Inter-Regional Trade Barriers

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Abstract

A gravity equation is derived from a general equilibrium inter-provincial trade model to fit into Chinese context. It takes into account of producers' preference as indicated by price discrimination, which introduces rich information to the gravity equation. It allows us to apply data with higher frequency and better availability in measuring the inter-regional trade barriers. We find that although inter-regional trade barriers increase in some periods, the main trend is decreasing especially after 1998.

I. Introduction

The debate on regional integration in China has raised interest of late. Young (2000) found that industry production converged while price diverged during the reform period up to 1997, which indicated that China experienced regional fragmentation while opening up internationally. His conclusion is confirmed by Poncet (2003, 2005) from the perspective of trade in goods. Building upon the gravity equation developed by Head and Mayer (2000) in measuring market fragmentation in the EU, Poncet found out that while Chinese provinces became more integrated with the rest of the world the inter-provincial barriers actually increased during the period of 1987 to 1997.

Their arguments however are challenged by recent research with up-to-date data, which generally concluded the reverse. A national-wide survey covering extensive industries and ownership types by the Development Research Center (2003) suggested the regional integration had increased since 1980 especially since 1994 when China reformed its taxation system. S. and R. Herd (2005) examined the role of private sectors during the period of 1998-2003 and pointed out that the barriers are falling. Moreover Fan and Wei (2003) compared the regional price deviation in China with that in US and Canada and find the

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evidence of relative price convergence, which further prove the increasing regional integration.

While most current literature tends to measure the degree of integration from the production concentration or price concentration, they ignore the interactions between provinces. There's a branch of research that aims to tackle such correlation. It focuses on the interregional spill-over effects, which measure the magnitude of output in one province that's contributed by the output growth from other province(s). This group of research generally confines interest on the GDP linkage only (e.g. Ying, 2000; Brun et al., 2002; Groenewold et al. 2007), leaving fundamental driving forces such as inter-provincial trade flows aside. In another word, they empirically test the spill-over effect without clarifying the mechanism through which the spill-overs take place. Meng and Qu (2007) extend the spill-over model to counter such shortage and come up with the Chinese regional dispersion power and sensitivity degree in their paper. Poncet (2003) was able to capture the essence of trade flow in determining the trade barriers. Their analysis however is limited to the availability of the China's Interregional Input-Output Table. The data is published with a long time lag, which stop researcher from doing up to date analysis. Besides, the data frequency is 5 years, which limited sample size and truncated too much information during the 5 years.

Has China become more integrated or segmented? To answer this question, we would like to focus on the regional interdependence and the relation between such interdependence and economic growth, which is important however neglected by most of current literature. A pioneer work has been done by Poncet (2003). Her method although reconciled the gravity equation with the available data in China can be questionable in both the approximation and data frequency. In order to fit gravity equation into Chinese context, Poncet (2003) actually approximated the aggregated trade flows for each province to the rest of China by its geometric mean, which can be severely bias when the trade flows are quite diversified. The trade flow data she applied provides only a small episode on the long history. It would be much ideal if we can use higher frequency data to capture a whole picture of historical development. This paper aims to compensate these two problems.

To apply information beyond inter-provincial trade flows, we need to explore more information sources. Inspired by Head and Mayer (2000) and Bergstrand (1986), we consolidate the general equilibrium framework with gravity equation. With Head and Mayer (2000)'s model, we takes into account of the economic fundamentals of interdependence such as trade flows. Stimulated by Bergstrand (1986) general equilibrium framework, we capture the economic activity from the producers' aspect. Furthermore, we introduce the price discrimination, a mechanism for producers to maximize their profit or market share, to capture producers' preference. The model derivation allows us to apply information that is not limited to the China's Interregional Input-Output Table. It represents a significant methodological departure from current literature by developing a gravity equation that readily allows us to make use of up-to-date information.

The remainder of this paper is organized as follows. Section 2 describes the regional interaction model. Section 3 describes our dataset. Section 4 provides the empirical evidence on the connection between economic growth and regional dependence. Section 5 concludes.

II. Model

Our model build upon Head and Mayer (2000)'s, which is originally applied in analysing border effect in European countries, and is inspired by the work of Poncet (2003) and Bergstrand (1986).

Most gravity equations are derived from an asymmetric specification of consumer preference, leaving the asymmetric specification of producer preference aside, since the demand of region i from region j is the essentially the supply of region j to region i. However in the application of Chinese context with limited data availability on regional domestic export and import, more information should be included in the gravity equation.

Given the domestic provincial trade data are calculated as the aggregated trade flow between each province and the 'rest of China', Poncet (2003) approximate the characteristics of the 'rest of China' (such as GDP, Price Level) with their production-weighted geometric mean. Her method reconciled Heand and Mayer(2000)'s model with the limited data in China. It's however questionable in the sense of approximation validity. In order for the geometric mean to equal to the arithmetic mean, which is originally captured by the model, the bilateral trade flows should be the same for each province. The more balanced the bilateral trade flow between each province to 'the rest of China' is, the closer geometric mean to the arithmetic mean is. Unfortunately, the trade flows distributions from one province to the others are always quite diversified (further data evidence), leading to an upward bias in such approximation.

Our method compensate such approximation bias. Moreover, it allows us to use more readily-available data other than the limited data on interprovincial trade flow. By applying the general equilibrium framework, we not only account for the consumer preference, which is well described by current literature, but also take into account of producer's preference, which we call price discrimination. While consumers are bias towards home products, producers don't necessarily set the price in favour of their home region. Instead, they may sell at a lower price in other region than their home region due to the concern of market share, profit margin, etc. They can also sell higher in province with high living expenditure and lower vice versa. Such price discrimination is more on firms' decision level, which we take into account without really specifying its component. It can either magnify or mitigate interprovincial trade barriers.

A. Demand of Region i – The Role of Importer

The demand by consumers in region i is satisfied by local products as well as products imported from other regions. Follow Head and Mayer (2000)'s model specification, consumers' utility function is given by:

$$U_i = \left(\sum_{j=1}^{N} \sum_{h=1}^{n_j} \left(a_{ij} x_{ijh} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (1)$$

S.t.

$$m_i = \sum_{k=1}^{N} m_{ik} = \sum_{k=1}^{N} x_{ik} p_{ik} \quad (2)$$

where a_{ij} denotes the preference weight for consumers in region i for products imported from region j; h refers to the goods variety, with a total number of n_j; x_{ijh} represents the total consumption of good h imported from region j by consumers in region i; σ is the elasticity of substitution between any two varieties; p_{ik} is the price paid by consumers in region i for goods imported from region j; m_{ik} stands for the imports value of region i from region j that maximize consumers' utility; m_i is the total consumption constraint or the wealth in regional level.

Solving the utility maximization problem leads to the demand function of region i for all goods imported from region j:

$$x_{ij}^{D} = \frac{a_{ij}^{\sigma-1} n_j p_{ij}^{-\sigma}}{\sum_{k=1}^{N} a_{ik}^{\sigma-1} n_k p_{ik}^{1-\sigma}} m_i. \qquad (3)$$

The bilateral imports value of region i from region j by summing for all varieties can be expressed as

$$m_{ji}^{D} = \frac{a_{ij}^{\sigma-1} n_j p_{ij}^{1-\sigma}}{\sum_{k=1}^{N} a_{ik}^{\sigma-1} n_k p_{ik}^{1-\sigma}} m_i. \qquad (4)$$

As specified by Head and Mayer (2000), the ad valorem barriers of φ for all cross-border trade. What's different here is that we take into account of price discrimination. We assume that producer sells their products to the representative distributers in each province with different price for the purpose of maximizing profit or market share. The distributers pay for transportation cost and sell them to consumers in their representative regions. Denote p_j as the mill price, d_{ij} the distance between region i and j and F_{ij} the indicator variable taking a value of one when $i \neq j$ and 0 vice versa, p_{ij} -the price paid by consumer in region i for goods imported form region j is given by:

$$p_{ij} = (1 + \varphi F_{ij}) d_{ij}^{\delta} b_{ij} p_j \qquad (5)$$

where $b_{ij} p_j$ is the price received by representative distributers in region i , $(1 + \varphi F_{ij}) d_{ij}^{\delta}$ is the transportation cost.

Again, following Head and Mayer (2000)'s specification, we borrow the results of Dixit and Stiglitz (1977) and define the number of varieties of goods as:

$$n_j = {}^{v_j}/_{q p_j}, \qquad (6)$$

Where v_j is the production value in region j and q is the production size that is assume to be identical for every firm.

Given the home-bias phenomenon in international trade, we assume the same tendency in provincial level, that is consumers to prefer goods produced in their residence. The consumption preferences a_{ij} is defined as:

$$a_{ij} = \exp(e_{ij} - \tau F_{ij}), \qquad (7)$$

where e_{ij} is a random component and τ measures the degree of home-goods bias.

B. Supply of Region *i* – The Role of Exporter

This part is enlightened by Bergstrand (1986)'s general equilibrium model of international trade. We apply such idea into China domestic inter-provincial trade and add the price discrimination. In region i, firms maximize their profit function:

$$\pi_i = \sum_{k=1}^{N} \sum_{h=1}^{n_i} x_{kih} b_{ki} p_i - W_i R_i \qquad (8)$$

s.t.

$$R_i = \left(\sum_{k=1}^{N} \sum_{h=1}^{n_i} (x_{kih})^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \qquad (9)$$

and

$$m_i = W_i R_i \qquad (10)$$

where R_i is the amount of resources in region i, which is allocated to produce different types of goods that maximize firms' profit; W_i is the value of a unit of R_i, p_j is the mill price, and x_{ki} is the amount of goods produced in region i exported to region j. The total consumption m_i in the previous part is equivalent to the income constraint here, which is determined by its natural endowment in region i. Notice that we introduce b_{ki} to capture the price discrimination across regions, $b_{ki} p_i$ is simply the price received by firms for goods selling to region j, and m_i as defined previously is the regional wealth.

Solving the profit maximization problem leads to the functions of bilateral supply and export flow value:

$$x_{ji}^{S} = \frac{b_{ji}^{\gamma}}{\sum_{k=1}^{N} b_{ki}^{\gamma}} m_i \qquad (11)$$

$$m_{ji}^{S} = \frac{b_{ji}^{\gamma} p_{ji}}{\sum_{k=1}^{N} b_{ki}^{\gamma}} m_i \qquad (12)$$

C. Equilibrium and Bilateral Net Export of region *i*

Assuming N^2 equilibrium conditions:

$$x_{ij} = x_{ij}^{S} = x_{ij}^{D}, i, j = 1, \dots, N \qquad (13)$$

Where x_{ij} is the actual trade flows from region j to i.

It implies that:

$$\frac{a_{ij}^{\sigma-1} n_j p_{ij}^{-\sigma}}{\sum_{k=1}^{N} a_{ik}^{\sigma-1} n_k p_{ik}^{1-\sigma}} m_i = \frac{b_{ij}^{\gamma}}{\sum_{k=1}^{N} b_{ki}^{\gamma}} m_j \qquad (14)$$

When i equals to j, we have:

$$\frac{a_{ii}^{\sigma-1} n_i p_{ii}^{-\sigma}}{\sum_{k=1}^{N} a_{ik}^{\sigma-1} n_k p_{ik}^{1-\sigma}} = \frac{b_{ii}^{\gamma}}{\sum_{k=1}^{N} b_{ki}^{\gamma}} \qquad (15)$$

Dividing equation (14) with equation (15) leads to:

$$\frac{a_{ij}^{\sigma-1} n_j p_{ij}^{-\sigma}}{a_{ii}^{\sigma-1} n_i p_{ii}^{-\sigma}} m_i = \frac{b_{ij}^{\gamma}}{b_{ii}^{\gamma}} m_j \qquad (16)$$

Using the facts that $p_{ij} = (1 + \varphi F_{ij}) d_{ij}^{\delta} b_{ij} p_j$, $a_{ij} = \exp(e_{ij} - \tau F_{ij})$, and $n_j = \frac{v_j}{qp_j}$, the equation is reduced to:

$$\frac{a_{ij}^{\sigma-1} \frac{v_j}{qp_j} \left[(1+\varphi F_{ij}) d_{ij}^{\delta} b_{ij} p_j\right]^{-\sigma}}{a_{ii}^{\sigma-1} \frac{v_i}{qp_i} (d_{ii}^{\delta} b_{ii} p_i)^{-\sigma}} m_i = \frac{b_{ij}^{\gamma}}{b_{ii}^{\gamma}} m_j \qquad (17)$$

Which is equivalent to:

$$(1 + \varphi F_{ij})^{-\sigma} \left(\frac{d_{ij}}{d_{ii}}\right)^{-\sigma\delta} \left(\frac{\exp(e_{ij} - \tau F_{ij})}{\exp(e_{ii}),}\right)^{\sigma-1} \frac{v_j}{v_i} \left(\frac{p_j}{p_i}\right)^{-1-\sigma} \left(\frac{b_{ij}}{b_{ii}}\right)^{-\sigma-\gamma} = \frac{m_j}{m_i} \qquad (18)$$

Taking log of both sides lead to:

$$ln\frac{m_j}{m_i} = ln\frac{v_j}{v_i} - (1 + \sigma) ln\frac{p_j}{p_i} - \sigma\delta ln\frac{d_{ij}}{d_{ii}} - (\sigma + \gamma) ln\frac{b_{ij}}{b_{ii}} - \sigma ln(1 + \varphi F_{ij}) - (\sigma - 1)\tau F_{ij} + (\sigma - 1)(e_{ij} - e_{ii}) \qquad (19)$$

Notice that constant term consists of the relative price discrimination - $\frac{b_{ij}}{b_{ii}}$, the ad valorem cross-province-border barriers - φ and the effect of residence-bias preference (or aversion to non-residence goods). It represents the overall interprovincial trade barriers, which is expressed by:

$$c = -(\sigma + \gamma) ln \frac{b_{ij}}{b_{ii}} - \sigma ln\left(1 + \varphi F_{ij}\right) - (\sigma - 1)\tau \mathrm{F_{ij}} \qquad (20)$$

The first components can be either positive or negative, the second is negative and the last is positive when $\sigma < 1$ and negative when $\sigma > 1$, which is implied by Poncet (2003). So the sign c can be positive or negative. Although the sign can't be decided, the relation between c and overall barriers can be identified. The higher the relative price discrimination, the higher the barrier, and thus the smaller c is. The higher the cross-province-border barriers, the smaller c is. If we take the stand of Poncet (2003) and define $\sigma > 1$, the more averse residents are to goods from other regions, the higher the barrier, and the smaller c is. Therefore, a small c indicates high barriers. In another word, a large c indicates low barriers.

III. Data and Measurement

The wealth and production value are measured by provincial GDP and gross industrial production value individually. While Poncet (2003) used the provincial wage deviation from national average, we approximate the mill price level with the provincial living expenditure. The advantages of applying living expenditure instead of wage deviation are two folds. First, the wage reported doesn't reflect labour's market price. This is especially true for wages reported by state-own enterprises, in which salary counts for a small proportion of workers' total income (sometimes even less then ½). Living expenditure doesn't have such problem. Second, firms employ both worker and capital in their production. Compared with wage which evaluates only price level in labour market, living expenditure, as a measure of overall price level, better reflects the mill price. All these data are extracted from All China Marketing Resarch.

The intra-provincial distance is measured on the basis of real length by railway between their capital cities. The bilateral distance between Hainan and the other provinces are approximated according to the longitude and magnitude.

Notice the model capture the relative value not the absolute value, we have to pair every bilateral trade relation. Excluding Hongkong, Taiwan and Macau, there're 31 provinces left, which compose 465 pairs of bilateral trade relations. The intra-provincial relations are abandoned to make sure the relative value is greater than 0. The reverse relations are not included to avoid duplication. For example, if the relation between Beijing and Tianjin are included in the sample, we will not calculate the relative value between Tianjin and Beijing. The bilateral relations are essentially the same from an economic point of view. However, their relative values as captured by the model are different. The consequence of including the bilateral relations in two expressions as represented by the different relative values is left for future discussion.

The sample period is from 1985 to 2006. The total number of observations is 10230. A summary statistics for the relative value are displayed in Table 1.

Table 1 – Statistics Summary

Variable	N	Mean	Standard Deviation	Min	Max
Relative Wealth	10230	4.770188	9.092405	0.055097	102.4289
Relative Production	10230	19.67403	85.7405	0.007502	1340.377
Relative Price	10230	1.097151	0.3462944	0.39436	2.447345
Bilateral Distance	10230	11.90924	12.13289	0.591857	96.86133

IV. Estimation Results

We first run regression on Eq. .. on pooled data. Following Poncet (2003), to avoid a correlation between relative production and error term, we constrain the coefficient on the log of relative production to be 1 by moving the relative production to the left of the equation. By specifying the dependent variable as $ln\frac{m_i}{m_j} - ln\frac{V_i}{V_j}$ and run the same regression again. The results for the two dependent variables are shown in Table 2.

The constants – a measurement for overall barriers are reported every year, so as to demonstrate the barriers' historical path. The coefficients for relative production, relative price and relative distances are reported as the time-series average of cross-section regression. Notice that the first estimation shows a higher R-squared than the second estimation.

Table 2 – China Inter-Provincial Trade Barriers

Following Poncet (2003), the dependent variables are set to be $ln\frac{m_i}{m_j}$ and $ln\frac{m_i}{m_j} - ln\frac{V_i}{V_j}$ separately. Barrier reports the yearly constant from the pooled in regression. Its t-value is reported after constants. The coefficients and t-value for the relative production, relative price and relative distance are the time-series average of cross-section regressions. The R-squared is the pooled in overall indicator. Unlike what's in Poncet (2003), our results shows a better model specification using dependent variable $ln\frac{m_i}{m_j}$. The total number of observations is 10230.

Dependent Variable Specification	$ln\frac{m_i}{m_j}$		$ln\frac{m_i}{m_j} - ln\frac{V_i}{V_j}$	
Barrier	Coefficient	t-value	Coefficient	t-value
1985	0.270	5.186	0.422	5.215
1986	0.206	3.999	0.294	3.491
1987	0.231	4.549	0.328	3.912
1988	0.252	5.147	0.310	3.813
1989	0.289	5.828	0.359	4.499
1990	0.296	5.861	0.351	4.291
1991	0.304	6.074	0.366	4.546
1992	0.280	5.524	0.330	3.953
1993	0.258	4.958	0.301	3.520
1994	0.233	4.452	0.258	2.889
1995	0.250	4.958	0.273	3.055
1996	0.227	4.768	0.239	2.799
1997	0.231	4.595	0.237	2.738
1998	0.344	6.254	0.332	4.902
1999	0.348	6.328	0.388	5.425
2000	0.335	5.937	0.373	5.063
2001	0.327	6.327	0.376	4.967
2002	0.312	6.374	0.375	4.859
2003	0.320	6.689	0.391	4.892
2004	0.315	5.762	0.376	4.275
2005	0.311	5.992	0.345	3.963
2006	0.266	5.040	0.188	2.297
Relative Production	0.282	64.298		
Relative Price	-0.058	-0.756	-0.309	-3.321
Relative Distance	-0.121	-5.132	-0.257	-7.082
R-squared	0.906		0.163	
N	10186		10186	

A. Barriers Analysis

Start with the analysis of the constant term. Notice that it's all positive and significant across our sample period, which indicates the dominance of price discrimination in composing inter-provincial barriers. Have a glance of the historical path of c in Figure 1. It increases from late 80s to early 90s, then falls until mid 90s, re-bounces in late 90s, followed by a gradual fall. To have a more direct vision on the barriers see Figure 2. The historical path shows that inter-provincial barriers increase generally during the period of 1991 to 1996 and the period of 1999 to 2006. It falls sharply in 1998 and gradually picks up after 1999, which may be the consequence of taxation system reform in 1994. It could be the overshooting reaction of barriers to tax-system reform. But since the barriers drop far beyond what's optimal, it gradually adjusts upwards. However the average inter-provincial barriers are still below the historical level as far as our sample period is concerned.

In summary, the trade barriers fluctuate but generally in the trend of decreasing. It increases after 1999, however remains to below historical average.

Figure 1 - Historical Path for Inter-provincial Barriers

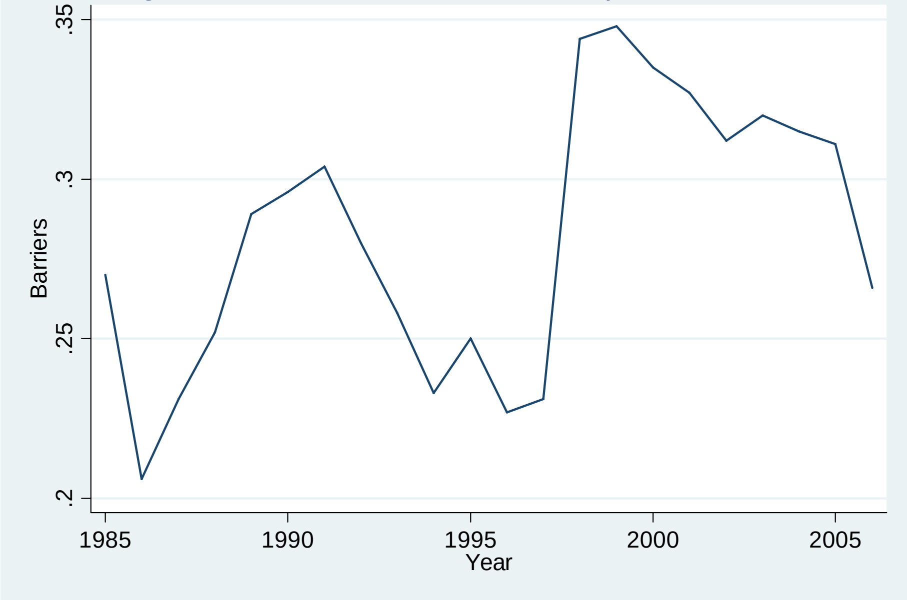
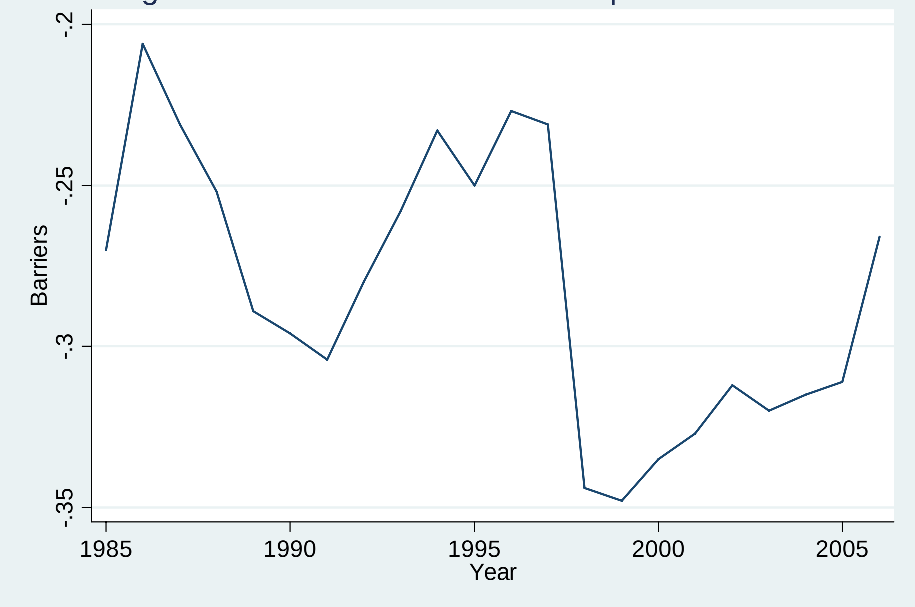


Figure 2 - Historical Path for Inter-provincial Barriers



B. The Impact of Relative Value

The coefficient for relative production and relative distance are significant, but not the coefficient for relative price. It indicates that the differentiation in mill price doesn't have a significant effect in the regional wealth diversification.

V. Conclusion

Base on the pioneer work by Bergstrand (1986), Head and Mayer (2000) and Poncet (2003), we derive a gravity equation within the framework of general equilibrium. It not only accounts of consumers' preference but also producers'. By doing so, we are able to estimate the inter-regional barriers without using the Chinese interprovincial trade data, which is limited to trade flow between each province and the rest of China and published with a long time-lag and low frequency.

Applying the data from 1985 to 2006, we find that the trend of inter-regional barriers is decreasing in the long run. They drop sharply followed the tax-system reform and gradually pick up afterwards. Despite the increase after 1999, the trade barriers are still below the historical average, although it's picking up. Notice however the cause and effect remains to be investigated.

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