NO RAZOR'S EDGE: REEXAMINING ALWYN YOUNG'S EVIDENCE FOR INCREASING INTERPROVINCIAL TRADE BARRIERS IN CHINA

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Abstract—Alwyn Young (2000) argues that barriers to interprovincial trade in China have increased during the reform period. This paper critically examines each of his five arguments and the evidence he presents. In all five instances, the argument is problematic and the evidence not robust. A comparison with the United States shows the Chinese evidence to be well within the range of that of a normal, relatively integrated large economy.

I. Introduction

SOMEWHERE, far away, is a strange country. It is marked by interprovincial trade embargoes, provincial governments trying to bid away each other's rents, silkworm cocoon wars, and a system of medieval roadblocks at which special charges are levied on trade. It is a country where local fiefdoms fiercely defend their enterprises against imports from other fiefdoms. At least that is what Alwyn Young (2000) wants us to believe. This scenario of all-out interprovincial (trade) war contrasts with an alternative scenario of sporadic protectionist measures in some provinces in the case of some products in some years.

Young presents his argument of increasing local protectionism in China in the context of how new distortions are created in the process of transition:

> In a partially reformed economy, distortions beget distortions. Segments of the economy that are freed from centralized control respond to the rent-seeking opportunities implicit in the remaining distortions of the economy. The battle to capture, and then protect, these rents leads to the creation of new distortions, even as the reform process tries to move forward. In this paper I illustrate this idea with a study of the People's Republic of China. (2000, p. 1091)

The idea that distortions beget distortions, that is, that changes in a partially reformed economy lead to the appearance of new distortions, appears nonfalsifiable. Changes to any economic system surely create some new opportunity for rent seeking. Precluding new opportunities for rent seeking may not even be desirable. Qian Yingyi (2003) argues that the intentional creation of efficiency-enhancing and interest-compatible "transitional institutions" accounts for China's overall reform success; it is not an argument against fostering best-practice institutions, but against "simplistic and naive views on institutional reform" (p. 330). This paper does not question that distortions can beget distortions.

This paper focuses on the content of Young's study: the argument for increasing local protectionism in China. I examine Young's argumentation and his evidence.

Young's article is preceded by a World Bank (1994) study on internal market development in China and followed by a dozen research articles that have attempted to analyze local protectionism in China, using a range of different measures. The conclusion on protectionism is mixed, but mostly in favor of decreasing local protectionism in the reform period.[1] Young's study, with its finding of increasing local protectionism, appears to be the most comprehensive as well as the most influential study of provincial trade barriers in China. He starts out by presenting an economic rationale for increasing local protectionism in China in the reform period and by providing anecdotal evidence of trade barriers. This is followed by four types of quantitative evidence that are all interpreted as signaling increasing trade barriers; evidence on cross-provincial (1) output convergence, (2) price divergence, (3) convergence in relative output (primary sector output divided by secondary sector output) combined with divergence in relative labor productivity and labor allocation, and (4) movements in grain yield or agricultural labor against comparative advantages.

Denoting trade barriers by p and the evidence by q, the arguments run as follows:

$$p \rightarrow q_1(q_2, q_3, q_4, q_5).$$

$$q_1(q_2, q_3, q_4, q_5) \text{ is.}$$

Therefore p is.

This is the fallacy of affirming the consequent. If one nevertheless proceeds along these lines, ideally, a strong argument is made as to why the causal link between p and q is plausible, and alternative explanations of q are ruled out. In Young's analysis, the causal links are weak and

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I apologize to Alwyn Young for picking apart what must have been painstaking work, but the issue of interprovincial trade barriers in China has been taken much more seriously, by Alwyn Young and others, than I think it deserves. I am deeply indebted to anonymous referees for their comments.

[1] Poncet (2003, 2005, 2006) finds increasing protectionism. Xiaobo Zhang and Kong-Yam Tan (2004) conclude on convergence in product and labor markets but fragmentation in the capital market. Li, Liu, and Chen (2005) find decreasing local protectionism in product markets. Bai et al. (2004), based on output patterns, conclude that "history plays the most important role in determining the degree of regional specialization, followed immediately by protectionism." Park and Du (2003) question two aspects of Young's study to find little empirical support that Chinese markets became less integrated in the reform period. Fan and Wei (2005), as well as Xu and Voon (2003), conclude on price convergence. Xu (2002) finds output growth convergence. Naughton (2003) reports growth of interprovincial trade in 1987–1992 exceeding growth in GDP and foreign trade, but acknowledges that significant barriers still exist to the movement of factors of production and to trade in services and intermediate goods.

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attempts to rule out alternative explanations are limited. The evidence (q) is not robust.

This paper proceeds in parallel to Young's paper and examines his qualitative and four quantitative arguments one by one. For each of these, I:

- Question the causality from p to q as presented by Young and provide an equally, if not more, convincing argument in favor of an alternative cause (say, p^*) of the observed q.
- Question the robustness of Young's evidence q.
- Show that the q observed in China lies well within the range of that of a normal, relatively integrated large economy in that it resembles the q' observed in the United States.

Separate appendixes with technical background information and additional arguments and evidence are posted at http://www.mitpressjournals.org/doi/suppl/10.1162/rest.91.3.599.

II. The Rationale for Cross-Provincial Trade Barriers

Young offers the following rationale for increasing provincial trade barriers:

> Under the plan, prices were skewed so as to concentrate profits, and hence revenue, in industry. As control over factor allocations was loosened, local governments throughout the economy sought to capture these rents by developing high margin industries. Continued reform, and growing interregional competition between duplicative industries, threatened the profitability of these industrial structures, leading local governments to impose a variety of interregional barriers to trade. Thus, the reform process led to the fragmentation of the domestic market and the distortion of regional production away from patterns of comparative advantage. (p. 1091)

He provides qualitative evidence for trade barriers in form of a "silkworm cocoon war" story for the late 1980s and refers to numerous Chinese newspaper and journal articles, as well as state regulations, that report trade barriers.[2]

A. *Causality*

The incentive mechanism for local governments to erect trade barriers that Young presents appears increasingly irrelevant, which would imply a decrease rather than an increase in the likelihood of trade barriers over time. Young writes that in the prereform period, "industry was paramount as a source of revenue," and "the sector still accounted for almost half of all budgetary revenue in 1995" (p. 1096). But any "paramount" role of industry as a source of revenue appears to have vanished by about 1990. In 1978, industry accounted for 42% of GDP but 75% of government budgetary revenues. By 1985, the two percentages were, respectively, 38% and 64%, by 1990 37% and 41%, and by 1995 42% and 44%. In other words, between 1990 and 1995, the share of government budgetary revenues from industry roughly corresponded to the share of industrial value added in the economy.[3] This revenue trend suggests that Young's incentives for provincial trade barriers diminished continuously over the reform period.[4]

Second, Young's starting point is problematic in that evidence of extensive trade barriers in the prereform period abounds, again questioning the likelihood for trade barriers to increase in the market-oriented reform period. Thomas Lyons (1990), in assessing the prereform planning system, writes of depressed interprovincial trade among noncentral agents and excessive interprovincial trade among central agents, i.e., a highly distorted trading system. Comparing transportation and output growth, Lyons (1985, 1986) argues that China's economic growth between the mid-1950s and the late 1970s to early 1980s was characterized by a tendency toward local self-sufficiency. In the Maoist period, no more than a few hundred types of producer goods were ever centrally planned, with only about one-fourth of national income originating in units controlled by the central portions of the planning system. Lyons quotes Chinese sources as reporting that every province "has become accustomed to shutting itself off from the rest of the economy, blindly seeking to build an independent system" (1986, p. 227).

Young himself acknowledges the absence of free interregional trade in the prereform period:

> In a planned economy, where state organs controlled the interregional movement of goods, price differentials could easily be maintained. In a market economy, however, with atomistic private arbitragers hard at work, large interregional differentials in the prices of traded goods could only be maintained with barriers to trade. (p. 1104)

But then he concludes that "twenty years of economic reform in the People's Republic . . . *have resulted* [emphasis added] in a fragmented internal market" (p. 1128). The literature shows that the market was highly fragmented at the outset of economic reform.

[2] Young (as all other literature) focuses on interprovincial trade only. "Market blockade" (*shichang fengsuo*) or "interregional blockage" (*diqu fengsuo*), the terms used in Chinese sources, cover the behavior at all levels, from supraprovincial regions to the village.

[3] Locally owned enterprises hand over their income taxes to the local government (since 1994, or a share of profit prior to 1994), while centrally owned enterprises do so to the central government. It is not the case that the share of industrial output under local control increased significantly in the period Young examined. For the value-added (GDP) and revenue data, see *Statistical Yearbook* 1993 (pp. 215, 217), 1996 (p. 225), and 2003 (p. 55).

[4] Alternatively, assuming the (hypothesized) establishment of new provincial trade barriers were indeed motivated by revenue generation, the declining revenue share from industry is evidence that trade barriers decreased over time.

Third, whatever incentives local governments may have to erect trade barriers, these are not their only incentives. Local government officials face incentives not to engage in extensive protectionism in order to avoid reprisals from other provinces. Furthermore, leading provincial government officials are part of the central nomenklatura and thus face incentives to follow central government orders, including those on keeping markets open.

B. Evidence

Young presents the silkworm cocoon war story as anecdotal evidence of new trade barriers and refers to numerous newspaper and journal reports. But stories can be found, as he admits (p. 1106), on growing interregional cooperation.[5] We do not have systematic direct evidence of an increase in trade barriers.

The other piece of evidence that Young provides are official statements. In his view, "The central regime railed, in a number of circulars, against interprovincial trade wars" (p. 1103). He cites a Chinese source (Chen Yongjun, 1994) as noting "circulars and directives against interregional trade barriers . . . issued by the State Council, Party Congress, People's Congresses, etc. in 1980, 1981, 1982, 1984, 1985, 1987, 1988, 1989, and 1990" (p. 1103). Following up on the details in Chen Yongjun, only the 1982 and 1990 State Council regulations directly address interregional trade barriers. The evidence for all other years consists of some marginal mentioning, on the order of half to one sentence, in otherwise lengthy regulations on other topics, or in the annual (particularly lengthy) government work reports.

While the 1982 regulation promoted a reduction in existing trade barriers more than prohibiting the establishment of new trade barriers, the 1990 State Council circular addressed an issue of current relevance that was either quickly resolved or not regarded as important later; the State Council issued no further circulars.[6] These two circulars would not seem to justify a portrayal of prolonged central regime railings against interprovincial trade wars.

C. Market Economy Benchmark: The United States

Protectionism is not particular to transition economies. When Boeing considers moving its world headquarters from Seattle to Chicago, governments in both cities offer incentives in an attempt to retain or attract the corporation. Local city councils may block large retailers from moving into town. Interstate banking was largely prohibited between 1927 and 1994, but not uniformly so across states (some states were less protectionist than others).

The fact that protectionism is a characteristic of all economies and comes in a variety of ways suggests the need for a clear definition of what is to be considered protectionism (or a "trade barrier") and the establishment of a benchmark of "acceptable" or "normal" protectionism. Young provides an exemplary list of barriers to trade but no definition of protectionism.[7] In the quantitative analyses (discussed below), he interprets specific changes in specific numerical measures as changes in barriers to trade, without, however, linking these measures to particular types or instances of trade barriers. Except in the third quantitative section, Young does not offer any benchmark, qualitative or quantitative, of what level or what kind of behavior might be considered "normal."

III. Quantitative Evidence 1: Provincial Specialization (Output Convergence)

Young's first piece of evidence in favor of increasing trade barriers in China is the "widespread convergence in the structure of output during the reform period, as the different provinces duplicated each other's industries" (p. 1093f). He measures changes in the structure of output using the sum of the "absolute and [or] squared deviations of sectoral output shares of China's different provinces from the group average" (p. 1106). In other words, he takes one province at a time, and for a given year, for each sector in this province, he calculates the sector's share in provincial output. He then contrasts the output share of a particular sector in a particular province with the average share of this sector across all provinces (average across provinces, or, separately, share in national data); this is the deviation. Deviations in absolute values are summed across all sectors and provinces to yield a sum of absolute deviations, or deviations are first squared, then summed, to obtain a sum of squared deviations.

Using data on primary, secondary, and tertiary sector value added since 1978, Young finds a steady 25% decline in the sum of absolute deviations between 1978 and 1992 and a steady 39% decline in the sum of squared deviations. Between 1992 and 1997 the measures of deviation are constant.[8] He concludes on increasing barriers to interregional trade between 1978 and 1992.

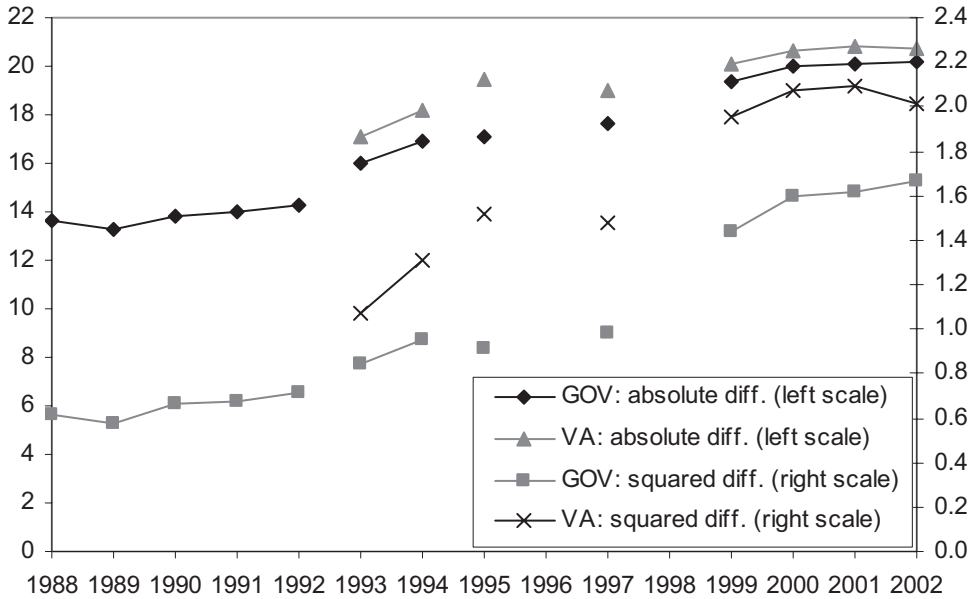
[5] I recount one personal experience of burgeoning interprovincial trade in 1994, when local protectionism should be running strongly following Young's accounts, in an appendix.

[6] Details on the two regulations (as well as on a regulatory framework for free trade of 2001, issued after the publication of Young's article) are provided in an appendix on government regulations and protectionism. That appendix also provides details on regulations in one locality and on newspaper reports. The original Chinese texts of the SC regulations are provided in a separate appendix.

[7] The list of barriers to trade consists of "tariff barriers (i.e., special charges levied at roadblocks), nontariff methods such as physical barriers, outright prohibition, low-interest loans, and other financial benefits for commercial establishments marketing local goods, fines for commercial establishments marketing nonlocal goods, legal restrictions on price differences between local and nonlocal goods sold in commercial establishments, local purchasing quotas, and administrative trivia (e.g., medical, sanitation, epidemic prevention, product quality, measurement, and other such licenses and certificates)" (p. 1102).

[8] Young also reports the results of two variations: weighting provincial shares by provincial output (which yields even more convergence) and

FIGURE 1.—DIVERGENCE IN THE COMPOSITION OF OUTPUT ACROSS INDUSTRIAL SECTORS IN CHINA



GOV: gross output value in current prices; VA: value added in current prices.

The data cover the directly reporting industrial enterprises (on other industrial enterprises, no sectoral data are available); this group of enterprises was redefined in 1998. Gross output value was redefined in 1995, with the new exclusion of the value-added tax as the main change. (For details on the redefinitions, see Holz & Yi-min Lin, 2001.)

The sectoral classification differs between three periods: 1988–1992 (36 sectors, covering virtually all of industry, presumably except the arms and ammunition industry), 1993–1997 (39 sectors, of which 37 sectors were used, because for one very minor sector, no 1995 and 1997 data are available, and for another very minor sector, only 1994 data are available), and 1999–2002 (25 major sectors only, out of 37 in the *Statistical Yearbook* [which excludes arms and ammunition], a different source that does not have sectoral data by province). For changes in the sectoral classification over time, also see Holz (2003, 2007). The number of provinces in the first two periods, 1988–1992, and 1993–1997, is 30 (separate Chongqing data are first available for 1997 and were folded back into Sichuan). The number of provinces in 1999–2001 is 31.

In the calculation of deviations, the average share of a particular sector in provincial total output is the arithmetic mean across provinces. Using the nationwide value to obtain the average share of a particular sector in nationwide total output yields identical time trends.

Source: *Industrial Yearbook,* numerous issues; *Industrial Census 1995,* Regional Volume (pp. 116–405).

A. *Causality*

Young argues, "Trade barriers tend to lower the internal prices and real outputs of products in which a region has a comparative advantage. This leads to a convergence in the nominal output shares of different sectors" (p. 1111). But one could argue that trade barriers should lead to divergence in the nominal output shares of different sectors over time: if provinces apply trade barriers selectively, as the anecdotal evidence suggests, each province could choose to protect only those industries in which it has a high comparative advantage (profit).

Young's argument also competes with arguments based on economic transition and development. First, once the prereform restrictions on the operation of the economy were removed and production and investment decisions became more market oriented, non-market-based specialization disappears (output converges). Second, local governments, under pressure to achieve rapid economic growth, have little choice but to develop the secondary and tertiary sector. Not only are problems of unemployment and underemployment being addressed, but the much higher labor productivity in the secondary and tertiary sectors guarantees that structural change translates into rapid economic growth. The less developed provinces, perhaps most desperate to catch up, have a large growth potential in the secondary and tertiary sectors (leading to interprovincial output convergence).[9]

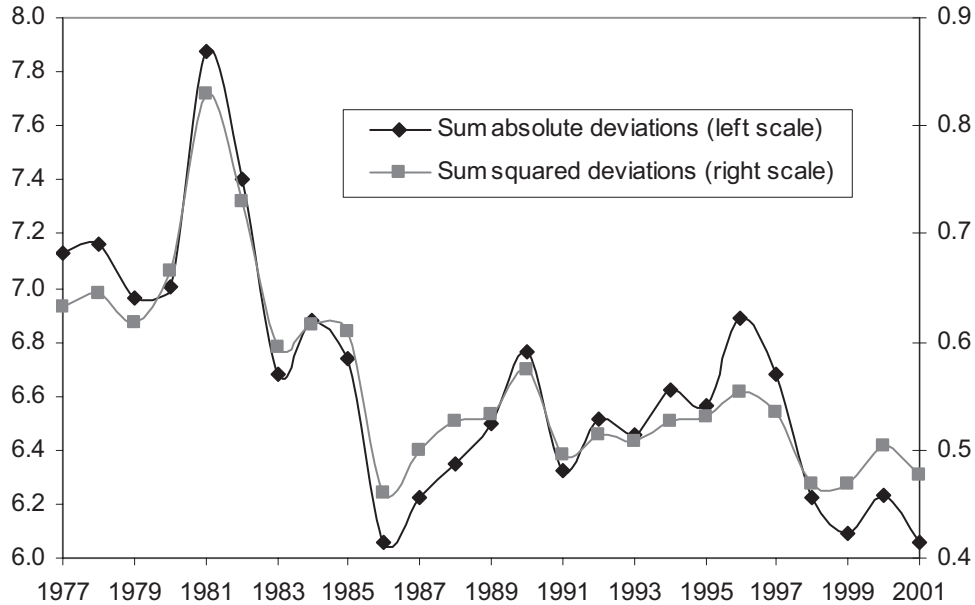
B. *Evidence*

If it were the case that provincial protectionism was causing provinces to become less specialized, then one would expect to see this most strongly in that sector in which, according to Young, the impulse to protectionism originates. However, the evidence shows the contrary. Within industry, production patterns across provinces diverged steadily over time (figure 1); this is what Young would expect them to do with decreasing trade barriers. The data are available for three periods—1988–1992, 1993–1997, and 1999–20002—with data on almost all the approximately three dozen individual industries in the first two periods, but in the third period, data on only two dozen individual industries (covering a redefined group of enterprises) are given. In each period, the trend is one of increasing divergence, as expected by Young in the case of

dividing provinces into coastal and interior (no difference in results). He also provides data for 1952–1992 based on the net material product of the five material production sectors in the traditional, socialist accounting system (the Material Product System). The sum of absolute (or squared) deviations of this time series shows a temporary decline around 1969, a long-term decline beginning in the mid-1970s, and in the reform period that follows, a similar pattern as the time series based on value added.

[9] Park and Du (2003) formalize an economic development argument: they repeat Young's sectoral exercise controlling for development level and provincial characteristics and find increasing specialization over the reform period. (I came across their work after completing the calculations and explanations in this section.)

FIGURE 2.—CONVERGENCE IN THE COMPOSITION OF VALUE ADDED ACROSS U.S. STATES



The data are gross state product data, approximately corresponding to the national concept of GDP.
The calculation procedures match those of Young and use mean state shares. (Using nationwide shares yields the same time pattern.)
Source: http://www.bea.gov/bea/regional/gsp/, accessed May 22, 2004, with detailed definitions on the Web page. An appendix on U.S. data on cross-state specialization and price dispersion provides more details.

no or decreasing trade barriers, independent of whether gross output value or value added is used as output measure, independent of whether the criterion is absolute deviations or squared deviations, and independent of whether the average share from which the deviations are measured is calculated as the average share across provinces or as the share of this sector in total output at the nationwide level.[10]

C. *Market Economy Benchmark: The United States*

Figure 2 reports the results of Young's exercise conducted for the United States for the years 1977, the first year for which these data are available from the Bureau of Economic Analysis, to 2001, the most recent year for which the data are available. Between the high point of 1981 and the final year of 2001, the sum of absolute deviations fell by 23% and the sum of squared deviations by 42%; over the whole period (1977–2001), the sum of absolute deviations fell by 15% and the sum of squared deviations by 25%. This means that the degree of convergence in the United States was approximately the same as that which Young identified for China.[11]

[10] Zhang and Tan (2004) calculate the Hoover coefficient of localization for each of the four (nonexhaustive) sectors (farming, urban industry, urban service, and rural nonfarm) for each year over 1978–2001. The sector-specific time trends vary; in the aggregate, specialization increases between 1991 and 1996. Bai et al. (2004) also calculate a Hoover coefficient of localization, for individual industries over 1985–1997 and find slightly decreasing specialization over 1985–1987/1988 and then increasing specialization thereafter.

[11] U.S. within-industry data, reported in the appendix on U.S. data on cross-state specialization and price dispersion, also show convergence over time (where Young, in the case of China, interprets convergence as an increase in trade barriers).

IV. Quantitative Evidence 2: Provincial Price Dispersion

Young writes "Ceteris paribus, trade barriers, which segment markets, will increase the variation of prices across those markets" (p. 1112). To measure price variation, he first calculates the standard deviation of the natural logarithm (ln) of the prices of a particular product across China's provinces; this is done for a number of products. Second, the ln of the standard deviation is regressed on product dummies and time dummies. He reports the coefficients of the time dummies as a measure of price dispersion.

Young uses four data sets (for four separate calculations):

1986–1993: Annual retail prices of 305 consumer goods in 30 cities
1986–1993: Annual procurement prices of 130 agricultural goods in 30 provinces
March 1990–May 1999: Monthly market prices of 49 industrial materials in 36 cities
June 1993–May 1999: Monthly market prices of 33 agricultural products in 36 cities.[12]

Based on the annual data for 1986 through 1993, he finds that "the dispersion of both retail and agricultural prices rose rapidly between 1986 and 1989, after which it fell

[12] The number of products, cities, and the time period covered are maxima; prices on all products in all locations (and, in the case of annual data, at the same quality specification) are not available at every point of time. For example, in the original sources of the data, the number of consumer goods in the first data set in the years 1986 and 1987 is only 132 (not 305). For further details, see the appendix on price data.

[until 1991 and 1992, respectively], and then rose again" (p. 1113). His finding on the monthly price data is that they "have gone through bouts of falling and rising dispersion" (p. 1114).[13]

A. *Causality*

If Young's assertion that "ceteris paribus, trade barriers, which segment markets, will increase the variation of prices across those markets" was correct, then one would expect the transition from nearly perfectly segmented, largely locally controlled markets in the prereform period (documented above) to the opening of some markets in the reform period to come with decreasing price dispersion. If price dispersion, however, were to have risen, then one could argue (as Young acknowledged, p. 1116) that it is due to growth in product variety in the reform period, with different provinces producing different varieties. The data Young used are unlikely to be able to control for increasing product variation. As he writes about his annual price data, "Overwhelmed by the number of new products appearing in the economy, the State Statistical Bureau completely abandoned the collection of these [annual] data in 1994" (p. 1112).[14]

On the other hand, one could also assert that more trade barriers means less price dispersion, whether because local governments plumb for sectoral guidance prices or because they collude with their neighbors in setting prices that do not lead to smuggling. After all, the purpose of trade barriers is not to cause prices to differ from the next locality but to impose high prices (i.e., to collect high rents). Incurring high costs in maintaining trade barriers would be counterproductive.

For the monthly data, Young asserts that "these bouts of falling and rising dispersion [of industrial materials prices in 1990–1999] are consistent with trade wars that are periodically interrupted and suppressed by the central government, only to resume once again, when central attention focuses on other matters" (p. 1114). He fails to provide any evidence of periodic central government interruption and suppression of trade wars. The 1982 and 1990 State Council circulars cannot account for the 2.5 cycles in monthly price dispersion Young documented for the years 1990 to 1999 (and not even for the pattern in annual price dispersion in the late 1980s).[15]

The observed patterns in price dispersion are perfectly well explained by institutional changes. Three elements are important to an institutional explanation:

1. When the central government determines prices, these tend to be set at a nationwide uniform or near-uniform level.
2. Economic transition and development mean that the role of planning decreases and that firms gradually establish their own distribution networks outside any planning system or government-controlled distribution system.
3. Transportation costs and transportation bottlenecks are nontrivial, delaying, if not preventing, full price arbitrage. Evidence of transportation bottlenecks and transportation costs is compelling to this day.[16]

The evidence suggests five stages of price dispersion. A brief explanation, with more details relegated to an appendix on price data, is as follows:

- The introduction of the dual-track price system in 1984–1985 causes price dispersion in 1986–1989 to rise. The share of market-determined prices for one particular good increases, but the precise share of trade at (typically higher) market-determined prices depends on the local trade mix and on centrally and locally determined local plan quotas.
- Reassertion of plan prices explains the falling price dispersion in 1991–1992.
- Renewed and far-reaching price liberalization, combined with differential local expansion, explain the rise

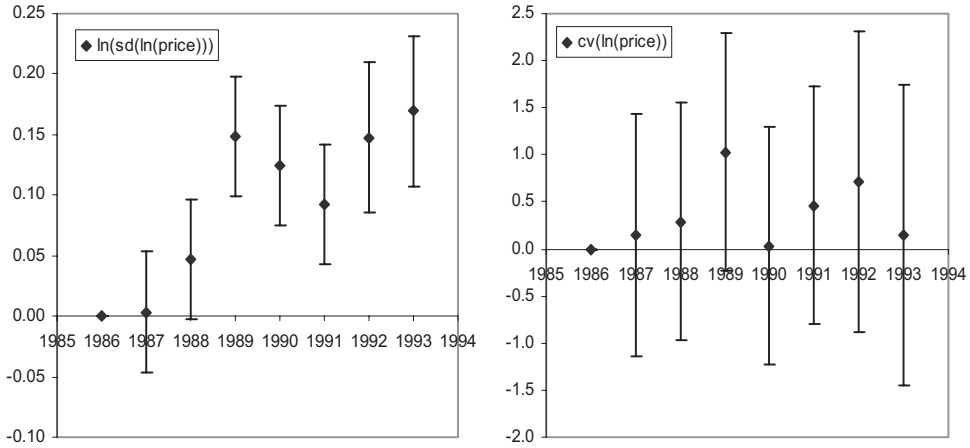
[13] Poncet (2006) examines the dispersion of monthly prices for each of seven agricultural products across 170 locations in China in the period 1987–1997 and finds, like Young, that price dispersion exhibits a wavelike pattern over time. In most years, if distance and fixed effects are controlled for, trading across provincial borders appears to imply extra price dispersion. Fan and Wei (2005) examine the dispersion of monthly prices of 93 goods and services in six product categories across 36 cities in China from 1990 to 2003. In panel unit root tests and nonlinear mean reversion, they find strong evidence of price convergence. In the aggregate, price dispersion appears to increase with time; however, once the analysis is conducted by product category, prices converge in five out of the six categories. Xu and Voon (2003), using two sets of annual retail prices for 1985–1993 and 1994–1998, covering 13 and 28 sectors, examine the co-movements of price changes and find decreasing price integration across provinces between the two subperiods 1985–1989 and 1990–1993 and then increasing price integration between 1990–1993 and 1994–1998. In all periods, sector-specific effects far outweigh province-specific effects three- to twenty-fold, and slightly more so in the short run than in the long run.

[14] What is true of products should equally well be true of product variety. The source of the annual price data Young used, with its brief product descriptions, reveals the difficulties of obtaining prices for identical products across localities.

[15] Young's only documentation of government action is the footnote referring to Chen Yongjun's (1994) book. Beyond the discussion above, all the dates in this source except 1990 refer to years before the periodic trade wars noted by Young erupted. In addition, if price dispersion changed if and only if trade barriers changed, the 1990 dip in measured annual price dispersion below the 1989 local maximum (for retail prices, here and in Young) is inconsistent with the fact that the SC issued its one circular only in late 1990 (which would indicate high trade barriers in 1990).

[16] Yifan Hu (2004) reports that in recent years, approximately 60% of coal output has been shipped by rail, accounting for approximately 45% of rail freight transportation (*yunliang*) and 33% of rail freight turnover (*zhouzhuanliang*). In the first ten months of 2003, national coal production was up 21.4% over the same period in the previous year, but rail transportation of coal in the months through September was up only 6.9%. He writes of many enterprises that cannot get the raw materials they need and cannot ship their products, of a railway system that can meet only 35% of demand, and of 50% price increases in the "last" six months in water transportation, where prices are not regulated. The article provides a multitude of specific examples and pieces of information on transportation bottlenecks.

FIGURE 3.—ANNUAL RETAIL PRICE DISPERSION OF CONSUMER GOODS



Each observation is the coefficient of the corresponding time (year) dummy in a regression of the dependent variable on a complete set of product dummies and time dummies for all years except the first (1986). The coefficient represents the difference in price dispersion compared to 1986. The vertical bars reflect ± 2 standard errors. Following Young's practice, the two products *People's Daily* and *Mass Movies* magazine are omitted, and a product year with fewer than five price observations (fewer than five cities reporting prices for that product for that year) is excluded. The chart on the left replicates Young's findings, with as dependent variable in the regression the natural logarithm of the standard deviation of the natural logarithm of the price of one good across cities in one year. For further discussion of the data and their coverage, see the appendix on price data.

Sources: Young (data posted online at http://gsbwww.uchicago.edu/fac/alwyn.young/research/) and his original source, the *Price Statistical Yearbook,* 1988 through 1994.

in price dispersion in 1993–1994. Price arbitrage takes time.[17]

- Central efforts at cooling the economy cause price dispersion to fall in 1995–1996.
- The reform of state-owned enterprises starting in 1997–1998 leads to fierce price cutting and selling below cost in some localities. Price dispersion rises in 1998–1999. Price arbitrage takes time.

B. *Evidence*

Young focuses on the (ln of the) standard deviation of (the ln of) prices of each product across provinces. However, differences in the inflation rate over time, as long as inflation affects all products equally, potentially confound his findings; a higher (lower) inflation rate implies a higher (lower) standard deviation. The coefficient of variation avoids this shortfall. In the following, the two agricultural procurement price series are dropped because Young's findings using agricultural procurement price data are no or little different from those using retail or industrial materials prices and because these data are of questionable meaning.[18]

Figure 3 (left) replicates Young's findings: price dispersion as measured by the ln of the standard deviation of the ln of prices increases between 1986 and 1989, falls between 1989 and 1991, and rises again in 1992 and 1993. The values of 1989 through 1993 are significantly different from that of 1986. Switching to the coefficient of variation of the ln of prices, all significance disappears (figure 3, right).[19]

The appendix on price data explores half a dozen variations. Two examples are given in figure 4, where the double natural logarithms are dropped (why should the ln be applied to prices, and then to the measure of variation?) and 1991 instead of 1986 is chosen as base year; 1991 was a low inflation year with little difference between market and plan prices so that the pricing regime does not matter. The result, using standard deviations, is a slight significance in 1986, 1987, and 1993 and a continuous increase over time (figure 4, left). (The results are similar for the coefficient of variation.) When the data are limited to a set of 41 products consistently defined over time and comparable across cities (figure 4, right), significance disappears almost completely; in variations of the dependent variable, significance disappears altogether.[20]

Figure 5 (left) reproduces Young's findings for industrial materials prices, with somewhat more significance due to

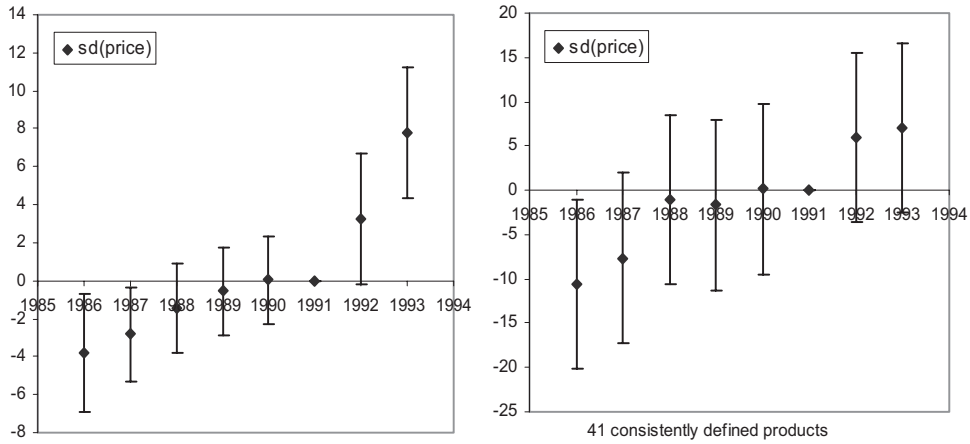
[17] Price liberalization may also proceed at a different speed in different provinces (due to central or local decisions that need not be related to issues of local protectionism).

[18] The appendix on price data gives an example of the impact of inflation on standard deviations and elaborates on agricultural procurement price data.

[19] Some prices are below 1 yuan RMB, which means that the coefficient of variation of their logs is negative. Because a large negative coefficient of variation indicates relatively large price dispersion, the regression was also run using the absolute values of all negative coefficients of variation, with identical results of nonsignificance. For a complete discussion of the complications between coefficient of variation and logarithms, see the price appendix.

[20] The R^2 in these regressions of a measure of price dispersion on sectoral dummies and year dummies is exceedingly low, below 0.1; if there were any impact of year on price dispersion, it accounts for less than 10% of the price dispersion. Rerunning Young's original regression (figure 3, left) without product dummies, year dummies account for only 2% of the variation in prices (in the ln of the standard deviation of the ln of prices). If the year dummies were to capture the effect of trade barriers (something that is contested), trade barriers explain 2% of price dispersion. Without product dummies, across the different dependent variables and with 1991 as base year, the year dummies are either all insignificant or significant only in the first two or last two years.

FIGURE 4.—VARIATIONS ON ANNUAL RETAIL PRICE DISPERSION OF CONSUMER GOODS



See the notes to Figure 3. For details on the 41 products, see the appendix on price data.

slightly different procedures (see the appendix on price data). Once the double ln is dropped (figure 5, right), significance almost completely disappears. The significance results using the coefficient of variation are similar, and the variation is small (see the appendix).[21]

C. *Market Economy Benchmark: The United States*

Figure 6 reports quarterly price dispersion across 26 products in 48 U.S. cities in the period January 1975 through April 1992, using Young's measure of price dispersion.[22] The pattern is wavelike, as in the case of China. The range of variation matches that in the monthly data for China. The 26 selected products satisfied criteria of completeness and comparability (as applied by other researchers), in contrast to China, where all available price data were used. Consequently, price dispersion in figure 6 is not as significant as in China.

V. Quantitative Evidence 3: Variance Decomposition

Young asks if the output convergence that he found in the first quantitative analysis could be due to reasons other than trade barriers. He considers and rejects as alternative reasons cross-provincial convergence of comparative advantage and common specialization driven by the opening to the international market.

Young focuses on the ratio of primary to secondary sector output. Output converges in that the variance (across provinces) of the ln of this ratio declined from 0.71 in 1978 to 0.53 in 1997. He decomposes this variance into the three components: (1) variance of the ln of the ratio of nominal sectoral labor productivity, (2) variance of the ln of the ratio of sectoral labor allocations, and (3) the covariance of the ln of the ratio of nominal sectoral labor productivity and the ln of the ratio of sectoral labor allocations, or

$$\mathrm{var}\left(\ln\frac{P_PQ_P}{P_SQ_S}+\left(-\ln\frac{L_P}{L_S}+\ln\frac{L_P}{L_S}\right)\right)=\mathrm{var}\left(\ln\frac{P_PQ_P/L_P}{P_SQ_S/L_S}\right)$$
$$+\,\mathrm{var}\left(\ln\frac{L_P}{L_S}\right)+2\,\mathrm{cov}\left(\ln\frac{P_PQ_P/L_P}{P_SQ_S/L_S},\ln\frac{L_P}{L_S}\right),$$

where P denotes price level, Q real output, L labor, and the subscripts p and s stand for primary and secondary sector, respectively. Table 1 reports his findings.[23] Between 1978 and 1997, the variance of (the ln of) relative labor productivity increased from 0.12 to 0.15 and of (the ln of) relative labor allocations from 0.56 to 0.73, while the covariance fell from 0.01 to negative 0.17.

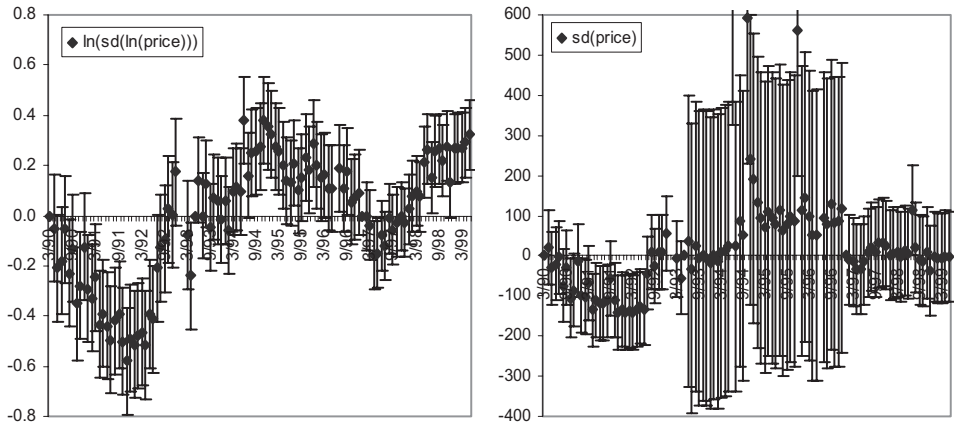
This means that "while China's provinces became more similar in terms of the composition of final output, they became increasingly *dissimilar* in terms of sectoral productivities and sectoral labor allocations. . . . If the convergence in the composition of output across China's provinces is driven by a convergence in the patterns of comparative advantage [rather than by trade barriers], then one should observe a growing similarity of labor allocations and productivities (i.e., the economies should be increasingly sim-

[21] In the case of the monthly data, Young considers inflation. He reports that using a "balanced sample locale pairs to construct period-by-period estimates of the rate of inflation in each product," one finds that "product inflation during the period [1990–1999?] has either an insignificant, or a significantly negative effect on price dispersion. In any case, the estimated pattern of fluctuations is . . . largely unaffected" (p. 1115). He does not mention inflation correction of the annual data.

[22] Chinese data are also city-level data and interpreted by Young as provincial data. For the U.S. data, see Parsley and Wei (1996). The Bureau of Labor Statistics does not publish absolute price data on specific, nationwide uniform products because it cannot guarantee comparability across localities. For further details on the U.S. data, see the appendix on U.S. data on cross-state specialization and price dispersion.

[23] Because Young's data are not accessible to me, table 1 not only reports his results but also redoes the calculations using data from Chinese official sources (including Zhejiang, on which Young had no data). Young's Lotus files are available on his Web site, but neither I nor our department's computer technician was able to open them.

FIGURE 5.—PRICE DISPERSION OF MONTHLY INDUSTRIAL MATERIALS PRICES



The figure covers three distinct periods, March 1990 to April 1993, May 1993 to December 1996 (with an increase in the number of localities covered from 24 to 35), and January 1997 to May 1999 (with a major redefinition of product specifications). See notes to Figure 3 on how to interpret the chart, and the appendix on price data for further details. Young's "industrial materials" refers to "means of production" (i.e., producer goods and materials).

Sources: Young (data posted online at http://gsbwww.uchicago.edu/fac/alwyn.young/research/) and some issues of his original source, the *China Price* magazine.

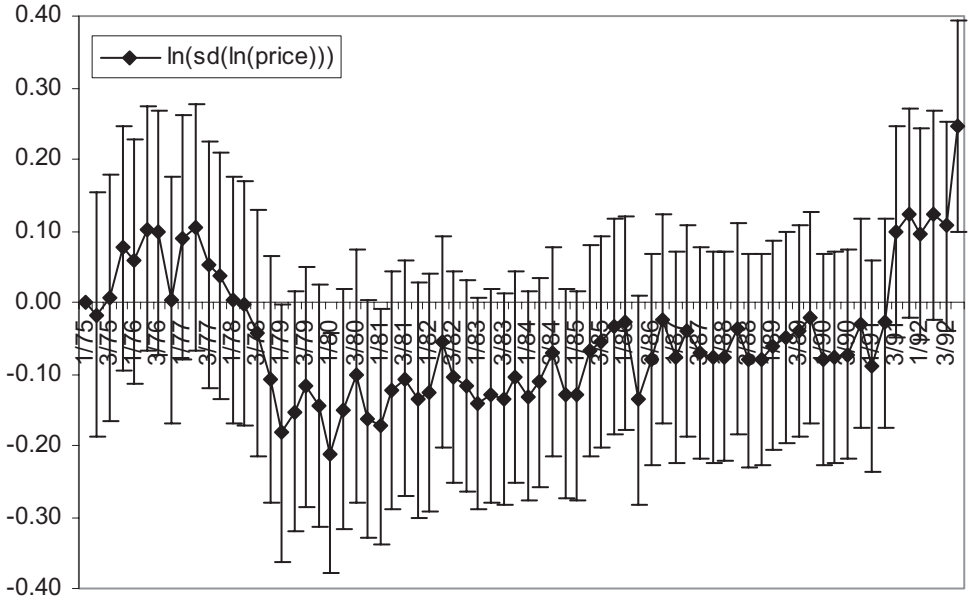
ilar on all dimensions). Similarly, common specialization driven by the opening to the international market should be accompanied by a growing similarity of labor allocations. None of this is present in the data" (p. 1117).

A. *Causality*

Young writes: "The [reform period] Chinese data . . . are compatible with a rise in trade barriers. [i] A growing diversity of nominal labor productivities could easily arise from growing interregional price disparities, which would increase both the variation of relative prices and, due to a decline in factor price equalization, the variation of real labor productivities. [ii] A rise in the variance of labor allocations could come from increasingly perverse labor allocations, as provinces poured resources into areas of comparative disadvantage, a view that would also not be incompatible with the growing negative correlation between productivities and factor allocations" (p. 1118).

A short refutation of the two mechanisms that supposedly link trade barriers to the patterns observed in the data is that interprovincial price dispersion, as seen in the previous section, has not grown, and in the period Young covered, the household registration system was still very much in force, hampering labor flows between provinces and from rural to

FIGURE 6.—PRICE DISPERSION ACROSS U.S. CITIES



The data are quarterly price data for 26 nonperishable goods in 48 U.S. cities (nationwide) in the period January 1975 through April 1992. For explanations, see Parsley and Wei (1996). Also see the appendix on U.S. data on cross-state specialization and price dispersion for further details. The dependent variable is the ln of the standard deviation of the ln of prices (as Young did in the case of China).

Source: http://mba.vanderbilt.edu/david.parsley/Research.htm, accessed June 26, 2004.

TABLE 1.—VARIANCE DECOMPOSITION, PRIMARY VERSUS SECONDARY SECTOR

	Variance of			Covariance of
	$\ln \frac{P_P Q_P}{P_S Q_S}$	$\ln \frac{P_P Q_P / L_p}{P_S Q_S / L_S}$	$\ln \frac{L_P}{L_S}$	$\ln \frac{P_P Q_P / L_P}{P_S Q_S / L_S}, \ln \frac{L_P}{L_S}$
Alwyn Young[a]				
China (28 provinces)				
1978	0.71	0.12	0.56	0.01
1997	0.53	0.15	0.73	−0.17
United States (50 states and D.C.)				
1977	1.18	0.31	0.63	0.12
1994	0.72	0.32	0.37	0.01
Calculations here[b]				
1978	0.66	0.12	0.52	0.01
Without Tibet	0.64	0.12	0.49	0.01
1981	0.75	0.15	0.71	−0.03
Without Tibet	0.75	0.15	0.65	−0.03
1997(1)[c]	0.53	0.15	0.69	−0.16
Without Tibet	0.48	0.14	0.59	−0.12
1997(2)[c]	0.53	0.13	0.75	−0.18
Without Tibet	0.48	0.12	0.65	−0.14
	Variance of			Covariance of
	$\frac{P_P Q_P}{P_S Q_S}$	$\frac{P_P Q_P / L_P}{P_S Q_S / L_S}$	$\frac{L_P}{L_S}$	$\frac{P_P Q_P / L_P}{P_S Q_S / L_S}, \frac{L_P}{L_S}$
Calculations here[d]				
1978	0.24	0.00	9.74	−0.02
Without Tibet	0.21	0.00	7.53	−0.02
1997(1)[c]	0.15	0.01	6.97	−0.10
Without Tibet	0.11	0.01	2.56	−0.06
1997(2)[c]	0.15	0.01	8.48	−0.11
Without Tibet	0.11	0.01	3.28	−0.07

[a] See Young's table IV (p. 1116). He presumably adds Chongqing (in the years when separate data are published) back into Sichuan, and he says he excludes Tianjian and Zhejiang (which would make a total of 27 provinces). He also reports 1952, 1965, 1978, and 1997 data for 14 Chinese provinces, but because the overall argument of his paper (distortions begetting distortions, or trade barriers) concerns only the reform period, earlier years are not examined here, and these data are not copied.

[b] In the calculations here, Chongqing is added back into Sichuan in the most recent years when separate data are available. Tianjin is excluded throughout because of a lack of labor data from 1978 to 1984. In contrast to Young's calculations, Zhejiang is included here (since the data are available), and Guangdong and Hainan are treated as two separate provinces throughout (again, the data are available), which make a total of 29 provinces.

[c] Employment data for 1997 are from *Fifty Years* (1) and the *Statistical Yearbook* (2).

[d] See note b. Young did not do these calculations, based on nonlogarithmic values.

Sources (province-specific page numbers): Sectoral value added: 1978, 1990: *GDP 1952–95;* 1997, 2002: *GDP 1996–2002*. Employment: 1978, 1990, 1997(1): *Fifty Years;* 1997(2), 2002: *Statistical Yearbook.* Individual, missing data in the years prior to 1996 are supplemented from *Seventeen Years.*

urban areas within a province.[24] Relative labor allocations then are the outcome of province-specific population growth, obstacles to migration, and the pace of secondary and tertiary sector development.

B. Evidence

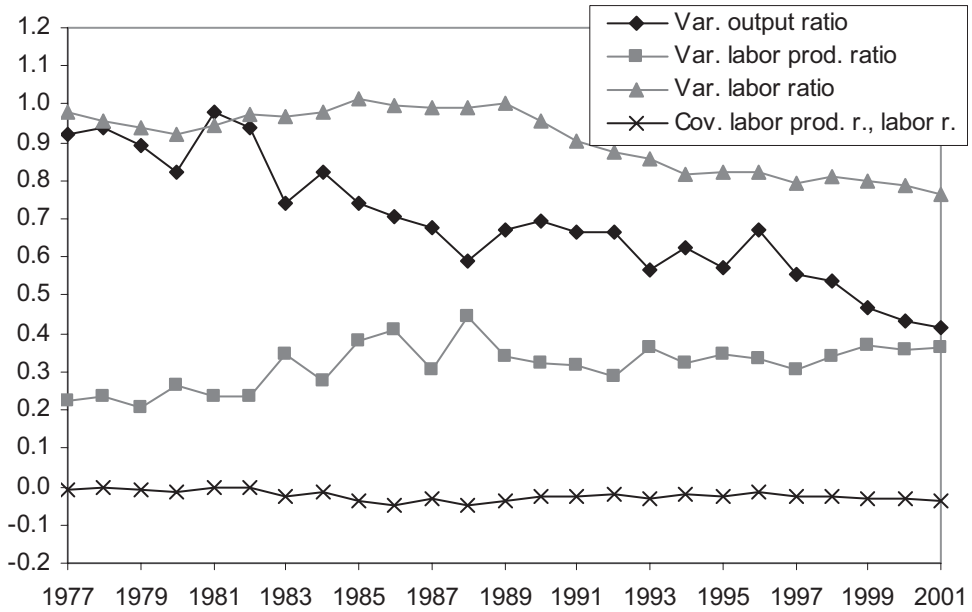
The bottom of table 1 reports the data that Young refers to when reporting that "while China's provinces became more similar in terms of the composition of final output, they became increasingly dissimilar in terms of sectoral productivities and sectoral labor allocations" (p. 1117). The data show that between 1978 and 1997, China's provinces did not become increasingly dissimilar in terms of sectoral productivities (the variance of relative labor productivity is almost unchanged at 0.01 versus 0.00) and the variance of relative labor allocation actually fell. If the outlier Tibet is omitted (its 1997 value of relative labor allocation is twice that of the next-highest province), the variance of the ratio of labor allocations even fell drastically, from 7.53 to 2.56 or 3.28, depending on the labor data used.[25] In other words, China's provinces did not become dissimilar in terms of sectoral productivities and sectoral labor allocations. The findings reported in the bottom of table 1 match what Young claims would be evidence for output convergence due to convergence of provincial comparative advantage or to common specialization in the opening to the international market.

China's provinces, as Young documented, became dissimilar only in the variances of the *natural logarithms,* but that is not his argument. Still, suppose he had in mind an unspecified argument based on behavior in terms of natural logarithms. Then his findings are sensitive to the time period chosen. Take, say, 1981 as the starting year, and use natural logarithms to match Young's manipulations. The findings are convergence in output, near-constant variance of relative

[24] A more detailed refutation is provided in the appendix on variance decomposition.

[25] The labor data are problematic in several respects; see the appendix on labor data. For charts of the relative nominal labor productivities and the relative labor allocations of all provinces in 1978 versus 1997, see the appendix on variance decomposition. A lesser outlier of Jilin in terms of relative nominal labor productivities makes no substantial difference to the results.

FIGURE 7.—VARIANCE AND COVARIANCE OF THE NATURAL LOGARITHM OF PRIMARY VERSUS SECONDARY SECTOR RATIOS, U.S. STATES



Output of the primary sector is gross state product in agriculture, forestry, and fishing, and of the secondary sector, gross state product in mining, construction, and manufacturing. Employment of the primary sector is farm employment, and of the secondary sector mining, construction, and manufacturing employment (in the private sector). The District of Columbia is omitted due to zero employment in agriculture; Delaware is omitted for 1999–2001 due to lack of employment data. Lack of employment data for Idaho and Minnesota in 1998 was bridged by using the average value of 1997 and 1999. Starting and final year in this figure are determined by the availability of employment data. (Employment data are also available for 2001–2004, but the industry classification changed.)

Sources: Output data: http://www.bea.gov/bea/regional/gsp/, accessed May 22, 2004; employment data: http://www.bea.doc.gov/bea/regional/spi/default.cfm, accessed December 16, 2005.

labor productivity, and possibly a faint decline in the variance of relative labor allocation—according to Young, a sign of no change, or of a decrease, in trade barriers.[26]

C. *Market Economy Benchmark: The United States*

Young in this one instance draws on U.S. data for comparison. For the period 1977 to 1994, he finds convergence in (the ln of) output, a near-constant variance of (the ln of) the ratio of labor productivity, a falling variance of (the ln of) the ratio of labor allocation, and a fall to near-zero covariance (in ln's) in 1994 (table 1). He does not associate this pattern with trade barriers and writes, "Unlike China, however, in the United States this convergence [in output structure] was associated with a large decline in the variance of labor allocations" (p. 1117).[27] This statement is incorrect in that the variance of labor allocations in China, as shown above, experiences a large decline. (It is only in the variance of the ln that it does not.) China's data exhibit exactly the pattern that Young ascribes, in his text, to the United States.

Second, ignoring rationales and examining data in natural logarithms, the U.S. trends of the period 1980 to 1989 match those of China (figure 7). The U.S. variance of the ln of the nominal output ratios fell (from 0.82 to 0.67), as in China. The variance of the ln of the labor productivity ratios slightly increased (from 0.26 to 0.34), as in China. The variance of the ln of the labor ratio increased (from 0.92 to 1.00), as in China. The covariance decreased (from −0.02 to −0.04), as in China.[28] In other words, trends are not robust over time.

Variances (of natural logarithms) of relative labor productivity and relative labor allocation are significantly larger in the United States than in China throughout all years.[29] Since Young interprets a reduction in these variances as a reduction in trade barriers, the level of variation in China, below that of the United States, is more than compatible with open markets.

VI. Quantitative Evidence 4: Agriculture and the Weather

In a final step, Young shows a movement of factor allocations away from patterns of exogenously given comparative advantage. He shows graphically that in 1978, labor intensity in agriculture (ln of primary sector employ-

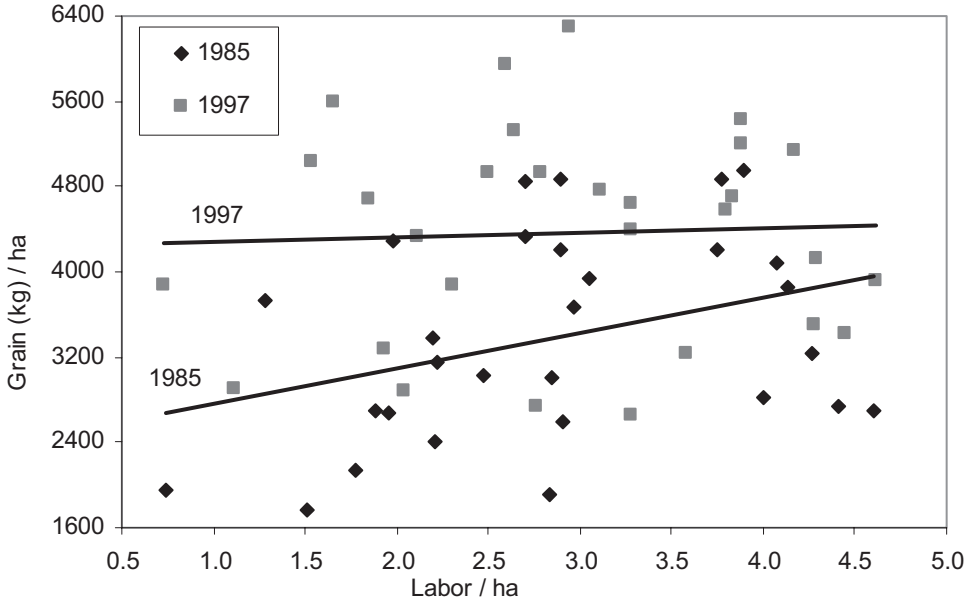
[26] Charts with the variances of all variables in all years, for the primary versus secondary sector, are provided in the appendix on variance decomposition. The appendix also presents data for secondary versus tertiary sector ratios. Young does not examine the variances of relative output of any combination of two industries within the secondary sector. Neither is this done here, because the output divergence observed for the within-industry case above is, following Young's logic, already a sign of decreasing trade barriers.

[27] For the United States, he ignores that the variance of the ln of relative labor productivities rose slightly over time—as it did in China.

[28] The values for the United States in 1977 and 1994 in figure 7 are different from those of Young reported in table 1. My sources (see notes to the figure) are identical to those of Young except for employment, where he uses the BEA's "state personal income 1968–95" data, whereas I use the BEA's "income and employment tables by SIC industry, 1958–2001," with "total full-time and part-time employment by industry." (I do not have access to Young's data; see note 23.)

[29] Compare figure 7 (for the United States) to the China data in table 1 or the corresponding figure for China provided in the appendix on variance decomposition.

FIGURE 8.—FACTOR INTENSITY AND PRODUCTIVITY, 1985 AND 1997

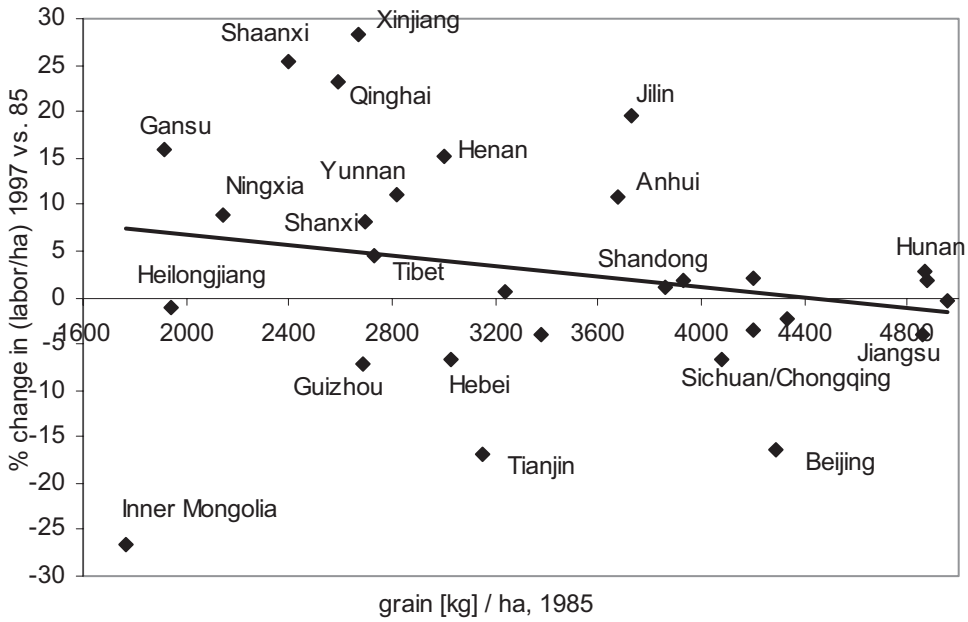


Source: Young's data set (data posted at http://gsbwww.uchicago.edu/fac/alwyn.young/research/) or, similarly, data from the *Statistical Yearbook* 1986 and 1998. Young's grain output values for Guangdong/Hainan and Sichuan/Chongqing in 1997 and his primary sector employment value for Shandong in 1997 were corrected using the *Statistical Yearbook* 1998 (from 32.693 m tons to 21.116 m, from 34.613 m tons to 46.190 m, and from 24.879 m to 25.105 m).

ment per hectar of sown land) was positively correlated with the grain yield (ln of grain output in tons per hectare of land sown with grain), something he views as a "natural" positive association (p. 1120). By 1997, however, that relationship had disappeared, and he suggests trade barriers as reason. Figure 8 reproduces Young's findings for 1985, the first year of his subsequent regressions, and for 1997. (Young uses 1978 as first year in his chart, and applies the ln, to obtain similar results.)

Figure 9, also reproducing Young's findings, shows that low-yield provinces in 1978 (here, 1985) experienced an increase in labor intensity in the following years, and vice versa for initially high-yield provinces. He argues that the 1978 yield reflects the technology available to a particular

FIGURE 9.—INITIAL PRODUCTIVITY AND CHANGE IN FACTOR INTENSITY, 1985 AND 1997



If the five western provinces of Shaanxi, Ningxia, Gansu, Qinghai, and Xinjiang, which in 1985 accounted for 5.9% of China's grain output and 6.4% of its population (*Statistical Yearbook* 1986, pp. 93, 176), are omitted, the slope turns slightly positive. If Heilongjiang is omitted, the slope turns slightly more positive; when Inner Mongolia, in addition, is omitted, the slope turns back slightly negative. The five top grain producers in China—Jiangsu, Shandong, Henan, Hunan, and Sichuan/Chongqing—accounted for 40% of total grain output in 1985.

Source and additional note: See Figure 8.

province, which in turn determines labor input per area of sown land. Labor intensity in the period 1978–1985 through 1997 thus moved against the comparative advantage (technology, original yield).

This move against comparative advantages is pursued in regressions with a weather-focused measure of comparative advantage (rather than the 1978 yield). Young regresses the annual provincial yield of 1985 through 1997 on input variables (irrigation, fertilizer, power, labor), year and province dummies, and three measures of rainfall: annual precipitation, annual precipitation squared, and the coefficient of variation of monthly precipitation. Multiplying the coefficient of each of the three rainfall variables by the variable value and summing the three terms yields an annual provincial weather value; averaging for each province over the 13-year period results in one time-invariant measure of provincial "weather," which Young interpreted as a measure of comparative advantage.

Regressing in a second step the various inputs, in particular labor, on this weather variable interacted with time (and on year and province dummies), the weather-time comparative advantage variable has a negative impact on all four inputs. This suggests that "over time provinces with better weather withdrew factors of production from agriculture" (p. 1124). Regressing the yield on the various factor inputs and weather interacted with time, both labor and comparative advantage have a negative impact on yield (table 2); this means that "provinces with good weather experienced declining yields" (p. 1126)—that is, provinces moved against their comparative advantages.[30]

A. *Causality*

Young argues for the causality from yield to labor intensity in that provinces endowed with a superior technology

> will have more productive land, raising the marginal product of labor on that land and drawing labor into the sector. . . . [But] with *barriers to trade* [emphasis added], the tendency for factors to flow into more productive sectors can be weakened and, possibly, reversed. In a free market economy, provinces with better agricultural yields would experience a decline in the price of grain, which would reverse the flow of factors of production into that sector. In China, with the enduring national and local controls over the price of grain, price mechanisms such as this are unlikely to be at play. Nevertheless . . . in provinces with productive land, farm labor, faced with limited internal demand, migrates into industrial activity. Evidence in favor of a reversal of the link between yields and factor intensities is given in [here, figure 9] which shows that the provinces with the most productive agricultural sectors in 1978 [here, 1985] were the ones that, relative to the mean change, experienced the greatest declines in the labor intensity of agricultural production (pp. 1121–1122).[31]

This argument is crucially flawed. Key to Young's argument is the assumption that the imposition of (or increase in) interprovincial trade barriers causes agricultural laborers in provinces with high agricultural yield to leave the farm (and laborers in provinces with low agricultural yield to enter the farm). Picture a province scarce in agricultural resources. Trade barriers are newly imposed. Independent of the initial yield, laborers will have to move into agriculture in order to ensure that the provincial population can be fed. The initial yield is irrelevant in the context of trade barriers. What is relevant is if the province initially is an agricultural surplus or deficit province, but that does not appear in Young's argument.[32] Young lacks both an explanation of the observed pattern and a test for changes in the degree of trade barriers.

The same logic applies to Young's regression of labor (and other factor inputs) on comparative advantage. The estimation results imply that provinces with a high comparative advantage (higher weather values) relatively reduce primary sector employment per area of sown land. But this finding cannot be related to trade barriers. Once trade barriers have been erected, a province will experience labor movements into agriculture if it is a grain-deficit province; it will experience labor movements out of agriculture if it is a grain-surplus province. Comparative advantage (weather) has no place in explaining labor movements in response to a change in trade barriers.[33] The same logic also applies to

[30] "Provinces with good weather experienced a relatively lower increase in yields" would be a more accurate statement. Young also reports results for the regressions of inputs on year dummies, weather, and weather interacted with time, that is, omitting provincial dummies and including the weather itself. The significance results largely disappear; the coefficients are the same, but the replacement of provincial dummies by the provincial comparative advantage (weather) leads to a poorer fit.

[31] In this passage, Young accepts the existence of national and local controls over the price of grain but interprets agricultural procurement price fluctuations in his second section as evidence of trade barriers.

[32] The argument based on scarcity assumes that more agricultural laborers per hectare of land yields more grain output per hectare of land sown with grain, a typical assumption (or observation) in economics. Young's assumption cannot be saved even by a chance correlation of initial yield with initial degree of surplus: yield is not correlated with the ratio of aggregate provincial household grain consumption to provincial grain production (in neither 1985 nor 1997). Details are provided in the appendix on regression analysis. In 1985, the correlation coefficient is −0.0792, and in 1997 −0.0845 (after correcting two typos in Young's grain output data); neither is different from zero at the 10% significance level. The same holds if grain output per capita is used as a measure of provincial grain surplus or deficit (with correlation coefficients of 0.3115 and 0.0048, neither significant).

[33] There is no chance relationship between weather and provincial grain surplus. In 1985, the correlation coefficient of weather with the ratio of aggregate provincial household grain consumption to provincial grain production is 0.0829, and in 1997 0.2792, using Young's original measure of weather, or 0.0703 and 0.2702 using a corrected weather measure, or −0.2148 and −0.2165 using a comprehensive weather measure (all explained in the text); none is statistically significantly different from zero (apart from the fact that the first four have the wrong sign for Young's argument). The same holds if grain output per capita is used as a measure of grain surplus (with correlation coefficients of 0.2062 and −0.1615 using the corrected weather variable, and 0.1577 and 0.1200 using the comprehensive weather variable).

TABLE 2.—PRODUCTIVITY, FACTOR ALLOCATIONS, AND THE WEATHER

	Young'-1, Yield	Young'-5, Labor	Young'-8, Yield	1', Yield	5', Labor	8', Yield	3SLS Labor	3SLS Yield
Year	.003	.006**	.019**	.005*	−.032**	.015**	−.025**	.011*
	(1.1)	(3.4)	(4.7)	(2.0)	(−6.3)	(2.4)	(−3.2)	(1.8)
Irrigation	.352**		.271**	.312**		.307**	−.101*	.257**
	(7.6)		(6.6)	(6.6)		(7.13)	(−1.8)	(5.9)
Fertilizer	.202**		.163**	.190**		.230**	−.098*	.178**
	(6.5)		(5.0)	(5.7)		(7.2)	(−2.3)	(5.4)
Small tractors	.044**		.024	.043**		.050**	.015	.049**
	(2.6)		(1.4)	(2.6)		(2.9)	(1.1)	(2.8)
Labor	−.122*		−.166**	−.118*		−.079		−.416**
	(−2.12)		(−2.9)	(−2.1)		(−1.3)		(−4.3)
Precipitation	.022**			.016*				
	(3.1)			(2.1)				
Precipitation squared	−.001**			−.001**				
	(−3.4)			(−2.7)				
Coefficient of variation of precipitation	−.035*			−.029				
	(−1.9)			(−1.5)				
Temperature				0.039*				
				(2.0)				
Temperature squared				−0.002*				
				(−2.3)				
CV of temperature				0.034**				
				(2.9)				
Sunshine				0.002*				
				(1.7)				
Sunshine squared				-9×10^{-6}*				
				(−2.1)				
CV of sunshine				−0.092*				
				(−2.3)				
Weather (Young) × time		−.157**	−.253**					
		(−4.1)	(−5.3)					
Weather × time					.095**	−.043*	.064**	−.005
					(6.3)	(−2.4)	(4.2)	(−.3)
Yield							.400*	
							(2.1)	
Fruit-grain output							.063**	
							(3.4)	
Relative productivity							−.251**	
							(−5.5)	
SOE share in investment							.061*	
							(2.1)	
Agricultural share in rural labor							.894**	
							(10.0)	
Rice-grain-sown								.130**
								(4.6)
Fruit-grain-benefit								.052**
								(3.7)
Prov. dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	.954	.978	.954	.958	.979	.951	.985	.951
Observations	375	377	377	372	377	377	364	

* Significant at 10% level. ** Significant at 1% level. *T*-statistics are in parentheses (*z*-statistics for 3SLS).

The observations are annual observations on 29 provinces (Guangdong combined with Hainan, and Sichuan combined with Chongqing) for the years 1985–1997. The data for the variables already used by Young are taken from him (or from the *Statistical Yearbook* series) except for four corrections of presumably typos, and the switch to a more meaningful series of agricultural farm machinery in the form of small tractors rather than "power" and a more meaningful measure of irrigation (all explained in the appendix on regression analysis). The numbers in the head row refer to the equations in Young's table V.

Yield: ln (grain output (10 tons)/grain sown area (ha)). (The choice of "10" units follows Young's practice.) Young's data with correction of typos.

Irrigation: ln (irrigated area/cultivated area).

Fertilizer: ln (chemical fertilizer (10 tons)/total sown area (ha)). Young's data.

Small tractors: ln (power of small tractors and hand-led tractors (kw)/total sown area (ha)).

Labor: ln (employment in primary sector (10 persons)/total sown area (ha)). Young's data with correction of typos.

Precipitation: average (for each year) monthly rainfall (cm). Young's precipitation data in first regression.

Temperature: average (for each year) monthly temperature (Celsius).

Sunshine: average (for each year) monthly duration of sunshine (hours).

Weather (Young): 1985–1997 average of province-specific annual values of the precipitation variables multiplied by the precipitation variables' coefficients in "Young'-1" column.

Weather: 1985–1997 average of province-specific annual values of the nine climate variables multiplied by the climate variables' coefficients in column (1').

Fruit-grain-output: ln (fruit output (tons)/grain output (tons)).

Relative productivity: ln (value added per laborer in primary sector/(provincial) GDP per laborer).

SOE share in investment: ln (investment expenditures by state-owned units/total investment expenditures).

Agricultural share in rural labor: ln (agricultural laborers/rural labor force).

Rice-grain-sown: ln (sown area of rice/sown area of grain). Since Qinghai province has no data on rice, inclusion of this variable implies the exclusion of Qinghai.

Fruit-grain-benefit: ln (net benefit [in yuan RMB] per laborer of growing fruit/of growing grain); national variable, that is, not province specific. (For details, see the appendix on regression analysis.)

Sources: Young (http://gsbwww.uchicago.edu/fac/alwyn.young/research/); *Statistical Yearbook* (issues of 1986–1998); *Fifty Years; Seventeen Years; Rural Yearbook.*

Young's regression of yield on weather.[34] A rationale to link trade barriers to Young's findings is lacking.

Provincial agricultural labor intensity may well move against provincial comparative advantage for a variety of reasons (not related to trade barriers), including that in imperfect labor markets with administrative limitations on labor movements, rural population growth may first of all translate into rural labor growth. Where are opportunities for nonagricultural employment growing the fastest? They are near cities, which for obvious geographical reasons tend to develop where agricultural productivity is high. In other words, high initial yield means relative reduction in labor intensity over time as farmers shift to easily (nearby) available nonfarm jobs.[35]

B. *Evidence*

With no logical argument to link the observed patterns in the data to trade barriers, there is no point in examining the evidence. The evidence is examined, nevertheless, in case the reader can think of some way (not mentioned by Young) to link the observed patterns to trade barriers.

One caveat throughout is that some of the variables are problematic: Young uses total primary sector employment per sown area as the variable to relate to grain yield rather than only employment in the production of grain, a limitation imposed by the data.[36] Young's regression analysis suffers from a number of econometric issues. Some of these issues are addressed in the following; others are discussed in an appendix on regression analysis.

Regarding figure 9, the evidence for a negative relationship between initial yield and change in labor intensity is not robust. Five western provinces—Shaanxi, Ningxia, Gansu, Qinghai, and Xinjiang—can explain the negative correlation.[37] If these five provinces, which in 1985 accounted for 5.9% of China's grain output and 6.4% of its population, are omitted, the slope turns slightly positive. What is special about these five provinces? All five are poor provinces with difficult geographic terrain and limited infrastructure; they are located far from the industrialized areas of China and are not known for entrepreneurial spirit. Rural population growth in these provinces may simply translate into rural labor growth.

Or consider the impact of changes in types of grain grown. For example, Inner Mongolia has the fourth-lowest comparative advantage (weather) value among all provinces and the lowest initial (1985) grain yield. With trade barriers, this heavily disadvantaged province, following Young, should move labor into agriculture. Instead, Inner Mongolia goes through the largest fall in labor intensity among all provinces: 27% between 1985 and 1997 (while increasing yields at a near-record level, 64%, third-highest increase among all provinces). Heilongjiang too had a low comparative advantage value, a slight reduction in labor intensity (−1%), and the highest increase in yield among all provinces (100%). Both provinces saw a massive shift out of wheat into corn and soybean production. Perhaps provincial self-sufficiency (trade barriers) forced these provinces to produce food grains prior to the reform period. The development of national grain markets in the reform period then allowed provinces to specialize in those types of grain for which their localities are most suited, and the type of grain then determines labor and other inputs and comes with a grain-specific yield.

Table 2 reproduces Young's core regression results, correcting four errors in his data and switching to more meaningful measures of irrigation and agricultural machinery.[38] (Both types of adjustments, together and independently, slightly improve or strengthen his key findings.) The first regression reported in table 2 identifies the contribution to yield of precipitation, precipitation squared, and the coefficient of variation of precipitation, with the three values subsequently combined into one provincial weather variable. Young's key findings of the negative impact of comparative advantage on labor and yield over time are in the second and third data columns (his regressions 5 and 8, with coefficient values of −.157 and −.253).[39] The regressions are problematic in four respects.

First, Young's source of provincial data on precipitation, the *Statistical Yearbook,* in adjacent tables reports monthly temperatures and duration of sunshine. These data would appear even more relevant as a measure of weather than precipitation: approximately half of all fields in China are irrigated, reducing the importance of precipitation; furthermore, irrigation water may come from rivers fed by rainfall in distant provinces. The fourth regression therefore repeats the first but makes use of all available climate information to derive new weather values. The subsequent two regressions (columns 5 and 6) repeat Young's core regressions using the new, comprehensive weather values derived from

[34] The argument is spelled out in the appendix on regression analysis.

[35] Another explanation of the observed patterns, in the words of Young, is that "agricultural production during the reform period has become less dependent upon the weather, the simple manifestation of technological progress that has undermined historical sources of comparative advantage in agriculture" (p. 1126). (He then repeats the initial yield-labor intensity argument, which I have shown above to be unrelated to trade barriers, as his "final defense.")

[36] Park and Du (2003) question the accuracy of the agricultural labor data as well as the combination of primary sector employment with grain production. They switch to a different data set with crop-specific labor data and net value added as a measure of output, and, controlling for comparative advantages (the weather times time variable), find a positive and significant impact of labor on soybean yield and an insignificant impact on wheat and corn yield. Weather times time has a negative and significant impact on labor inputs only for wheat.

[37] The five provinces have some of the very lowest "weather" (comparative advantage) values, except Shaanxi, which has a medium value. These cases thus also affect the regressions.

[38] Details are provided in the appendix on regression analysis.

[39] For the regressions, I adopt Young's practice of using the ln of variable values because the consequence of doing so, in regression analysis, has a clear and useful meaning (of coefficients measuring percentage changes).

the fourth regression.[40] Young's finding in the case of labor is now reversed: provincial labor intensity moves along rather than against comparative advantage (coefficient of .095); this is the equivalent of a positive slope in figure 9, solely due to a better measure of comparative advantage. Young's findings for yield are partially reversed: labor intensity does not have a negative impact on yield; rather, it has no impact: the yield still moves against weather, but the size of the effect is greatly reduced (−.043).[41]

Second, with Young arguing for a causality from grain yield to labor intensity, a natural consequence is to allow for such a causality in the regressions. The 3SLS results for the system of one labor intensity and one yield equation are reported in the last two columns of table 2. The regressions include a number of controls (instruments), such as types of grain sown and relative measures of nongrain production by agricultural laborers (who are related in their totality to sown area in Young's measure of labor).

In the labor regression, the higher the yield and the higher the comparative advantage value, the higher the labor intensity, according to Young a sign of no trade barriers. In the yield regression, labor intensity is negatively correlated with yield (as Young finds), while comparative advantage exhibits no relationship with yield (contrary to his finding). Overall, provinces are clearly not moving in labor or yield against their comparative advantage once endogeneity of labor and yield are controlled for and (some) omitted variables are included.[42] The control variables all come with plausible coefficients, with the coefficient signs interpreted one by one in the appendix on regression analysis.

Third, Young assumes that yield and factor inputs follow a deterministic trend. But it is unlikely that an increase in trade barriers, or improvements in seed technology or machinery, or the creation of new job opportunities in the nonagricultural sector follow a perfectly predictable trend. More likely than not, a large element of randomness is involved. The procedure then is to take first differences of yield and factor inputs (all in ln, as in Young's regressions), and to rerun the core regressions, those with labor and yield as dependent variables. Comparative advantage (weather) never matters for the annual change in labor or yield (table 3), nor does weather interact with time (if included despite the fact that first differences were already taken).[43]

TABLE 3.—PRODUCTIVITY, FACTOR ALLOCATIONS, AND THE WEATHER, FIRST DIFFERENCES

	dLabor	dLabor	dYield	dYield
dIrrigation			.142	.156
			(.8)	(.9)
dFertilizer			.151**	.152**
			(3.1)	(3.1)
dSmall tractors			−.035	−.033
			(−.6)	(−.5)
dLabor			−.057	−.061
			(−.5)	(−.5)
Weather	−.141	−.061	−.239	−.494
	(−1.6)	(−.3)	(−1.1)	(−1.1)
Year		−.001		−.002
		(−1.0)		(−.7)
Weather × time		−.012		.040
		(−.5)		(0.7)
R^2	.007	.036	.034	.035
Observations	348	348	348	348

*/** Significant at 10%/1% level. *T*-statistics are in parentheses.
Variables are defined as in table 2 (see notes to table 2). d = first differences.

Fourth, all province-specific, nonweather, time-dependent factors are omitted from Young's regressions. But as long as they are minimally correlated with provincial average weather, they end up being indirectly captured by the coefficient of his comparative advantage value interacted with time. A wide range of factors is plausibly correlated, even if only weakly, with Young's weather values; they range from province-specific government agricultural policies over time (possibly mandated by the center) to improvements in specific seed technology (for one type of grain produced in a limited set of provinces), changes in province-specific rural attitudes toward migration, and provincial rules on land tenure. The coefficient of Young's measure of comparative advantage thus potentially captures relative weather plus time-dependent omitted variables.

To take province-specific, time-dependent but not necessarily weather factors into account, yield is first regressed on

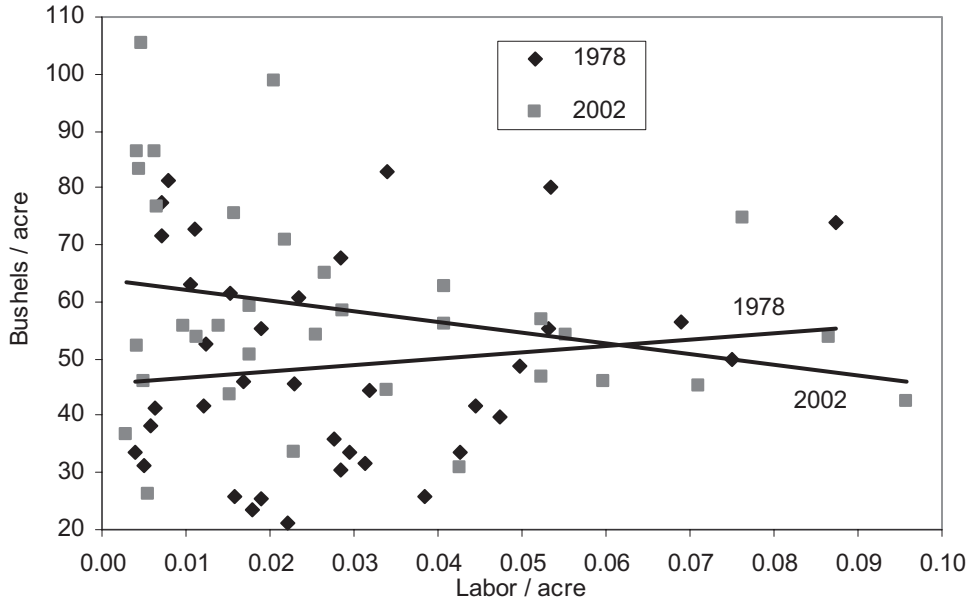
[40] Spearman's coefficient of rank-order correlation between the two measures of weather (Young's measure based on precipitation, first column, versus the new measure based on temperature, precipitation, and sunshine, fourth column) at 0.1345 is significantly different from zero only at a 24% significance level; that is, using a standard 5% or 10% significance level, the two weather measures are not correlated.

[41] With labor as the dependent variable, the coefficient of weather (times time) changes from negative .157 in the case of Young's weather variable to .095 using the new, comprehensive weather values. Because the weather variables change between the two regressions, these absolute values of the coefficients cannot be directly compared; only the sign immediately conveys meaning. In the regression with yield as a dependent variable, the coefficient of weather (times time) changes from negative .253 to negative .043. A one-standard-deviation increase in the value of weather (0.055) is associated with about 0.2% per year slower growth in yield compared to 0.6% per year slower growth in Young's case (third column, with a standard deviation of Young's more limited measure of weather of 0.022) and compared to a mean provincial trend growth of yield of 2.5% per year.

[42] The reported results differ in no significant way if the three control variables of irrigation, fertilizer, and small tractors are omitted from the labor regression (as Young does). They are included because they appear, a priori, relevant. The reported 3SLS results in terms of the effects of comparative advantage over time on yield as well as on labor hold for all variations of the 3SLS regressions that I have explored, as does the effect of yield on labor. The effects of labor on yield lose significance in two scenarios. The appendix on regression analysis reports the results of some variations of the 3SLS regression, going for both a more elaborate and a minimalist setup.

[43] Including irrigation, fertilizer, and small tractors in the labor regressions does not change the results. In the labor regression only, if year is included (and weather interacted with time is not), year is significantly negative; alternatively, if weather interacted with time is included but year is not, weather interacted with time is significantly negative (but not so for yield, where weather interacted with time, or, separately, year, remain insignificant throughout these variations). In the regression reported in the table, I include both simultaneously, year and weather interacted with time, so that weather interacted with time cannot capture general time effects but only comparative advantage effects.

FIGURE 10.—FACTOR INTENSITY AND PRODUCTIVITY, GRAINS MEASURED IN BUSHELS (U.S. STATES)



A cut-off point for labor intensity of 0.1 is applied. Only those grains are included that in the agricultural census are measured in bushels (corn for grain, wheat for grain, oats for grain, barley for grain, sorghum for grain, soybeans for beans). In 1978, grains measured in bushels accounted for 100% of grain output (all items) in about two-thirds of all states (across many states, data on several grains were "not available") but in 2002, all states had diversified away from grains measured in bushels. In part, this could be an artifact in that in 1978, no state had any entry for "corn for silage or greenchop," a nonbushel item, and this output was possibly included in "corn." For further notes and sources, as well as additional data, see the appendix on regression analysis.

Young's usual control variables (irrigation, fertilizer, small tractors, and labor), provincial characteristics (provincial dummies), and provincial characteristics interacted with time. The coefficients of the last capture the average annual provincial growth rate in yield after controlling for factor inputs and time-independent provincial characteristics. In a second step, the thus obtained 29 provincial growth rates (coefficients) are regressed on a constant and the comprehensive weather variable (covering 9 climate variables). Weather has no significant impact on provincial growth rates at or anywhere near the 10% significance level. Replacing the constant by three regional dummies (East, Center, West) makes no difference. In other words, once provinces are allowed to exhibit province-specific development patterns outside the common trend interacted with Young's imposed straitjacket of relative comparative advantage (the relative values across provinces embedded in the weather variable), comparative advantage in the form of weather no longer plays any role in explaining provincial changes in yield over time. Proceeding similarly for labor, with or without the three control variables (irrigation, fertilizer, and small tractors) in the first step regression, weather has a positive and significant impact on provincial changes in labor over time.[44]

C. *Market Economy Benchmark: The United States*

Figure 10 reports 1978 and 2002 labor intensity and yield for the United States, where the yield measure covers those grains that in the agricultural census are uniformly measured in bushels (grain details are in the notes to the figure). For these grains, rather complete data are available for both years. With a focus on those states with total farm employment per acre of harvested land below 0.1 in order to avoid outliers from determining the outcome (with details in the appendix on regression analysis), the positive slope of the year 1978 disappears by 2002, as in China between 1978 or 1985 and 1997.[45] (In the United States, it even turns negative.)

VII. Conclusion

Young concludes: "The central proposition of this paper is, seemingly, unbelievable. One is asked to accept that twenty years of economic reform in the People's Republic . . . have resulted in a fragmented internal market with fiefdoms controlled by local officials whose economic and political ties to protected industry resemble those of the Latin American economies of past decades" (p. 1128). The central proposition of his paper is not "seemingly, unbelievable." It *is* unbelievable.

[44] The significance levels, identical in the two variations of the dependent variable (the provincial time coefficients obtained in the regression of labor on provincial dummies, provincial dummies interacted with time, and in one variation including the three control variables), are 1% with intercept and 5% with three regional dummies.

[45] Further details on the data and the results if a labor intensity of 0.3 is used as a cut-off point and/or if all grains are included (and trying to convert the different measurements) are reported in the appendix on regression analysis.

Across Young's arguments, the causal link between trade barriers and the evidence is weak or nonexistent, and alternative explanations for the evidence appear at least as (if not more) plausible. If, nevertheless, his theoretical argumentation were accepted and one moves on to a careful examination of the evidence, there is no evidence for increasing barriers to trade. If anything, the evidence shows that barriers to trade decrease over time. Where Young refers to but does not document a resemblance of China to Latin American economies of the past, with fiefdoms controlled by local officials with economic and political ties to protected industry, I have documented a strong resemblance to the United States today.

The title of Young's paper, "The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China," refers to the Katha-Upanishad: "Sages say the path [to salvation] is narrow and difficult to tread, narrow as the edge of a razor." The findings here suggest that China's economic reforms have not strayed from the safe path, at least as concerns avoiding the swamp of trade barriers. The path seems sufficiently wide—perhaps the size of a major highway—that some puddles in some stretches appear to have been irrelevant.

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