistic competition framework inspired by Krugman (1980) and derive a gravity equation from an asymmetric specification of consumer preferences. For each differentiated variety h , let c_{ijh} be the total consumption by the representative agent in province i of goods h from partner j and a_{ij} , the preference weight of consumers in i for products imported from j ¹³.

The bilateral C.I.F. value of imports of province i from partner j , m_{ij} , is obtained through the maximization of the following CES utility function under the budgetary constraint:

$$U_i = \left(\sum_{j=1}^N \sum_{h=1}^{n_j} (a_{ij} c_{ijh})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} s.t. \quad m_i = \sum_k m_{ik} = \sum_k c_{ik} p_{ik} \forall h$$

with k covering all partners so that $k=1, i, j, \dots, N$ and p_{ik} the delivery price of goods imported by i from k ¹⁴ and σ the elasticity of substitution between any two varieties.

We obtain the bilateral imports of i from j by summing imports for each variety: $m_{ij} = \frac{a_{ij}^{\sigma-1} n_j p_{ij}^{1-\sigma}}{\sum_k a_{ik}^{\sigma-1} n_k p_{ik}^{1-\sigma}} m_i$ where n_j is the number of varieties in j .

A gravity equation is derived from this expression after defining prices p_{ij} and preferences a_{ij} and after taking into account the proportionality between production v_j and the number of varieties n_j yielded by the Dixit-Stiglitz model¹⁵ in order to eliminate n_j and n_k terms in the equation.

We define the price paid by consumers in province i for goods produced in partner j as a multiplicative function of production price in j , p_j , distance between the two partners d_{ij} and barriers (tariff and non-tariff), u_{ij} , applied by province i on its imports from j so that $p_{ij} = (1 + u_{ij}) d_{ij}^\delta p_j$.

We hypothesize that trade barriers u_{ij} are null inside provinces ($j = i$) but positive if $i \neq j$. Let's call B_{ij} a dummy variable that takes the value of one when trade flows cross borders and zero otherwise, that is to say $B_{ij} = 1$ when $i \neq j$ and $B_{ii} = 0$. We obtain equation 1

¹³This consumer utilities specification allows heterogeneity in bilateral preferences and enables consumers to value products differently depending on their origin.

¹⁴It is composed of production price and transaction costs to bring goods from k to i .

¹⁵In the model of monopolistic competition, the quantity of production (noted q) is identical for every firm. With v_j the production value in j , we have the equality $v_j = qp_j n_j$ and thus $n_j p_j = \frac{v_j}{q}$.

$$m_{ij} = \frac{a_{ij}^{\sigma-1} v_j (B_{ij}(1+u)d_{ij}^\delta)^{1-\sigma} p_j^{-\sigma}}{\sum_k a_{ik}^{\sigma-1} v_k (B_{ik}(1+u)d_{ik}^\delta)^{1-\sigma} p_k^{-\sigma}} m_i.$$

We specify consumer preferences a_{ij} as composed by a domestic bias (noted DB_{ij}) and by an error term normally distributed ϵ_{ij} : $a_{ij} = \exp(DB_{ij} + \epsilon_{ij})$. We define that $DB_{ij} = 0$ when $i = j$ (intra-provincial trade) but that it is negative when $i \neq j$ so that $DB_{ij} = -\beta$. In this latter case, the representative consumer prefers local goods to outside goods and feels a positive aversion β vis-à-vis products imported from the other side of the frontier. We hypothesize that a common border mitigates this home bias so that it is null for local goods but equal to $a_{ij} = \exp(-\beta + \eta Adj_{ij} + \epsilon_{ij})$ if goods come from the outside.

Substituting for all the previously defined components in the definition of m_{ij} and transforming the equation in logarithm leads to:

$$\begin{aligned} \ln m_{ij} = & \ln m_i + \ln v_j - \delta(\sigma - 1) \ln d_{ij} - \sigma \ln p_j + (\sigma - 1) \eta Adj_{ij} \quad (2) \\ & - (\sigma - 1) [\beta + \ln(1 + u)] B_{ij} + \epsilon_{ij} - I_i \\ \text{with } I_i = & \ln(\sum_k \exp[\ln v_k - \sigma \ln p_k + (\sigma - 1)(-\delta \ln d_{ik} - [\beta - \eta Adj_{ij} + \ln(1 + u)] B_{ik}) + \epsilon_{ik}]) \end{aligned}$$

Equation 2 expresses imports of province i from partner j as a function of the importer's consumption, the exporter's production, the distance between them, production price of the supplier, the inclusive value I^{16} and border effects.

We follow Head and Mayer (2000) to solve the problematic estimation of I_i . The authors decide to transform the gravitational relation into relative terms with respect to intra-provincial trade flows. Subtracting from equation 2 its expression in the case where $i = j$, that is to say $\ln m_{ii}$, from both sides of the equality and noting $\theta = -(\sigma - 1)\delta$, the distance elasticity of trade, leads to equation 3:

$$\begin{aligned} \ln \frac{m_{ij}}{m_{ii}} = & \ln \frac{v_j}{v_i} + \theta \ln \frac{d_{ij}}{d_{ii}} - \sigma \ln \frac{p_j}{p_i} - (\sigma - 1) [\beta + \ln(1 + u)] \\ & + (\sigma - 1) \eta Adj_{ij} + e_{ij} \quad \text{with } e_{ij} = (\sigma - 1)(\epsilon_{ij} - \epsilon_{ii}) \end{aligned}$$

Equation 3 displays the allocation mode of provincial import spending between local goods and foreign goods. The constant term includes the effect of tariff and non-tariff barriers u as well as the impact of aversion to foreign goods β . This negative term measures the global border effect. It represents the deviation of observed relative trade flows from their value predicted in absence of barriers by our model.

¹⁶Head et Mayer (2000) call I_i the "inclusive value" of importer i . This term encompasses the characteristics of all potential suppliers of importer i such as their economic size, production price, distance and border effect.

We apply this model to estimate international and domestic trade integration of Chinese provinces between 1987 and 1997. We will verify the capacity of Chinese reforms to reach their initial goal of greater liberalization and spatial rationalization. We would expect to find decreasing border effects both for inter-provincial and international trade flows over the period of study. The reduction in both domestic and international trade barriers should moreover have accelerated since the deepening of the reforms in 1993. Indeed, the resolution adopted in November 1993 by the Third Plenary Session of the Central Committee to establish a “socialist market economy” aimed at alleviating remaining distortions and at extending to the rest of the country liberal policies that were until then confined to the coast.

5 Empirical estimation

application to Chinese context

We develop an original method to reconcile the model with the available data.

Chinese inter-provincial trade data are limited to trade flows between each province and the ‘rest of China’. No data on bilateral trade flows between provinces is available¹⁷. Trade data between each province and the rest of the country are extracted from provincial Input-Output tables computed by the Chinese National Bureau of Statistics. Domestic trade flows have been obtained for 27 provinces in 1987, 25 provinces in 1992 and 23 provinces in 1997. More details on the data sources are provided in appendix.

The ‘rest of China’, noted roC , differs for each considered province and can be thought of as a distinct country whose characteristics (production, production price and distance to partners) are generated as a sum or an average of the characteristics of the constitutive provinces.

The production of the ‘rest of China’ V_{roC} corresponds to the sum of productions v_j of the provinces that make up the ‘rest of China’:

$$V_{roC} = \sum_{j \neq i} v_j.$$

We deduce the formula of other ‘rest of China’ characteristics directly from our model on the ground that $m_{i-roC} = \sum_{j \neq i} m_{ij}$. Equation 1 gives us $m_{ij} = \frac{\exp(-\beta + \epsilon_{ij})^{\sigma-1} v_j (B_{ij}(1+u)d_{ij}^\delta)^{1-\sigma} p_j^{-\sigma}}{\sum_k \exp(-\beta + \epsilon_{ik})^{\sigma-1} v_k (B_{ik}(1+u)d_{ik}^\delta)^{1-\sigma} p_k^{-\sigma}} m_i$. If we

¹⁷We will not estimate the impact of provincial borders on trade flows between the provinces that they separate but in fact the effect of each province’s boundaries on its trade with all the other provinces.

simplify the notation and call $\gamma = \exp(-\beta + \epsilon_{ij})^{\sigma-1} (1+u)^{1-\sigma}$, we get $m_{i-roC} = \frac{\gamma \sum_{j \neq i} v_j d_{ij}^{\delta(1-\sigma)} p_j^{-\sigma}}{\sum_k a_{ik}^{\sigma-1} v_k (B_{ik}(1+u)d_{ik}^{\delta})^{1-\sigma} p_k^{-\sigma}} m_i$.

We hypothesize that the weighted arithmetic mean $\sum_{j \neq i} \frac{v_j [d_{ij}^{\delta(1-\sigma)} p_j^{-\sigma}]}{V_{roC} \frac{v_j}{V_{roC}}}$ can be proxied by the weighted geometric mean $\prod_{j \neq i} [d_{ij}^{\delta(1-\sigma)} p_j^{-\sigma}]^{\frac{v_j}{V_{roC}}}$ ¹⁸.

In absence of correlation between d_{ij} and p_j (we find a coefficient of correlation that is lower than 0.02), $\prod_{j \neq i} [d_{ij}^{\delta(1-\sigma)} p_j^{-\sigma}]^{\frac{v_j}{V_{roC}}}$ equals $\prod_{j \neq i} d_{ij}^{\frac{v_j}{V_{roC}} \delta(1-\sigma)} \prod_j p_j^{-\frac{v_j}{V_{roC}} \sigma} = \prod_{j \neq i} d_{ij}^{\frac{v_j}{V_{roC}} \delta(1-\sigma)} \prod_j p_j^{-\frac{v_j}{V_{roC}} \sigma}$

As a consequence, we can say that m_{i-roC} is almost equivalent to expression $\frac{\gamma V_{roC} \prod_{j \neq i} d_{ij}^{\frac{v_j}{V_{roC}} \delta(1-\sigma)} \prod_j p_j^{-\frac{v_j}{V_{roC}} \sigma}}{\sum_k a_{ik}^{\sigma-1} v_k (B_{ik}(1+u)d_{ik}^{\delta})^{1-\sigma} p_k^{-\sigma}} m_i$.

When we transform this equation in logarithm and subtract its expression in the case where $i = j$, that is to say $\ln m_{ii}$, from both sides of the equality and note $v_{j*} = \frac{v_j}{V_{roC}}$ the share of j in the output of the ‘rest of China’, we obtain:

$$\begin{aligned} \ln \frac{m_{i-roC}}{m_{ii}} &= \ln \frac{v_{roC}}{v_i} - \theta \ln \frac{\prod_{j \neq i} d_{ij}^{v_{j*}}}{d_{ii}} - \sigma \ln \frac{\prod_{j \neq i} p_j^{v_{j*}}}{p_i} \\ &\quad - (\sigma - 1) [\beta + \ln(1+u)] + e_{ij} \quad \text{with } e_{ij} = (\sigma - 1) (\epsilon_{ij} - \epsilon_{ii}) \end{aligned}$$

We deduce that the formula for effective distance between each province and the ‘rest of China’ is given by the production-weighted geometric mean $\prod_{j \neq i} d_{ij}^{v_{j*}}$ of bilateral distances d_{ij} between the province i and all the other Chinese provinces j .

The average production price inside the ‘rest of China’ equals the production-weighted geometric mean $\prod_{j \neq i} p_j^{v_{j*}}$ of production prices p_j in the provinces that form the ‘rest of China’.

results

The model corresponds to equation 3 presented above¹⁹.

Our dataset includes 869 international flows and 75 flows from the ‘rest of China’. We decompose the model’s constant into 2 elements

¹⁸Recall that $\sum_{j \neq i} \frac{v_j}{V_{roC}}$ is equal to 1. It is true that the geometric mean always yields results inferior to those given by the arithmetic mean. However, the degree of underestimation is all the lower that $d_{ij}^{\delta(1-\sigma)} p_j^{-\sigma}$ is small. In our case it is quite close to zero. In the literature, estimates of the distance elasticity of trade place $\theta = \delta(1-\sigma)$ between -0.5 and -1.5 while estimates of the elasticity of substitution between varieties σ range between 6 and 11.

¹⁹We apply the same logic as Helliwell (1997) to correctly identify the border effect and properly separate it from the common border effect. The goal is to measure the greater intensity of trade between a province and “itself” rather than with an unrelated partner (whether or not they are neighbors). As a consequence, the common border dummy variable is set equal to 0 when transactions occur between the province and “itself” or between the province and the ‘rest of China’.

depending on whether provincial trade occurs with the rest of China (inter-provincial border effect) on the one hand or with a foreign partner on the other (international border effect). The latter is a global indicator of average trade barriers on international imports. The former catches the average bias by which a Chinese province gets its supplies more from “itself” than from the rest of the country. It reflects the magnitude of domestic market fragmentation since it underlines that despite homogeneity of culture, currency, language and institutions, provincial borders impede trade flows, even after distance, prices and economic sizes are controlled for.

We start with an estimation of equation 3 of our model on pooled data (international and domestic partners for 1987, 1992 and 1997)²⁰. We decompose both international and inter-provincial border effects into 3 elements depending on the year. It allows to control for temporal heterogeneity and to study the evolution of domestic and international trade integration.

The Ramsey Reset regression specification error test for omitted variables rejects the good functional form of estimation in column 1²¹. The coefficient on the log of relative production is significantly lower than its predicted unitary value specified in the Dixit-Stiglitz version of the trade model. We suspect that econometric problems lead to an understatement of the production coefficient that in turn could bias other coefficients of interest²². As emphasized by Harrigan (1996), output and trade are jointly determined in equilibrium. This could lead to a correlation between relative production and the error term. In order to respond to the simultaneity problem, we decide to force the coefficient on the log of relative production to be one. This approach is preferred to the instrumental variables method. Not only does the imposition of a unitary elasticity on production avoid the need for instrumental variables but also it can mitigate another potential econometric problem - measurement problem for production. To the extent that the production data is inaccurate, a bias towards zero may be exhibited in the coefficient on $\ln \frac{m_{ij}}{m_{ii}}$. Depending on cross-correlations, other right

²⁰A Chow test does not reject that domestic and international trade flows can be pooled in a single regression.

²¹Probabilities of not rejecting a specification problem are given in the last line of the table.

²²Theoretically a lower than unitary value of the coefficient could arise because countries with larger production are manufactured at a greater scale. Thus, rises in relative production overstates the number of varieties offered. We however assume the theory to be correct and give priority to the econometric problems explanation emphasized by the rejection of the Ramsey Reset.

hand side variables may obtain biased coefficients as well. Moving $\ln \frac{v_i}{v_j}$ to the left hand side of equation 3 gives:

$$\ln \frac{m_{ij}}{m_{ii}} - \ln \frac{v_j}{v_i} = \theta \ln \frac{d_{ij}}{d_{ii}} - \sigma \ln \frac{p_j}{p_i} - (\sigma - 1) [\beta + \ln(1 + u)] \\ + (\sigma - 1) \eta Adj_{ij} + e_{ij} \quad \text{with} \quad e_{ij} = (\sigma - 1)(\epsilon_{ij} - \epsilon_{ii})$$

Production disappears from the right hand side and therefore can no longer cause a simultaneity problem. The restricted specification results in column 2 differ from the previous ones by attributing greater trade reduction to distance, price and domestic border effects and less to international border effects. Common border effects also become larger. The coefficient on relative price becomes significant and increases above one, in accordance with the theory. Indeed, it represents the price elasticity. The distance coefficient is quite consistent with the empirical literature. The R^2 is reduced because the explanatory power of relative production no longer contributes to the calculation. The Ramsey Reset test no longer rejects the good specification of column 2, attesting of the reliability of our border effects estimates.

The endogeneity of which province-partner pairs have positive trade has the potential to generate selection bias²³. We run estimations using Heckman's one-step procedure (Full Information Maximum Likelihood)²⁴. In every case, the non-significance of the correlation coefficient rho underlines the absence of endogeneity of the selection process with respect to our model equation.

Our results (columns 2 to 5) confirm that, all things equal, Chinese provinces have got more and more integrated with the rest of the world. The average international border effect has reduced greatly between 1987 and 1997 especially since 1992. On the opposite, the inter-provincial border effect that is a global indicator of inter-provincial trade barriers has increased over the same period. We quantify border effects following McCallum (1995) in using the ratio of imports from self to imports from others, holding other things equal. This consists in taking the exponential value of the estimated border effects. Our average indicator of impediments to domestic trade increased from 12

²³Statistical yearbooks do not provide trade flows data using an exhaustive list of international partners and could select the partners on the basis of their international status or on the basis of their diplomatic relations with China.

²⁴This method consists in simultaneously estimating a probit explaining the selection process of the positive flows and introducing Mills ratios in the estimated initial equation. Explanatory variables in the probit are the relative explanatory variables of the model, their level values as well as dummies by continent of origin of international partners and provincial dummies.

[exp(2.51)] in 1987 to 16 [exp(2.78)] in 1992 and reached 27 [exp(3.30)] in 1997. It therefore appears that Chinese provinces' international integration has gone together with domestic market disintegration.

Table 1: Chinese provinces' international and domestic Border Effects

Dependent Var.	$\ln(\frac{m_{ij}}{m_{ii}})$	$\ln(\frac{m_{ij}}{m_{ii}}) - \ln(\frac{v_j}{v_i})$				
Specification	1	2	3	4	5	
Foreign				Coastal	Interior	
Border 1987	-6.54*** (0.33)	-6.48*** (0.37)	-7.97*** (0.55)	-6.49*** (0.37)	-6.46*** (0.37)	
1992	-6.83*** (0.33)	-6.36*** (0.35)	-7.65*** (0.36)	-6.37*** (0.36)	-6.32*** (0.36)	
1997	-6.55*** (0.33)	-6.02*** (0.36)	-7.28*** (0.37)	-6.02*** (0.36)	-5.96*** (0.37)	
Domestic						
Border 1987	-1.22*** (0.22)	-2.51*** (0.21)	-3.09*** (0.20)	-1.90*** (0.29)	-2.92*** (0.18)	-2.52*** (0.21)
1992	-1.47*** (0.22)	-2.78*** (0.22)	-3.38*** (0.22)	-2.37*** (0.24)	-3.10*** (0.25)	-2.65*** (0.22)
1997	-1.93*** (0.24)	-3.30*** (0.23)	-3.91*** (0.23)	-2.93*** (0.38)	-3.52*** (0.22)	-2.91*** (0.23)
Rel. production	0.51*** (0.04)					
Rel. distance	-0.58*** (0.07)	-0.78*** (0.07)	-0.49*** (0.07)	-0.79*** (0.07)		-0.77*** (0.07)
Rel. prices	-0.29 (0.17)	-1.21*** (0.15)	-1.14*** (0.15)	-1.20*** (0.15)		-1.24*** (0.16)
Adjacency	1.77*** (0.49)	1.83*** (0.57)	2.34*** (0.55)	1.83*** (0.58)		1.85*** (0.59)
Hong Kong			2.98*** (0.22)			
Rho		-0.06 (0.14)	0.06 (0.13)	0.05 (0.13)		-0.09 (0.13)
R-squared	0.56	0.50	0.56	0.51	0.50	
Obs. Nb.	944	944	944	944	944	
Ramsey Reset	0.02	0.80	0.42	0.75	0.84	

Heteroskedastic consistent standard errors in parentheses;

*** significance at 1% level.

Our results reflect the failure of Chinese authorities to promote domestic openness and crush economic structure fragmentation along the provincial limits. The rise of Chinese provinces' domestic border effect over time contrasts with results obtained on other economies (Canada, USA, European Union, OECD). The reduction of trade flows intensity inside China can therefore be interpreted as a move towards disintegration of Chinese domestic market: locally produced goods supply a growing share of the local consumption to the detriment of goods produced in the rest of the country. This move runs counter to the logic of regional specialization according to comparative advantages and economies of scale.

As a test of robustness, we include a dummy variable that takes the value of 1 for trade with Hong Kong. Results (column 3) confirms the existence of specific trade-promoting relationships between Chinese provinces and Hong Kong. The dummy enters with a significant positive coefficient and there is a logical upward adjustment of international borders effects, since they correspond to the average home biases for international partners other than Hong Kong. Impediments to trade with Hong Kong remain however greater than those to inter-provincial flows. The average border effect between Chinese provinces and their brother territory is around 100, that is more than 5 times the average domestic border effect.

As a final step we decompose the temporal evolution of domestic border effects between coastal and inland provinces²⁵. Both categories of provinces experience a decrease in domestic trade intensity between 1987 and 1997. Maritime provinces not only benefit from favorable access to international markets and more developed transport infrastructure but also pioneered economic liberalization and international trade opening-up. The ‘coastal’ dimension can as a matter of fact be assimilated to an indicator of high reformist achievement. Expected results from the differentiation between coastal and interior provinces’ border effects are ambiguous. On the one hand coastal provinces have better transport equipment, have been less accused of autarchic behavior than the interior and rely on the rest of the country for their inputs of production (raw materials, energy...). On the other hand, their international opening could have proceeded at the expense of inter-provincial trade. Our findings support the first argument: impediments to trade are lower in coastal provinces than in interior provinces. Our indicator of domestic trade barriers is two times lower for Maritime provinces than in the rest of China. It reaches 7, 11 and 18 on the coast against 18, 22 and 34 in inland provinces in 1987, 1992 and 1997 respectively, stressing that domestic trade fragmentation is higher in interior provinces than in the coastal fringe of China. These results refute that lower inter-provincial trade is a corollary of greater international trade engagement. On the contrary, internationally engaged provinces are also the most domestically integrated.

We find that if Chinese reforms succeeded in promoting international trade openness, they failed at achieving greater domestic market integration both in coastal and interior provinces. While our indicator

²⁵The Maritime Provinces are Beijing, Tianjin, Shanghai, Hebei, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Liaoning.

of total international trade barriers dropped by 60% between 1987 and 1997 (from $\exp(6.48)$ to $\exp(6.01)$), our indicator of impediments to inter-provincial trade almost doubled.

Rawsky and Mead (1998) argue that two decades of reforms have reduced the reliability of China's statistical system -designed to aid the management of an administratively controlled, non-market economy. They contend that statistics have progressively lost track of growth for sectors such as construction, transport and services. We need to ensure that increasing understatement of domestic trade flows are not responsible for the decrease in inter-provincial trade intensity that we find²⁶. We recall that no decline in interprovincial trade is reported by our data. In fact, domestic inflows (in current yuan) doubled between 1987 and 1992 and further increased by 90% between 1992 and 1997. However, over the same periods, production was multiplied by 2.4 and 2.6 respectively. As a basis for comparison, international imports soared by a factor of 4.6 between 1987 and 1992 and of 5.2 between 1992 and 1997. Domestic trade growth thus falls behind output and international trade expansion. We make sure that this result does not stem from declining coverage of our domestic trade data. We consider a scenario where our domestic trade flows (inflows and outflows) understate the real figures by 5, 20 and 40% respectively in 1987, 1992 and 1997. We compute the re-adjusted figures and use them to estimate our model. Results (column 5) continue to display an increase in our indicator of domestic trade barriers. A linear hypotheses test rejects that 1987 and 1997 border effects are equal.

International border effects, despite their decrease, remain very high, especially with partners that do not share a border with China. We find that Chinese provinces consumed about 650 times more local goods than goods from these countries in 1987 against 400 in 1997. If the partner is adjacent, these numbers are 84% lower [$1-\exp(-1.83)$]. Our indicator of international trade barriers turns out to be huge especially in comparison with results found in other studies²⁷ and with inter-provincial border effects over the same period.

We can express the magnitude of provincial border effects based on tariff-equivalent. We need to make an assumption about the elasticity of substitution σ in order to obtain an estimate of the ad-valorem of the border effect: Exponential of [border effect/ $(\sigma - 1)$]-1. We consider

²⁶I thank Rawsky for suggesting this verification.

²⁷International border effects of Chinese provinces in 1997 turn out to be 40 times higher than the figure computed for Canadian international trade.

results obtained by Head and Ries (2002): values of σ ranging between 7 and 11²⁸. We use $\sigma = 9$ and find that the tariff-equivalent of border effects between Chinese provinces and international partners amounts to 123% in 1987 and 112% in 1997. The tariff-equivalent of impediments to inter-provincial trade is 37%, 41% and 51% respectively in 1987, 1992 and 1997.

These latter figures underline the imperfect integration of the Chinese domestic market. Indeed, impediments to inter-provincial in China are quite high. Our indicators of Chinese domestic market integration between 1987 and 1997 (border effects doubling from 12 to 27 and tariff equivalents increasing from 37% to 51%) are directly comparable with the results found for the European Union, OECD countries or the Canada-US integration. The magnitude of Chinese provinces' border effects turns out to be closer to that existing between independent sovereign countries than to that measured inside individual countries such as the US or Canada. Integration between different countries is slowed down by their nationalism, by the heterogeneity of their institutions, norms and legislations as well as by linguistic and cultural differences between them. These factors should not be existing or should less affect trade in a single unified country. The comparable magnitude of Chinese inter-provincial trade flows intensity with that of trade flows between different sovereign countries emphasizes the imperfect integration of China's domestic market. An identical tariff-equivalent of around 40% in China and in the EU during the 1990s implies a lower market integration achievement in China than in Europe. The increase of domestic border effects between 1987 and 1997 appears as an issue of concern as it proves the failure of the Chinese reforms to promote trade liberalization inside the country. Decreasing domestic trade flows intensity appears all the more alarming that it deepens the dichotomy between the interior and the coast in China. Despite a simultaneous move towards greater international trade integration and lower domestic integration, our results clearly indicate that Chinese provinces remain far more integrated with the rest of the country than with any other foreign partner, including Hong Kong. Indeed, in 1987, a Chinese province consumes on average 53 times more goods imported from the rest of the country than from the

²⁸Head and Mayer (2000) rely on $\sigma = 9$ and find a tariff-equivalent between 37 and 45% for European countries. Wei (1997) computes a tariff-equivalent of the border effect between OECD countries using $\sigma = 20$ because of the predominance of intra-industry trade in the trade flows of these countries. He finds a tariff-equivalent of 5%.

rest of world, against 15 in 1997. Our results furthermore underline that domestic fragmentation is not a corollary of internationalization since coastal provinces turn out to be the most engaged both in inter-provincial and international trade. These findings confirm that the move towards domestic fragmentation finds its roots in a tendency for self-sufficiency and autarchy notably in interior provinces in addition to a substitution effect between domestic products and international products in favor of the latter.

6 Conclusion

This study aimed at measuring the magnitude of China's domestic market fragmentation and Chinese provinces' international integration between 1987 and 1997 using the border effects method. Our results confirm the successful promotion of international trade opening of Chinese provinces by the reforms since 1987. Global barriers to international trade remain however huge, far higher than those observed between EU countries or between Canada and the rest of the world. These values confirm that despite great cuts in China's trade protection, important obstacles remain to the free entry of foreign goods into the Chinese market.

Concerning the degree of Chinese domestic market integration, we find that not only is inter-provincial trade flows intensity low but also that it has decreased between 1987 and 1997. Barriers to trade between Chinese provinces turn out to be closer in magnitude to that on international trade (within the EU or between Canada and the US) than that on trade flows within a single country (inside Canada or US). Chinese domestic market integration is low since, despite the absence of cultural, linguistic, currency, institutional differences, provincial boundaries deter trade to the same extent as borders separating sovereign countries. Provinces' consumers purchased, in 1997, 27 times more local goods than goods from the rest of the country against 16 in 1992 and 12 in 1987. This evolution underlines the failure of reforms to promote domestic integration and the growing division of Chinese domestic market into cellular sub-markets.

Even if Chinese provinces remain up to now far more integrated with the rest of the country than with any other foreign partner (including Hong Kong) and if at the current rate it would take more than 50 years to reverse the situation, our results seem to confirm the pertinence of alarming forecasts about the danger of China's move towards

internal disintegration.

Appendix 1: DATA sources

Provincial Trade with the ‘rest of China’. Input Output tables are available for 28 provinces as data are missing for Tibet, Hainan and Tchongqing. One province in 1987 (Qinghai), three in 1992 (Anhui, Heilongjiang and Inner Mongolia) and five in 1997 (Anhui, Hebei, Heilongjiang, Shandong and Guizhou) list only net outflows and are thus not useful for studying inter-provincial trade. Eleven provinces in 1992 and seven in 1997 separate inflows and outflows into domestic and foreign sectors. I have deduced domestic trade flows for the other provinces using provincial import and export data from the Ministry of Foreign Trade (MOFTEC) in Almanacs of China’s Foreign Economic Relations and Trade. Not only do the MOFTEC data match those given by the input output tables for the provinces that decompose trade flows between domestic and international but also they are the only ones available before 1992. MOFTEC is furthermore the only source of bilateral international trade flows by province. Since 1992, two additional series of international trade were released (aggregates by province, no bilateral flows): the customs series by origin/destination and the customs series by localization of the importer/exporter. The figures given by the China’s Customs Statistics for the imports are systematically superior to these from the MOFTEC²⁹. Using the former series (instead of MOFTEC data) yields lower values of imports from the ‘rest of China’ and thus is unfavorable to the argument that domestic trade is large and thus that border effects are low. We have estimated the model using the Customs data to generate the imports from the ‘rest of the country’. It leads to a slight revaluation of the domestic border effects for each year. The evolution over time is unchanged, the rise of domestic border effects between 1992 and 1997 is in fact even more rapid. Conversion from local currency to US dollars is based on exchange rates extracted from the World Development Indicators.

²⁹The potential for mismeasurement in international trade by province is well known and is discussed at length in an appendix available from the author upon request. I provide a more complete discussion of the implications on the border effect value of the imperfections of the international trade series (inclusion of services, inclusion of processing trade...). I show that these defects globally tend to overestimate the imports from the ‘rest of China’ and thus to underestimate border effects. This underestimation furthermore increases over time. In no way would the use of flawless data challenge our result of increasing barriers to domestic over the period of study. On the opposite, the correction of the imperfections would induce the amplification of the increase of our indicator of domestic trade barriers between 1987 and 1997.

International trade. Provincial international trade flows by partner are taken from Almanacs of China’s Foreign Economic Relations and Trade from the Ministry of Foreign Trade and completed by Provincial Yearbooks. Chinese Customs do not publish disaggregated data by province and partner at the same time.

Intra-provincial trade flows. Each province’s imports from “itself” m_{ii} are computed following Wei (1996)’s method, that is by subtracting the province’s total exports (to domestic and foreign partners) from production.

Prices. We approximate international production prices by aggregate price levels expressed relatively to US prices extracted from the Penn World tables. We compute Chinese provincial prices by multiplying China aggregate price level expressed relatively to US prices by the provincial deviation for the national average wage. Yearly provincial and national wages in current yuan are taken from the China statistical Yearbooks.

Production. The lack of comparable production data for every foreign country leads us to use GDP data (in current US dollars) from the World Development Indicators. Chinese provincial GDPs are taken from the China Statistical Yearbooks.

Distance between provinces and the ‘rest of China’. Bilateral distances between provinces i and j are measured on the basis of real distance by truck in kilometers between their capital cities.

International Distance. International distances between Chinese provinces and their international trade partners are computed as the ‘greater circle’ distances between their respective capital cities.

Intra-provincial distance.

The estimation of internal trading distance has become the key issue in the literature of border effects. Indeed, the computed level of internal distance directly affects the estimated border effect. Internal distance within a country or a province can be thought as the average trading distance between two random points of this country or province. The averaging procedure should however be consistent with the gravity model. Equation 1 of our empirical model determines that gravity forces not only work between Chinese provinces and their international partners but also inside Chinese provinces. The same way that international trade declines with the distance between the capital cities of the two partners, intra-provincial trade must also decline with the intra-provincial distance d_{ii} . This last condition has however not been so far integrated in the border effects calculations.

Several approaches to measure within-unit distances currently co-exist in the border effects literature. Initial papers (Wolf (1996) and Wei (1996)) employ fractions of distances to the capital cities of neighbor countries. A second strand in the literature assumes that the country has a specific geographic shape and a specific spatial distribution of the activity in order to calculate the average distance among points within the country. This approach leads to compute the internal distance as a function of the surface area. If a disk-shape is assumed, the average distance will be a fraction of $\sqrt{\text{surface area}/\pi}$. A third and more desirable method relies on actual data on the spatial distribution of economic activity within the country rather than on approximations. Notably, Helliwell and Verdier (2000) calculate internal distances of Canadian provinces as the population-weighted average of intra-city, inter-city, city-to-rural-area and rural-area-to-rural-area distances.

We agree argue that none of the methods used so far to compute internal distances is appropriate since none is derived in a manner consistent with the gravity trade model. Recall that our model imposes a constant distance elasticity of trade $\theta = -(1 - \sigma)\delta$ that should be taken into account when calculating the average distance between two points. Simple average or production-weighted average of distances between sub-sets is not appropriate.

Our goal is to develop a correct measure of intra-provincial distance without relying on arbitrary values of θ . The consistency between international and internal distances is crucial to ensure the reliability of our border effects estimates. The measurement method of internal distance therefore needs to be directly derived from our gravity-like trade model. In this paper we develop a formula for effective intra-provincial distance in China that is entirely consistent with our gravity model without imposing a specific value on θ .

We aim at calculating the internal distance of a province P . The province P corresponds to a set of points. The average intra-provincial distance D_{P-P} can be derived in two steps: first we compute the average of distances d_{ij} between a point $i \in P$ and all points j of the province P , that we note D_{i-P} . Then we aggregate D_{i-P} on all the possible points i to obtain the effective intra-provincial distance D_{P-P} .

We start from equation 1 of our model in the case where i and j are located in the province P . Recall that we assume that no barriers impede intra-provincial trade ($a_{ij} = 0$ and $B_{ij} = 0$ if i and j belong

to the same province P).

$$m_{ij} = \frac{v_j (d_{ij})^\theta (p_j)^{-\sigma}}{\sum_{k \in W} a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}} m_i \text{ with } \theta = -(1-\sigma)\delta$$

Recall that $P \subset W$ and that W corresponds to all points k in the world including points in the province P and points not located in P (either located in the rest of China or in international partners). In fact, $\sum_{k \in W} a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}$ can be decomposed in two terms $\sum_{k \in P} v_k (d_{ik})^\theta (p_k)^{-\sigma}$ and $\sum_{k \in W-P} a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}$

Let's call $VI_i = \sum_k a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}$ the inclusive value of i for the sake of simplification. We have $m_{ij} = \frac{v_j (d_{ij})^\theta (p_j)^{-\sigma}}{VI_i} m_i$

The value of imports of province P from itself m_{P-P} can be derived from m_{ij} through the following aggregation:

$$m_{P-P} = \sum_{i \in P} \left(\sum_{j \in P} m_{ij} \right)$$

We thus have

$$m_{P-P} = \sum_{i \in P} \left(\sum_{j \in P} \left[\frac{v_j (d_{ij})^\theta (p_j)^{-\sigma}}{\sum_k a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}} m_i \right] \right) = \sum_{i \in P} \left(\sum_{j \in P} \left[\frac{v_j (d_{ij})^\theta (p_j)^{-\sigma}}{VI_i} m_i \right] \right)$$

Our goal is to make some manipulations to express m_{P-P} as a function of the production in the province v_P , the production price in the province p_P , the inclusive value VI_P of the province, the total value of imports of the province $m_P = \sum_{k \in M} m_i$ and of the effective intra-provincial distance D_{P-P} so that:

$$m_{P-P} = \frac{v_P (d_{P-P})^\theta (p_P)^{-\sigma}}{VI_P} m_P$$

Let's advance step by step and perform first the summation for all the j of the province using the same methodology as when we computed the summation on all the provinces that form the 'rest of China'. If we rely on the hypotheses that the weighted arithmetic mean $\sum_{j \in P} \frac{v_j}{\sum_{j \in P} v_j} d_{ij}^\theta p_j^{-\sigma}$ can be approximated by the weighted geometric mean $\prod_{j \in P} [d_{ij}^\theta p_j^{-\sigma}]^{\frac{v_j}{\sum_{j \in P} v_j}}$ and that d_{ij}^θ and $p_j^{-\sigma}$ are not correlated, we deduce that

$$m_{P-P} = \sum_{i \in P} \left[\frac{\sum_{j \in P} \left[\frac{v_j}{\sum_{j \in P} v_j} (\sum_{j \in P} v_j) d_{ij}^\theta p_j^{-\sigma} \right]}{VI_i} m_i \right] \text{ is almost equivalent to:}$$

$$m_{P-P} = \sum_{i \in P} \left[\frac{\sum_{j \in P} v_j \prod_{j \in P} \left[(d_{ij})^{\frac{v_j}{\sum_{j \in P} v_j}} \right]^\theta \prod_{j \in P} \left[(p_j)^{\frac{v_j}{\sum_{j \in P} v_j}} \right]^{-\sigma}}{VI_i} m_i \right]$$

Let's denote $v_P = \sum_{j \in P} v_j$, we have the equation (5)

$$m_{P-P} = \sum_{i \in P} \left[\frac{v_P \prod_{j \in P} \left[(d_{ij})^{\frac{v_j}{v_P}} \right]^\theta \prod_{j \in P} \left[(p_j)^{\frac{v_j}{v_P}} \right]^{-\sigma}}{VI_i} m_i \right]$$

We can observe that the only formula for effective distance between

a point i of P and P that is derived by the model is $d_{i-P} = \prod_{j \in P} \left[d_{ij}^{\frac{v_j}{v_P}} \right]$ while the formula for production price in the province P is $p_P = \prod_j \left[p_j^{\frac{v_j}{v_P}} \right]$.

Now we need to perform the second summation, this time on all the i of the province. For the sake of simplification, let's call p_P the formula for production price of P $\prod_j \left[p_j^{\frac{v_j}{v_P}} \right]$ that is independent of i and set $d_{i-P} = \prod_{j \in P} \left[d_{ij}^{\frac{v_j}{v_P}} \right]$.

We need to rely on some hypotheses to transform equation (5) into something of the form: $m_{PP} = \frac{v_P (d_{P-P})^\theta (p_P)^{-\sigma}}{VI_P} m_P$

Recall that $m_P = \sum_{i \in P} m_i$. The first hypothesis we need to make is that for every point i in the province P , its share in the total imports of the province P is equal to its share in the total production of the province P . We thus assume that $\frac{m_i}{\sum_{i \in P} m_i} = \frac{m_i}{m_P} = \frac{v_i}{\sum_{i \in P} v_i} = \frac{v_i}{v_P}$. Multiplying equation (5) by $\frac{m_P}{m_P}$ we get

$$m_{P-P} = v_P \sum_{i \in P} \left[\frac{d_P^\theta p_P^{-\sigma}}{VI_i} m_i \frac{m_P}{m_P} \right] = v_P \sum_{i \in P} \left[\frac{v_i d_P^\theta p_P^{-\sigma}}{VI_i} m_P \right].$$

At this point of our research, we accept a simplification about VI_i that we hope we will resolve in the near future through more algebraic development.

Recall that

$$VI_i = \sum_{k \in P} v_k (d_{ik})^\theta (p_k)^{-\sigma} + \sum_{k \in W-P} a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}.$$

VI_i incorporates the influence of characteristics of all potential suppliers k of importer i such as their economic size, distance and border effect. As we have underlined above, potential suppliers k include suppliers from the province P and suppliers from the outside $W - P$. In the case of the suppliers k from outside the province, we can assume that the influence of their characteristics relative to i that is to say $\sum_{k \in W-P} a_{ik}^{\sigma-1} v_k (B_{ik} (1+u) d_{ik})^\theta (p_k)^{-\sigma}$ is equal to their influence relative to c with c being the center of the province P . As a matter of fact, we hypothesize that VI_i is the same for every i of the province P and is equal to VI_c with c being the capital city of the province. We have:

$$VI_i = \sum_{k \in P} v_k (d_{ik})^\theta (p_k)^{-\sigma} + \sum_{k \in W-P} a_{ck}^{\sigma-1} v_k (B_{ck} (1+u) d_{ck})^{1-\theta} (p_k)^{-\sigma}$$

Looking at the two components of VI_i , we understand that the first one $\sum_{k \in P} v_k (d_{ik})^\theta (p_k)^{-\sigma}$ should systematically be inferior to the second one $\sum_{k \in W-P} a_{ck}^{\sigma-1} v_k (B_{ck} (1+u) d_{ck})^\theta (p_k)^{-\sigma}$.

International distances d_{ck} if $k \in W-P$ between the center of the province and international partners are far greater than distances between two

points of the province d_{ik} if $k \in P$. The same is true for the production value: the production of any international partner v_k if $k \in W-P$ is far higher than the production of a point k in the province v_k if $k \in P$. Moreover the ‘international’ component of VI_i incorporates multiplicative positive terms (a_{ik} and $B_{ik}(1+u)$) that do not exist in the ‘local’ component.

At this point of our research let’s consider that $\sum_{k \in P} v_k (d_{ik})^\theta (p_k)^{-\sigma}$ is negligible compared to $\sum_{k \in W-P} a_{ck}^{\sigma-1} v_k (B_{ck}(1+u) d_{ck})^\theta (p_k)^{-\sigma}$ and let’s assume that

$$VI_i \approx \sum_{k \in W-P} a_{ck}^{\sigma-1} v_k (B_{ck}(1+u) d_{ck})^\theta (p_k)^{-\sigma} \text{ and therefore that}$$

$$m_{P-P} \approx v_P \sum_{i \in P} \left[\frac{\frac{v_i}{v_P} d_{i-P}^\theta p_P^{-\sigma}}{\sum_{k \in W-P} a_{ck}^{\sigma-1} v_k (B_{ck}(1+u) d_{ck})^\theta (p_k)^{-\sigma}} m_P \right].$$

We have expressed VI_i in a manner independent of i but dependent on the center c of the province P . In fact, we have considered that VI_i is an approximation to VI_P .

$$\text{We therefore have } m_{P-P} \approx \frac{v_P p_P^{-\sigma} m_P}{VI_P} \sum_{i \in P} \left[\frac{v_i}{v_P} d_{i-P}^\theta \right].$$

Approximating the weighted arithmetic mean $\sum_{i \in P} \frac{v_i}{v_P} d_{i-P}^\theta$ by the weighted geometric mean $\prod_{i \in P} d_{i-P}^{\frac{\theta v_i}{v_P}}$, we obtain $m_{P-P} \approx \frac{v_P p_P^{-\sigma} m_P}{VI_P} \left[\prod_{i \in P} d_{i-P}^{\frac{\theta v_i}{v_P}} \right]^\theta$.

In China, provinces are administratively sub-divided into prefectures. We compute the intra-provincial distance as the production-weighted geometric mean of bilateral distances between prefectures of provinces. Let l and m be the prefectures of province i we have : $d_{ii} = \prod_{l \in i} d_{il}^{\frac{v_l}{v_i}}$ with $d_{il} = \prod_{m \in i} d_{lm}^{\frac{v_m}{v_i}}$. Data on GDP of provincial prefectures are taken from *Cities China 1949-1998*. Bilateral distances between prefectures l and m are measured on the basis of real distance by truck in kilometers between their capital cities.

Appendix 2: Repartition of absorption

Figure A: Importance of international goods in provinces' absorption

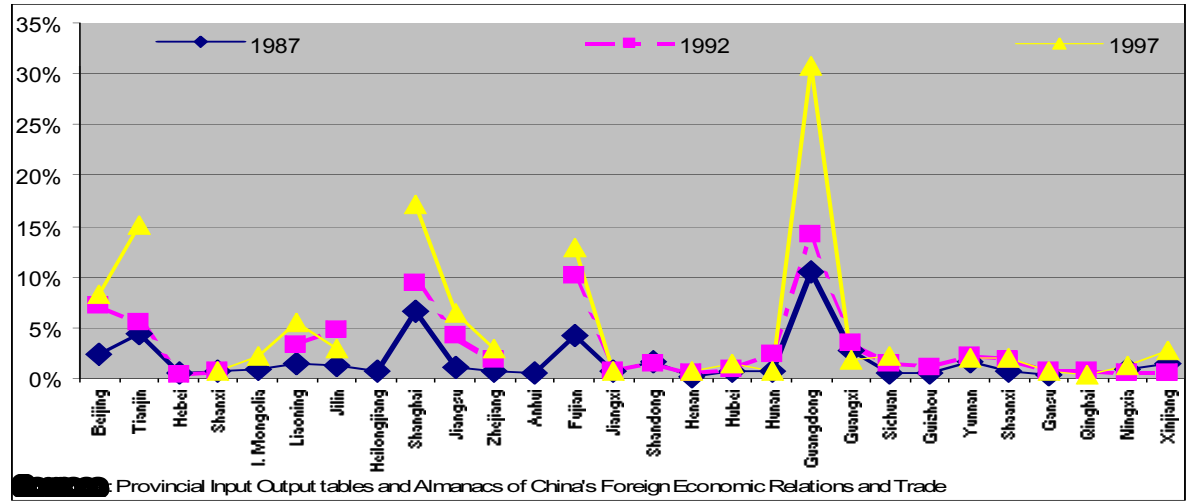


Figure B: Importance of goods from the rest of China in provinces' absorption

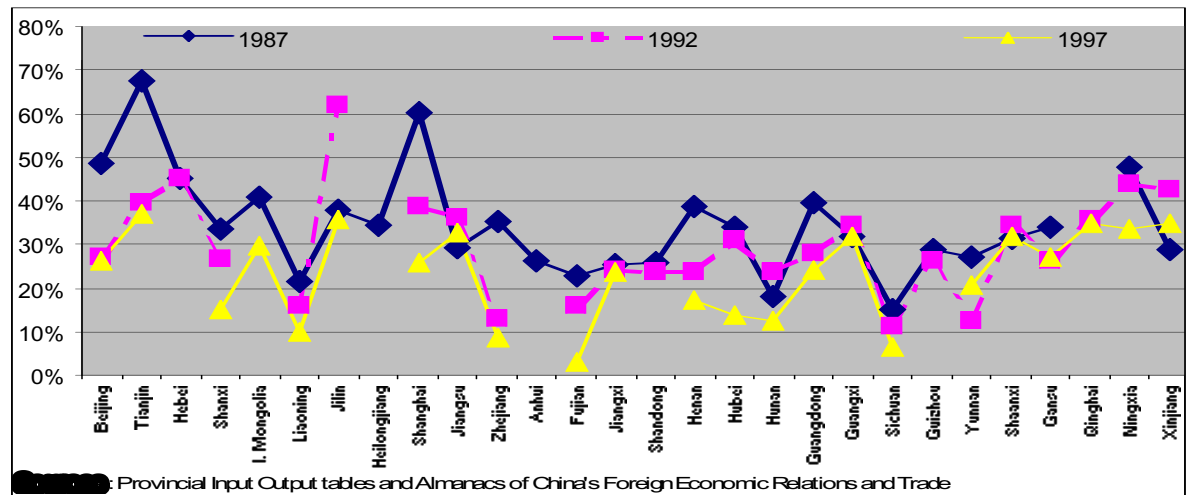
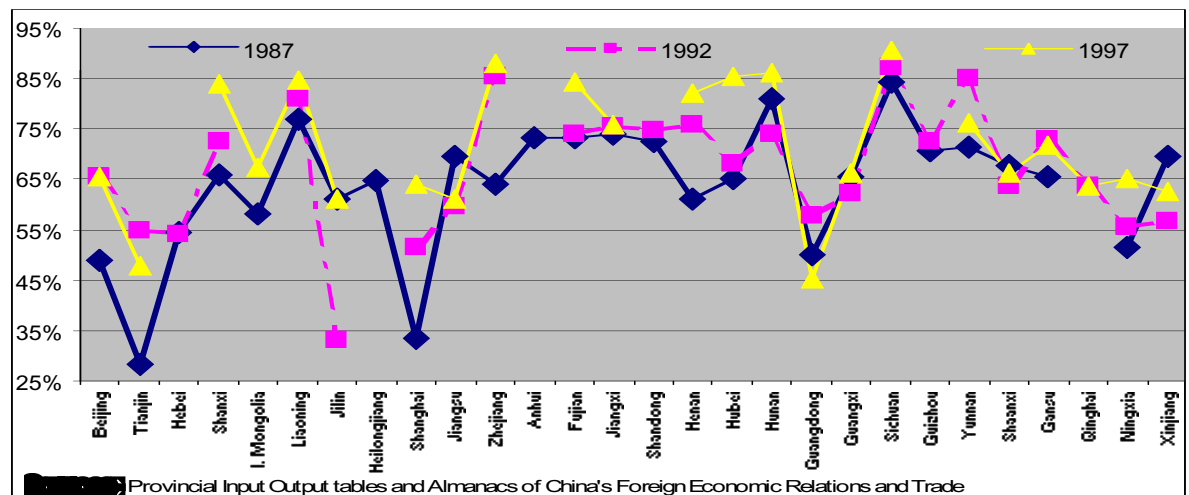


Figure C: Importance of local goods in provinces' absorption



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