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Institutional determinants of vertical integration in China ☆

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ABSTRACT

Where legal systems and market forces enforce contracts inadequately, vertical integration can circumvent these transaction difficulties. But, such environments often also feature highly interventionist government, and even corruption. Vertical integration might then enhance returns to political rent-seeking aimed at securing and extending market power. China offers a suitable background for empirical examination of these issues because her legal and market institutions are generally weak, but nonetheless exhibit substantial province-level variation. We report that Chinese firms in the 2000's are more vertically integrated than the U.S. firms in the 1990s. We find that vertical integration is more common where legal institutions are weaker and where regional governments are of lower quality or more interventionist. Further, firms led by insiders with political connection are more likely to be vertically integrated. Finally, vertical integration among politically unconnected firms is associated with elevated per capita GDP level and growth, while vertical integration among politically connected firms is unrelated to local economy performance.

1. Introduction

This paper explores the relationship of vertical integration to institutional development and its impact on economy performance. We define *vertical integration* as common control over adjacent production stages. In an economy with perfect markets – that is, with no transaction costs – vertical integration is intrinsically inefficient because it prevents specialization and

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creates intra-organizational complexity and politics (Milgrom and Roberts, 1988). In addition, integrating vertically related businesses under the common ownership induces organizational costs, including the higher costs of monitoring workers and measuring performance in the more complex organizations (Alchian and Demsetz, 1972; Klein, 2014). However, a variety of convincing reasons can explain vertical integration in real economies.

First, transaction costs in dealings between suppliers and customers can induce vertical integration. Well known information asymmetries and agency problems can induce anticipatable opportunistic behavior, and so distort investment. If legal institutions and market forces are too dysfunctional to let firms contract around such transactions problems, vertical integration is a plausible solution (Khanna and Palepu, 1999; Klein et al., 1978; Williamson, 1975).

Second, weak legal institutions and market disciplinary forces can reflect underlying political economy infirmities – such as excessive regulatory burdens, political interference, or corruption – that can hinder market transactions. Vertical integration can be a rational response to circumvent such bureaucratic impediments and secure, e.g., reliable factor supplies (Stigler, 1951). But this need not end the story, for such economies induce political rent seeking (Krueger, 1974). If regulatory burdens, political interference, or even corruption become important factors in day-to-day business, firms invest resources in influencing them by "lawyering up", lobbying, or even bribing influential public officials. Once firms acquire the ability to influence government officials, lobbying for regulatory or other barriers to competition is a natural use of such influence (Tullock, 1965). Vertical integration reflects the expansion of a rent-seeker's boundaries. In addition, a vertically integrated monopoly is unambiguously more profitable than a sequence of vertically related single-market monopolies (Spengler, 1950).

Empirical studies of vertical integration predominantly examine a given industry in a given developed economy for vertical integration as a response to expected opportunistic behavior (Chipty, 2001; Fan, 2000; Joskow, 1987; Masten, 1984; Monteverde and Teece, 1982; Mulherin, 1986; Ohanian, 1994; Teece, 1976 and others).[4] Relatively few studies test for a link between vertical integration and institutional development or examine the impact of vertical integration on economy-level performance in the context of a developing economy. Yet these are precisely where legal systems and market forces are known to be especially problematic (De Soto, 2000). Studies of vertical integration in such economies – where contracting solutions are unreliable, political rent-seeking is rife, and corporate governance is largely unsupervised by shareholders – should provide the most powerful evidence of its economic functions.[5]

A notable exception is Acemoglu et al. (2009), who use cross-country data to show that vertical integration is significantly greater in countries with higher contracting costs yet greater financial market development. Cross-country studies, though immensely valuable, are unavoidably vulnerable to omitted variable problems, as well as data comparability and measurement problems.[6] For example, innumerable latent factors linked to culture, history, politics, or even language can affect human behavior and hence the organization of the economy as well as institutional development.

Studying province-level data from China mitigates these criticisms, at least to some extent; for these factors are largely common across provinces. Due to variation in proximity to the outside world and in pre-liberalization conditions, different provinces stand at substantially different levels of institutional development. By Western standards, in the 1990s and 2000's legal systems in many parts of China seem sclerotic, political rent-seeking looks rampant, and state control seems pervasive (Allen et al., 2005; Che and Qian, 1998; Cull and Xu, 2005; Fan et al., 2007; Montinola et al., 1995). But these problems are much worse in some provinces than in others (Qian and Weingast, 1996, 1997). Against a common cultural background, this variation in institutional development provides a useful laboratory for exploring how businesses organize themselves in response to their institutional environments.

We use China's input–output (IO) table to measure the prevalence of vertical integration among publicly listed firms (excluding financial firms) in each of China's various provinces, special administrative regions, and autonomous regions — which we collectively call "provinces" for brevity.[7] Controlling for potential asset specificity (Klein et al., 1978; Williamson, 1979) and other plausible factors, we find vertical integration more common in regions with weaker legal systems, worse local government, and less developed market economies. We interpret this as consistent with vertical integration as a corrective measure to circumvent institutional lacuna and a manifestation of political rent seeking.

From biographical information, we define each firm's top executives, whom we call CEOs regardless of their Chinese titles, as apparatchiks if they are now or have ever been Communist Party or state officials. We find apparatchik-run firms to be unusually prone to vertical integration. Alternatively, we measure political connections as access to the privilege of industry entry and to bank loans, both of which are de facto rationed. These further analyses again show that more politically connected firms are more vertically integrated. These results are consistent with at least some vertical integration arising to expand returns to political rent-seeking.

[4] See Lafontaine and Slade (2007) for a survey of the literature.

[5] Parallel concepts are investigated in the foreign direct investment literature, which finds that multinational firms prefer full ownership (i.e., integration) of their foreign subsidiaries where transaction difficulties intrinsic to the nature of the business are high (e.g., Henisz, 2000). Unfortunately, such studies shed scant light on integration as a response to weak legal or market institutions because confounding interpretations arise. For example, foreign and domestic firms have different capabilities for dealing with a wide range of institutional infirmities beyond weak legal and market institutions. These differences constrain their roles as acquirers and acquired (see e.g. Feenstra and Hanson, 2005).

[6] For example, industries that are vertically related in the United States might not be elsewhere, where different technologies require different inputs. Also, contracting cost measure, to be comparable, must be simple — for example "the number of steps required in collecting a debt." Yet, a similar step might be more onerous in one legal system than another.Acemoglu et al. (2009) find meaningful results despite such challenges.

[7] This methodology was developed by Fan and Lang (2000), and used by Shahrur (2005), Fan and Goyal (2006), Acemoglu et al. (2009), and Acemoglu et al. (2010).

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Finally, we are interested in the relationship between vertical integration and regional economy development. If vertical integration is a second best solution to transaction difficulties under weak institutions, it would correlate with improved economy performance. On the contrary, if vertical integration is for rent seeking, its impact on economic performance is less certain. We examine this by averaging the extent of vertical integration across connected and unconnected firms based in a given province to construct province-level measures of the prevalence of vertical integration. The results show that more prevalent vertical integration accompanies higher provincial per capita GDP levels and growth rates in provinces whose vertically integrated firms are predominantly run by non-apparatchiks. In contrast, widespread vertical integration is not significantly related to per capita GDP levels or growth rates in provinces whose vertically integrated firms are predominantly apparatchik-run. To the extent that our analysis is subject to caveats like omitted variables and alternative interpretations, the findings here are tentative.

The paper proceeds as follows. Section 2 develops our hypotheses. Section 3 describes the sample, discusses empirical measures, and provides descriptive statistics. Our main results are reported in Section 3.4.3. Section 4 concludes.

2. The economics of vertical integration

By vertical integration, we mean the integration of activities belonging to distinctly identifiable separate but vertically related industries. To illustrate, consider Weiqiao Group, the largest textile company in China in the 2000s. The group's primary business is producing textiles. But it also grows its own cotton, makes the cotton into yarn, weaves and fabricates the yarn into textiles, imprints the textiles with colors before selling them to customers, and operates its own electricity plant to power its other operations. Weiqiao exemplifies a degree of vertical integration commonplace in China, but rare in developed market economies. What are likely explanations and economic implications?

2.1. Transaction costs and vertical integration

Market transactions between separately run vertically related firms can be costly. Coase (1937) posits that transactions occur within a firm (vertical integration) if the cost of arm's length transactions between specialized firms exceeds that of coordinating multiple activities within one firm. Coase's insight begat an influential literature on the costs of transactions between vertically related businesses (e.g., Klein et al., 1978; Lucas, 1978; and Williamson, 1973, 1975).

Klein et al. (1978) and Williamson (1979) point out that anticipated opportunistic behavior stemming from asset specificity, low transaction frequency, and uncertainty associated with the transactions in question leads to inefficiency. Consider two independent units engaging in upstream and downstream production, each making a specialized investment in period one to prepare for production in period two. Once an investment is made, the resulting asset cannot be used for another purpose without a substantial loss in its value. This cost of adapting the asset to other uses, called asset specificity, can induce the other transacting parties to extract rents ex post (Klein et al., 1978). In the context of China, for example, one manifestation of such behavior is on low supply of quality that makes it hard to safeguard ex post troubles to vertically related firms. This sort of opportunistic behavior is possible because of information asymmetry around the transaction — either a genuinely exogenous unanticipated change or a calculated rent-extraction. This foreseeable possibility induces time-inconsistent behavior that reduces the expected return to specialized investment, and therefore curtails it, resulting in a deadweight loss to the economy. Another source of inefficiency arises because the value of one vertically related business depends on the other — on its effort level and flexibility as well as its willingness to share information and to coordinate employment and investment strategies.

If these inefficiencies are large, integrating the vertically related firms into a single company may be less costly than market transactions between separate firms (Coase, 1937). Since the costs of arm's length transactions are due to weak legal systems rendering contracts unenforceable, and property rights therefore unprotected, reorganizing the businesses under a common owner alleviates these problems (Alchian, 1965).

Asset specificity, whereby assets in place cannot be reassigned to other uses, and uncertainty about the value of contracts are fundamental determinants of transaction costs. Asset specificity often depends on access to alternative suppliers and customers. For example, a factory built in a city with inadequate road and rail links to other cities can be at the mercy of local suppliers and customers who demand changes in the terms of contracts. But a factory in a city with efficient transportation links to other cities can do business with more distant suppliers or customers if local ones become too irksome. Of course, if local customers and suppliers can be trusted to perform as they have agreed, efficient transportation links are less critical (see, e.g., Joskow, 1987).

Thus, our starting point is that *a firm is likely to be more vertically integrated, ceteris paribus, if its transactions are subject to high performance uncertainty and it is located in a region with poor transportation infrastructure.*

2.2. Institutional determinants of vertical integration

While integration into a single firm could be a solution to these transaction difficulties, its drawback is that extensive vertical integration renounces the benefits of specialization (Smith, 1776), diluting management's focus and monitoring incentive (Klein, 2014), and even inducing “territorial” political conflicts within the company (Milgrom and Roberts, 1988).

2.2.1. Legal system

Many transaction difficulties can be avoided if the performance of local customers and suppliers can be guaranteed with effective legal contracts that can be enforced quickly, cheaply, and reliably. Contracts that clearly lay out each party's rights and

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obligations in each set of circumstances can substantially reduce the feasibility and gains from ex post bargaining to extract rents. Reliable contracting can also reduce shirking, stipulate effort, govern information sharing, and predetermine degrees of cooperation. Carefully drafted legal contracts can precisely stipulate legal development and prohibit their infringement. These considerations suggest that *vertical integration should be more extensive in firms located in regions with weaker legal institutions*.

2.2.2. Market forces

Market forces can also discipline opportunistic behavior, rendering integration unnecessary. Highly visible transactions provide market participant information about the behavior of firms and their insiders. Importunate shirking, inadequate performance, and disdain for legal development all engender bad reputations and warn away future potential business partners. Acquiring a reputation as an opportunist, who reneges on promises and manipulates business partners, can become a serious liability. In a free market, where people can choose their business partners, any firm that plans to remain a "going-concern" chooses to behave reliably and honorably (Klein and Leffler, 1981).

Extensive government intervention can weaken market forces by forcing firms to transact with politically favored firms. For example, heavy-handed regulation in China deters entry into the electricity generation business to protect State-owned enterprises. These sporadically renege on commitments to supply electricity, a practice quite prevalent in the 1990s and not unknown in the 2000s — perhaps because of simple incompetence, or perhaps in attempts to extract bribes for reliable power supplies. Since no alternative power suppliers are permitted, electricity users must accept behavior that could not persist in an open and competitive market for electricity.

Vertical integration can again provide a way out. The textiles business discussed above, Weiqiao, opted for vertical integration by constructing an in-house electricity plant. The cheapest technology operated on a scale larger than Weiqiao required, so the firm found itself with more electricity than it needed. Forbidden from selling power, Weiqiao began refining aluminum to make profitable use of its excess electricity.

Aluminum smelting is not obviously related to Weiqiao's core textile operations, but requires vast amounts of electricity. Sequential vertical integration of this sort can look like unrelated diversification, but is not. Again, the state's suppression of market forces is responsible (Alchian, 1965). Such multi-stage vertical integration would make no sense had Weiqiao been able to sell its surplus electricity.

In the United States, these considerations are primarily of historical interest. For example, the United States retained wartime price controls on many goods into the early post World War II era. Peacetime economic fundamentals left some of these prices too low to cover production costs, and caused firms to cease producing the price-controlled goods. This left downstream users of the price-controlled goods contending with extreme shortages of critical inputs. Since offering higher prices in arm's length transactions was illegal, customer firms merged with their suppliers (Stigler, 1951). One unit of the vertically integrated firm could then compensate the other for its costs without violating the price control laws, since no actual "sale" occurred at any specifiable "price".

But in 21st century China, these same considerations arise. Heavy-handed regulation induces vertical integration both by undermining market forces that otherwise would encourage market transactions between vertically related firms and by inducing distortions that disrupt intermediate goods markets. Hence, our third hypothesis is that *a firm is more likely to adopt a vertical integration strategy where markets are heavily regulated and/or underdeveloped*.

2.2.3. The other side of the coin

Our consideration will be incomplete without paying attention to the contribution in Alchian and Demsetz (1972) which argues that joint team production faces a metering problem: it refers to the challenge in measuring each input's contribution and thus appropriately incentivizing and rewarding each in joint production. An owner–manager can organize and monitor the workers in a firm, therefore directly handling the metering problem and improving team productivity. Klein (2014) links this to the transaction cost theory of the firm and points out that the metering and monitoring problem is greater the more complicated is a firm. Vertical integration certainly raises a firm's complexity and thus the possibility of inefficient production.

In other words, the concerns raised in Klein et al. (1978) are about the costs of using the market for vertically related activities stemming from the bargaining and coordination problems which in turn stemming from individual factor owners' tendency to extract quasi-rents and shirk. Alchian and Demsetz (1972) focus on the role of an entrepreneur and his firm, as defined in Coase (1937), in overcoming contracting problems arising from the measurement issue.

However, the entrepreneur's monitoring capacity is limited in the real world, which in turn limits the size of a firm. Moreover, the entrepreneur's incentive is also limited. In the Alchian and Demsetz (1972) discussion, the entrepreneur is a residual claimant, a manager–owner who imposes no agency problems on herself. However, in reality, where management and ownership are often separate, the manager's objective can deviate from that of diffused residual claimants, inducing costs of incentive alignment (Jensen and Meckling, 1976).

In the context of China, SOE managers' are surely not owners of the firms, and therefore subject to the incentive alignment issue and associated agency costs. Likewise, privately owned firms may have a concentrated control problem leading to resource extraction for private benefits. Moreover, the market and legal institutions in the country are generally weak. Although the weak legal institutions and market forces raise the cost of using the market and therefore increase the benefit of integration between vertically related businesses, they also raise the cost of using internal organization as implied by the analysis in Alichian and Demsetz (1972) and Klein (2014). Whether the Chinese firms become more or less vertically integrated in response to the country's weak institutions seems to be an empirical issue. Adding one more layer of complexity, China is subject to underdeveloped corporate

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governance and the separation of government and business is far from complete. Therefore vertical integration decisions of these firms could be affected by non-value pursuing managers which the next section turns to.

2.2.4. Political connection

Onerous regulations limiting the right to operate a business in China lead to several very important additional considerations. Bureaucrats' powers to allocate these rights, and to interfere in businesses' operations, foster a specialized class of rent-seeking firms, which gain business opportunities by trading favors with bureaucrats and sustain their competitive advantage through corporate insiders who once served as bureaucrats.

These rent-seeking firms often use their political influence to obtain localized state-enforced monopolies. They would then use integration to extend the scope of monopoly power by expanding the monopolist's market power upstream and downstream. That is, a vertically integrated firm might magnify the returns to its investment in political clout by foreclosing competition in those industries as well.

Such local monopolists would also opt for vertical integration to avoid "double marginalization" (Spengler, 1950). Double marginalization arises where vertically related monopolists fail to internalize the implication of one's high price on the other's profits, and hence collect less monopoly rents than if they coordinate their action to maximize their joint profits. Contractual arrangements might achieve such coordination, so integration is particularly appealing where contracting options are limited (Cabral, 2000).

State and Party officials might welcome such expanded monopolies. Corrupt officials might cooperate in their establishment for a share of the monopoly rents created, but honest officials might also find that dealing with a single firm simplifies social engineering negotiations with the business sector.

These considerations motivate our fourth hypothesis: *the more deeply a firm is connected with official bureaucrats, the more vertically integrated is the firm's business structure*.

2.2.5. Good government

At a more general level, regulation per se might well matter less than the overall quality of government. A government more rife with bureaucrats' intent on extracting rents, collecting bribes, or even explicitly expropriating private property would motivate firms to invest more heavily in official connections merely to cope. Moreover such an environment raises the costs of market transactions, and thus reinforces firms' incentives to integrate vertically. Not only would firms with extensive investments in official connections vertically integrate to enhance their rent-extraction, but politically unconnected firms would do the same to avoid arm's length transactions in markets rendered dysfunctional by predatory government officials.

Hence, our fifth hypothesis is that *firms are more likely to integrate vertically in regions with lower quality government*.

2.2.6. Summary

We thus expect a firm to be more vertically integrated if its managers are politically connected and if it lies in a China province or special district characterized by poor quality government, weak legal systems, and/or ill-developed markets.[8]

2.3. Vertical integration and economy performance

Overall, this reasoning suggests that coordination and (ex post) bargaining issues deter undiversified firms from forming in vertically related industries. Where weak market disciplinary forces and dysfunctional legal institutions make arm's-length contracts of uncertain value, vertical integration can be an efficient second best solution. Indeed, this insight underlies Rosenstein-Rodan's (1943) view that a state-coordinated Big Push is a necessary precursor to the rapid industrialization of a developing economy. Even in a developed economy, vertical integration can be an economically rational response to extensive government intervention — for example, Stigler (1983) attributes America's late-1940s merger wave to firms circumventing the country's policy of continuing wartime price controls. These considerations suggest that vertical integration might also be growth enhancing in China.

However, it is also possible that vertical integration in China could reflect politically connected firms' successful rent-seeking aimed at accumulating monopoly power — with unclear implications for economic efficiency and growth. On the one hand, the vertical integration of multiple monopolists, each already existing by dint of political connections, could enhance efficiency (Shleifer and Vishny, 1993).[9] On the other hand, vertical integration aimed at building new monopolies or extending existing monopolies further along product chains worsens inefficiency and, by signifying high returns to political rent-seeking, could discourage economic activity and retard growth (Krueger, 1974; Murphy, Shleifer and Vishny, 1991).

One possible synthesis of these considerations might posit more vertical integration being correlated with elevated per capita GDP levels and growth rates if vertical integration is largely a tactic used by politically unconnected firms seeking to cope with weak institutions, but with the correlation being of uncertain sign if vertical integration is more commonly associated with

[8] Khanna and Oberholzer-Gee (2005) find that the extent of government interference in each province correlates with the existence of large firms. They argue that either political interference protects incumbents or incumbents must attain a certain size to combat interference.

[9] The argument is as follows: a highway with only one toll booth generates more efficient traffic patterns than a similar highway featuring multiple independently run toll booths, with each toll booth owner maximizing her toll revenues. A coordination problem in the latter case leads each operator to charge too high a toll, resulting in inefficiently low traffic.

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politically connected firms amassing monopoly power. If so, we might posit that *per capita GDP should be more positively correlated with vertical integration where firms are less politically connected.*

3. Data, measurement, and basic statistics

We examine the validity of the above hypotheses using China as our empirical setting. Because of substantial variation in both the strength of market forces and the quality of institutions across its regions, China provides a natural testing ground for these issues. This variation, against a less heterogeneous cultural background, provides a unique opportunity to examine the roles of market and legal institutions in firm vertical integration decisions. Another advantage is that publicly available information lets us identify which Chinese firms receive preferential treatment or are 'connected' with government officials.

The following first describes our sample and our measure of vertical integration, and then explores patterns of firm vertical integration.

3.1. Sample

Our sample includes most companies listed on the Shanghai and Shenzhen stock exchanges from 2002 to 2010. The China Securities Regulatory Commission requires that listed companies disclose segment information for all business segments comprising more than 10% of consolidated sales, assets or profits. Disclosed information about a given segment typically includes an industry name, a description of products or services, and segment sales. We manually collect these data from annual reports starting in 2002, since from that year on coverage and reporting quality substantially improve.

Companies reporting non-positive sales or incomplete segment sales and industry sector information are dropped. Financial firms are excluded because their financial statements are not comparable to those of other firms. Our final sample consists of 1912 firms and 11,563 firm-year observations. The sample firms account for almost 80% of total listed companies.

We define a firm's *primary industry* as the industry in which it has the largest sales. Our firms' primary industries span the whole economy, with the most common being the machinery, equipment, and instrument sector, followed by the glass, mineral and metal sector, the petroleum and chemical sector, and the commerce (trade) sector. Table 1 describes the sample by year and industry.

Table 1
Sample by year and industry. Our sample consists of non-financial listed companies in Shanghai and Shenzhen Stock Exchanges from 2002 to 2010. All such firms are included except companies reporting non-positive sales or incomplete segment sales and industry sector information.

Panel A: Sample by year

Year	Obs.	Percentage
2002	965	8.3%
2003	1048	9.1%
2004	1109	9.6%
2005	1223	10.6%
2006	1208	10.4%
2007	1314	11.4%
2008	1487	12.9%
2009	1457	12.6%
2010	1752	15.2%
Total	11,563	100%

Panel B: Sample by industry

Industry	Obs.	Percentage
Agriculture, forestry and fishing	156	1.3%
Mining	180	1.6%
Food and beverages	540	4.7%
Textile, apparel and leather	420	3.6%
Lumber, furniture, paper and printing	337	2.9%
Petroleum, chemicals, rubber and plastic products	1255	10.9%
Glass, minerals and metals	1336	11.6%
Machinery, equipment and instrument	2559	22.1%
Medicine and biological products	685	5.9%
Utility	524	4.5%
Construction	263	2.3%
Transportation	472	4.1%
Commerce	1254	10.8%
Real estate	897	7.8%
Services	685	5.9%
Total	11,563	100%

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3.2. Vertical integration proxy

Given that direct firm-level vertical integration data are unavailable, we modify the methodology of Fan and Lang (2000) to use China's input–output matrix and our firm-level data, described above, to construct a firm-level proxy for vertical integration intensity. The construction of this vertical integration measure involves two steps.

In the first step, we create inter-industry vertical relatedness coefficients. This involves computing the coefficients between each pair of 122 industries defined in the 2002 Chinese input–output table. The table reports, for each pair of industries i and j, the value of inputs from industry i used by industry j as a fraction of the value of industry j's total output. We denote this fraction as v_{ij}. Either a high v_{ij} or a high v_{ji}, or both, suggests opportunities to integrate activities in i and j in the same firm. We therefore define the vertical relatedness coefficient between industries i and j as

$$V_{ij} = \max\left(v_{ij}, v_{ji}\right). \quad [1]$$

In the second step, we construct a firm-level vertical integration measure by computing the weighted average vertical relatedness coefficients of each pair of its segments, excluding same-segment pairs. To do this, we construct a matrix of indicator variables $[\delta_{i,j}]$ for each firm, setting $\delta_{i,j}$ to one if the firm operates in both industries i and j, and to zero otherwise. We then define the firm's vertical integration measure as:

$$V_{max} = \frac{1}{n-1}\sum_{i=1}^{n} w_i \sum_{j \neq i} V_{ij}\delta_{i,j} \quad [2]$$

with $V_{i,j}$ defined as in Eq. (1) and with w_i a weight equal to the sales of the firm's segment in industry i. We divide the weighted sum in Eq. (2) by $n - 1$ to account for its mechanical increase with the number of segments the firm contains.[10] For a one-industry firm ($n = 1$), we set V_{max} to zero.

An example illustrates. Huangshan Tourism Development Co., Ltd. has three segments in 2002: tour operation, hotels, and transportation, accounting for 59%, 20%, and 21% of firm sales, respectively. Using the input–output table, we estimate that tour operation employs 0.0700 of hotel services to produce one yuan of output, and conversely hotels consume 0.0020 of tour operation products for every yuan of output generated. The inter-industry relatedness coefficient of tour operation with hotels, V_{ij}, is thus 0.0700, the maximum of the two input requirement ratios. Similarly, the relatedness coefficient of hotels with transportation is 0.0056, and that of tour operation with transportation is 0.0465. The equation above then lets us estimate the overall extent of vertical integration of the firm, defined as $1/2 \times [59\% \times (0.0700 + 0.0465) + 20\% \times (0.0056 + 0.0700) + 21\% \times (0.0465 + 0.0056)]$, or 0.0474.

In other words, a firm's level of vertical integration is the sales-weighted average of the vertical relatedness coefficients of all pairs of industries in which the firm reports sales.

We calculate V_{max} for each firm each year. Table 2 summarizes the vertical integration measure. Panel A shows the averages of V_{max} to be 0.0258. That is, the firms potentially could transact 2.58 fen (the Chinese unit for "cent") of its business dealings with in-house affiliates, for every yuan of output it produces. In terms of time series, the average degree of vertical integration is stable over time. Across the 15 broad industries, our proxy indicates vertical integration to be most pronounced in mining, agriculture, forestry and fishing, but is lowest in medicine and biological products.

We are interested in comparing the extent of vertical integration between Chinese and U.S. firms. In order to make the comparison we first examine whether industries in the two countries exhibit similar degrees of vertical relatedness. We find that Chinese inter-industry vertical relatedness coefficients are highly correlated with those calculated from a U.S. input–output table. The Pearson coefficient arrives at 0.542 and is significant at the one percent level. Then, we compare the vertical integration intensity of our sample firms with that of the U.S. firms as reported in Fan and Lang (2000). To be consistent with the Fan and Lang's study, we redefine the inter-industry vertical relatedness coefficient as $V_{ij} = 1/2(v_{ij} + v_{ji})$ and focus on privately owned multi-segment firms. The mean vertical integration intensity for the Chinese firms between 2002 and 2010 is 0.0235. Fan and Lang (2000) report that the average vertical integration intensity of U.S. firms between 1979 and 1997 is 0.0195. It appears that Chinese firms in the 2000's are more vertically integrated than the U.S. firms in the 1990s.

Ours is one of the several possible methods for constructing a vertical integration index. One alternative would distinguish input integration from output integration. Input integration, v_{ij}, measures the fraction of industry j's input sourced from industry i; that is scaling the (i,j) entry in the I/O table by industry j's total input. Output integration is then the fraction of output from industry i allocated to industry j; that is scaling the (i,j) entry in the I/O table by industry i's total output. One might legitimately define vertical relatedness in either way, or as the average, minimum, or maximum of the input and output measures, depending on the question at hand. All these alternatives generate results qualitatively similar to those shown in the tables.

For studies using Chinese input–output data, a critical issue is noise due to end consumption and imports. Large amount of end consumption and/or imports would induce noise in total output which is used as the scaling factor. Upon consulting experts on

[10] For example, consider a three-segment firm with one-third of its sales in each industry. If the vertical relatedness coefficients for pairs of the segments were each one, the weighted sum of each pair of vertical coefficients is two. Dividing this sum by two (three minus one) rescales the vertical measure back to one. Unadjusted, the sum would rise with the number of segments.

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Table 2
Patterns of vertical integration. Summary statistics by year and industry for the firm-level vertical integration measure. Firms are more vertically integrated if their segments lie in industries that source or sell more extensively to each other in China's national input–output table.

Panel A: Vertical integration intensity by year

Year	Obs.	Mean	Median	Std. dev.	Min.	Max.
2002	965	0.0244	0.0125	0.0488	0.0000	0.5299
2003	1048	0.0251	0.0131	0.0504	0.0000	0.5299
2004	1109	0.0263	0.0131	0.0517	0.0000	0.5299
2005	1223	0.0264	0.0131	0.0519	0.0000	0.5299
2006	1208	0.0267	0.0131	0.0494	0.0000	0.5299
2007	1314	0.0258	0.0131	0.0498	0.0000	0.5881
2008	1487	0.0267	0.0121	0.0546	0.0000	0.6837
2009	1457	0.0266	0.0116	0.0527	0.0000	0.6837
2010	1752	0.0244	0.0097	0.0483	0.0000	0.6837
Total	1,1563	0.0258	0.0124	0.0509	0.0000	0.6837

Panel B: Vertical integration intensity by industry

Industry	Obs.	Mean	Median
Agriculture, forestry and fishing	156	0.0843	0.0346
Mining	180	0.0860	0.0299
Food and beverages	540	0.0391	0.0143
Textile, apparel and leather	420	0.0386	0.0166
Lumber, furniture, paper and printing	337	0.0193	0.0078
Petroleum, chemicals, rubber and plastic products	1255	0.0262	0.0162
Glass, minerals and metals	1336	0.0326	0.0065
Machinery, equipment and instrument	2560	0.0232	0.0072
Medicine and biological products	685	0.0178	0.0015
Utility	524	0.0246	0.0175
Construction	263	0.0237	0.0206
Transportation	472	0.0132	0.0102
Commerce	1254	0.0250	0.0258
Real estate	897	0.0078	0.0041
Services	684	0.0209	0.0126

China's official statistics, we are confident that our vertical integration indices are likely to be less contaminated by these problems and thus reflect domestic industry sourcing from each other, scaled by domestic industry total output.[11]

3.3. Data caveats

Our data are observations of individual firms. However, vertical integration is accomplished by placing two or more distinct one-industry firms under common control. Common control is most readily effective by combining these firms into one, but can also arise if a group of seemingly independent firms come under the direct or indirect control of a single dominant shareholder (Morck, Wolfenzon and Yeung, 2005).[12] Because business groups are present in China (Fan et al., 2013) and we cannot identify vertical integration via business groups due to data limitations, we may well underestimate the overall incidence of vertical integration.

If integration via business group is the norm, we should find no discernable relationship between individual firms' vertical integration and our various other variables. If integration occurs through both mechanisms, and if business groups simply add noise to our variables, any significant findings become all the more credible.

Of course, if business group formation is governed by unknown factors that interact inauspiciously with our variables, clear econometric problems arise. Dealing with these effectively would require the complete categorization of all group ties among all listed Chinese firms. The construction of such a dataset lies well beyond the scope of this study; however, we hope to explore this issue in subsequent research.

3.4. Focal independent variables

This section describes the independent variables used to proxy for possible economic determinants of vertical integration.

Some of these are province-level variables. The People's Republic of China is a federal state composed of twenty-two provinces (*shěng*, or 省), four province-level municipalities (*zhíxiáshì*, or 直辖市), five autonomous regions (*zīzhìqù*, or 自治区), and two

[11] We thank Shuchang Qi, deputy director of census center in National Bureau of Statistics, and Shouzhong Ge, professor of national economic statistics in Shanghai University of Finance and Economics, for answering our inquiry.

[12] Other alternatives, such as cross-holdings, interlocking boards, director appointment clauses in corporate charters, and the like are also possible. See Khanna and Yafeh (2007).

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special administrative regions (*tèbié xíngzhèngqū*, or 特别行政区). Our list of provinces excludes Taiwan, which the People's Republic considers a breakaway twenty-third province. The municipal governments of Beijing, Tianjin, Shanghai, and Chongqing exercise province-level powers. The legislatures of the five autonomous regions – Tibet, Guangxi, Xinjiang, Inner Mongolia, and Ningxia – exercise slightly broader powers than those of the provinces, and each contains substantial non-Han populations. The governments of the two special administrative regions, Hong Kong and Macau, exercise many of the powers of national government, though not foreign affairs or defense. The two special administrative regions are not included in our sample. For simplicity, we use the term *province* to refer to all of these included regions, which the People's Republic classifies as province-level administrative divisions.

3.4.1. Asset specificity and uncertainty

Vertical integration is a response to asset specificity and uncertainty associated with arm's length transactions. We capture asset specificity with a key institutional feature — the quality of each province's *transportation infrastructure*, as reflected in the total length, in kilometers, of railways, waterways, and highways in the province divided by its total geographic area, in square kilometers. Inadequate regional transportation infrastructure restricts parties' ability to find alternative business partners, and so heightens asset specificity problems by aggravating the potential for hold-up problems. This elevates the costs of market transactions, rendering vertical integration more desirable.

We gauge performance uncertainty by input *price uncertainty*, as in Lieberman (1991) and Fan (2000). We define the input price uncertainty in a year as the standard error of the residuals of a regression of the log of an industry's annual inflation-adjusted primary input price index on a time trend using the previous ten year data. We employ the input–output table to identify the primary input of an industry. Price uncertainty of a firm is the firm's primary industry's input price uncertainty as defined above. Higher price uncertainty should raise arm's-length transaction costs and therefore render vertical integration more likely.

3.4.2. Institutional factors

Section 2 hypothesizes that vertical integration should correlate with various institutional deficiencies, such as weak legal institutions, low quality government, and lagging market development.

Our index of *legal development* is published by *The Annual Report of Urban Competitiveness in China* (Li, 2002–2010). Researchers at the Chinese Academy of Social Science survey a sample of ordinary citizens, entrepreneurs, and scholars in multiple cities to gauge the "competitiveness of cities" in China. The questions related to legal development measure (i) the likelihood that property rights are protected; (ii) the protection of intellectual rights; and (iii) the degree of contract enforcement by courts. Applying a principal component analysis to these survey data creates a city level index of legal development. We aggregate the city level index to the province level by taking its average across all cities in each province.

The measure of *government development* also comes from *The Annual Report of Urban Competitiveness in China* (Li, 2002–2010), which is based on the survey of multiple cities across China. The related survey questions include (i) the degree of bureaucratization; (ii) the frequency of government expropriation, and (iii) the level of citizen satisfaction with governments. Similarly, a principal component analysis is applied to create a city level index of government development. We aggregate the city level index to the province level by taking its average across all cities in each province.

Finally, we require a general measure capturing the extent to which intermediate goods are allocated by markets rather than by bureaucrats. Unfortunately, such a measure is not available. We therefore substitute a proxy: the importance of employment in the private sector as opposed to the state sector. Specifically, our *market development* proxy is the percentage of workers in the province officially registered as employed in the private sector – that is, registered as employed in private enterprises or as self-employed individuals (*gètíhù* or 个体户) – rather than as employees of state-owned enterprises or state and Party organs. These data are from *The Index of Marketization of China's Provinces*, as compiled by Fan, Wang and Zhu (2002–2010). The index measures market development in each province by year. We expect that a high degree of private sector employment is associated with a vibrant general market activity.

3.4.3. Rent-seeking potential and political connections

Section 2 also points out that vertical integration might be motivated by rent-seeking. We therefore construct a set of political connection variables to capture firms' potential returns to political rent-seeking.

Following Fan et al. (2007), our first political connection variable is *apparatchik CEO*, an indicator variable set to one if a firm's CEO is, or has been, a state or Communist Party official of the central government, the regional government, or an industry bureau.

Our second measure, *business privilege*, also an indicator variable, is set to one if any of the firm's lines of business is a heavily regulated sector (utilities, postal services, communication, railroad transportation, air transportation, mining, metals, or finance) and to zero otherwise. In China, the right to operate in these sectors is highly restricted, and must be granted by the State.

We surmise that corporate insiders with Party or government backgrounds, or who obtained the right to operate in a heavily regulated industry, are likely to be politically connected. We therefore take these two variables as reflecting political rent-seeking ability. We assume that such ability opens further political rent-seeking opportunities, and hence provides superior access to business opportunities.

Our third proxy for political connection is long-term leverage, measured by each firm's long-term debt over its total assets. Sapienza (2004), Khawaja and Mian (2005), and Allen et al. (2005) argue that politically connected firms have better access to

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bank financing in general. Because China's banks are all state-controlled, this bias is quite likely even stronger there. We therefore set an indicator variable *high leverage* to one if a firm's long-term debt over total assets is above the median for all firms in that province, and to zero otherwise. A caveat is in order here, however, for this variable has a potential alternative interpretation — better access to capital facilitates acquisitions, including acquisitions of vertically related firms.

3.4.4. Other controls

We consider several more variables as controls. First, larger firms might be more vertically integrated than smaller ones simply because they are larger. For example, economies of scale in a core line of business might translate into similar economies in secondary and tertiary lines of business, rendering vertical integration less costly. We gauge firm size by the natural log of the firm's total assets.

Young firms might be more vertically integrated than old firms because it takes time to establish exchange relationships in China's emerging marketplace. Or young firms might be more vertically integrated if formerly fully state-owned enterprises are highly vertically integrated at their IPOs, and acquire more focus subsequently. To control for either eventuality, we measure firm age by the number of years the firm has been listed, and denote this as *years listed*.

We also include provincial *per capita gross domestic product* (GDP) to account for the effects of regional economic conditions on firm organizational structure. This control also mitigates the possibility that our transportation infrastructure and institutional variables might proxy for general province-level development.

Table 3 summarizes the definitions and data sources for these variables.

3.5. Descriptive statistics

Table 4 reports basic descriptive statistics across pooled observations for each variable. The number of observations differs across variables because some are province-level while others are industry- or firm-level. Substantial variation in institutional quality across China's regions is confirmed by the substantial standard deviations of the province-level institutional variables.

Table 5 reports Pearson correlation coefficients between pairs of time-serial mean variables of interest. Vertical integration correlates positively with price uncertainty, and negatively with transportation infrastructure. Vertical integration also correlates negatively with institutional strength, as measured by our province-level legal, government, and market development indexes. Vertical integration significantly correlates positively with all three measures of political connection. These findings leave scope for all the drivers of vertical integration considered above.

Finally, the table warns of potential multicollinearity between the transportation infrastructure variable and legal development ($\rho = 0.727$), government development ($\rho = 0.607$), market development ($\rho = 0.655$) and also the provincial level GDP per capita ($\rho = 0.787$). Likewise, per capita GDP also correlates significantly positively with legal development,

Table 3
Definition of variables.

Variable	Definition	Data source
Legal development	An index measuring (i) the likelihood that property rights are protected; (ii) the protection of intellectual rights; and (iii) the degree of contract enforcement by courts.	The annual report on urban competitiveness in China
Government development	An index measuring (i) the degree of bureaucratization; (ii) the frequency of government expropriation, and (iii) the level of citizen satisfaction with governments.	The annual report on urban competitiveness in China
Market development	An index measuring the percentage of employment in private enterprises or self-employed individuals.	The index of marketization of China's provinces
Apparatchik CEO	An indicator set to one if the firm's CEO is now or has ever been a bureaucrat of the central government, a local government or an industry bureau; and to zero otherwise.	Fan et al. (2007)
Business privilege	An indicator set to one if the firm operates in a heavily regulated industry (utilities, postal services, communication, railroad transportation, transportation by air, mining, metals, or finance); and to zero otherwise.	Corporate annual reports
High leverage	An indicator set to one if the firm's total outstanding long-term loans exceed the median level for all firms in the province, and to zero otherwise.	CSMAR[a]
Price uncertainty	The standard error of the residuals of a regression of log of the firm's largest segment's primary input price on a time trend over the previous ten years.	China Price Yearbook
Transportation infrastructure	Total length of all highway, railway, and waterway in the province in kilometers divided by its total geographic area in square kilometers.	China Statistical Almanac
Firm size	The natural logarithm of firm assets.	CSMAR
Years listed	The number of years since the firm's IPO.	CSMAR
Per capita GDP	The province's per capita GDP in tens of thousands of yuan.	China Statistical Almanac
Per capita GDP growth	The annual growth rate of per capita GDP.	China Statistical Almanac
Capital	The natural logarithm of cumulative annual capital investment, estimated from a perpetual inventory model with 7% depreciation rate, in the province from 1984.	China Statistical Almanac
Education	The fraction of the province's population able to read and write.	China Statistical Almanac

[a] CSMAR is China Stock Market & Accounting Research Database, developed by Shenzhen GTA Information Technology Co., Ltd.

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Table 4
Descriptive statistics of variables. Variables are defined in Table 3. Samples for firm-level variables are 11,563 firm-year observations for 1912 firms from 2002 to 2010. Province-level variables have up to 279 province-year observations over 31 provinces from 2002 to 2010. Price uncertainty is an industry-level variable with 848 industry-year observations on 111 industries from 2002 to 2010.

Variable	Obs.	Mean	Median	Std. dev.	Min.	Max.
Asset specificity & uncertainty						
Price uncertainty	848	0.1607	0.1728	0.0627	0.0075	0.2503
Transportation infrastructure	279	0.6532	0.5337	0.4746	0.0326	2.3585
Institutional development						
Legal development	279	0.6456	0.6470	0.1110	0.4240	1.0000
Government development	279	0.5895	0.6230	0.2306	0.0980	1.0000
Market development	279	7.4222	7.4500	3.2430	0.3400	14.6500
Political connection						
Apparatchik CEO	11,563	0.1252	0.0000	0.3310	0.0000	1.0000
Business privilege	11,563	0.2038	0.0000	0.4028	0.0000	1.0000
High leverage	11,563	0.5016	1.0000	0.5000	0.0000	1.0000
Other variables						
Firm size	11,563	21.3892	21.2829	1.1923	10.8422	28.1357
Years listed	11,563	8.7801	9.0000	4.3144	1.0000	21.0000
Per capita GDP	279	1.9758	1.4933	1.5093	0.3153	9.4920
Per capita GDP growth	279	0.1494	0.1480	0.0923	−0.2066	0.4514
Capital	279	9.2504	9.3902	1.0332	5.6307	11.3351
Education	279	0.8912	0.9136	0.0786	0.4514	0.9725

government development, and market development. We revisit these correlations below when we discuss our multiple regressions.

4. Empirical results

4.1. Vertical integration and its determinants

We now turn to multiple regressions that control for other factors that might affect vertical integration. We run these on pooled firm-year data. Our province level variables exhibit no variation across firms within each province. Likewise, we have industry-level variables that exhibit little or no variation across firms in each industry. Finally, some of our firm level variables may well exhibit little variation through time. To avoid upward biased t-statistics, we employ standard errors clustered by firm and year throughout, as recommended by Petersen (2009).

The values of our vertical integration measures V_{max} are bounded below by spikes of observations at zero — presumably because some firms decide the net costs of operating in multiple industries along the value chain outweigh the net benefits of specialization. To resolve this data censor problem, we employ Tobit regression. Table 6 reports the regression results.

The first column in Table 6, denoted as regression 6.1, reveals price uncertainty significantly positively correlated with vertical integration intensity. Further, the coefficient of transportation infrastructure is significantly negative, suggesting that a weak transportation system correlates significantly with greater vertical integration. We interpret this pattern as consistent with greater vertical integration occurring where asset specificity and uncertainty problems pose greater threats to overly specialized firms.

The second pattern is evident in regressions 6.2 through 6.5, which all show more extensive vertical integration in provinces with worse legal protection for private property rights, worse government, and less developed market economies. These institutional variables are clearly economically significant too. For example, based on regression 6.2, setting all the independent variables at their means, a 10% improvement in the property rights reduces vertical integration by 7.73%, almost 1.52 times larger than the standard deviation of the vertical integration measure. Similarly, a 10% improvement in "government quality" reduces vertical integration by 4.77%. Market development has a similar economic significance, and a 10% improvement reduces vertical integration by 5.08%.

We take this pattern as consistent with a transaction cost explanation of vertical integration: it lets firms circumvent weak institutions that render private transactions problematic.

The third pattern evident in Table 6 pertains to our measures of political connections. Because Table 5 shows the three proxies for "connections" significantly correlated with each other, Table 6 presents separate regressions – 6.3, 6.4, and 6.5 – including each political connection proxy in turn, rather than a single regression including all three. The political connection variables, *apparatchik CEO*, *business privilege* and *high leverage*, are all significantly positively correlated with vertical integration. Political connections have very high economic impact. For example, switching a firm's CEO from not being a prior government bureaucrat to being one increases vertical integration by 40.45%. We interpret these results as consistent with politically connected firms being more vertically integrated due to rent seeking.

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Table 5
Pearson correlation of coefficients. The variables are described in Table 3. Numbers in parentheses are p-levels for rejecting zero correlation. All correlations of variables are of time-series means.

		V_{max}	1	2	3	4	5	6	7	8	9	10	11	12	13
Asset specificity and uncertainty															
1	Price uncertainty	0.0518 (0.02)													
2	Transportation infrastructure	− 0.0608 (0.01)	− 0.0056 (0.80)												
Institutional development															
3	Legal development	− 0.1007 (0.00)	− 0.0117 (0.61)	0.7274 (0.00)											
4	Government development	− 0.1044 (0.00)	− 0.0384 (0.09)	0.6071 (0.00)	0.7025 (0.00)										
5	Market development	− 0.0980 (0.00)	− 0.0321 (0.16)	0.6553 (0.00)	0.8490 (0.00)	0.6653 (0.00)									
Political connection															
6	Apparatchik CEO	0.0469 (0.04)	0.0462 (0.04)	− 0.0909 (0.00)	− 0.0923 (0.00)	− 0.0928 (0.00)	− 0.1010 (0.00)								
7	Business privilege	0.1209 (0.00)	0.2797 (0.00)	− 0.1278 (0.00)	− 0.1433 (0.00)	− 0.1084 (0.00)	− 0.1393 (0.00)	0.0508 (0.03)							
8	High leverage	0.0864 (0.00)	0.1074 (0.00)	0.0003 (0.99)	− 0.0072 (0.75)	0.0087 (0.70)	− 0.0047 (0.84)	0.0027 (0.90)	0.2187 (0.00)						
Other variables															
9	Firm size	0.1063 (0.00)	0.1453 (0.00)	0.0990 (0.00)	0.0294 (0.20)	0.0286 (0.21)	0.0298 (0.19)	0.0646 (0.00)	0.3001 (0.00)	0.4320 (0.00)					
10	Years listed	− 0.0183 (0.42)	0.0962 (0.00)	− 0.1330 (0.00)	− 0.2271 (0.00)	− 0.3133 (0.00)	− 0.2800 (0.00)	0.1663 (0.00)	0.0282 (0.21)	− 0.0214 (0.35)	0.0232 (0.31)				
11	Per capita GDP	− 0.0405 (0.07)	0.0008 (0.97)	0.7874 (0.00)	0.7087 (0.00)	0.5689 (0.00)	0.7300 (0.00)	− 0.1094 (0.00)	− 0.1247 (0.00)	0.0014 (0.95)	0.1408 (0.00)	− 0.1913 (0.00)			
12	Per capita GDP growth	0.0027 (0.90)	− 0.0441 (0.05)	− 0.2623 (0.00)	− 0.2506 (0.00)	− 0.0668 (0.00)	− 0.2043 (0.00)	− 0.0376 (0.10)	0.0382 (0.09)	0.0872 (0.00)	− 0.0199 (0.38)	− 0.2277 (0.00)	− 0.3834 (0.00)		
13	Education	− 0.0232 (0.31)	0.0020 (0.93)	0.3381 (0.00)	0.3235 (0.00)	0.2970 (0.00)	0.3011 (0.00)	− 0.0270 (0.23)	− 0.0336 (0.14)	− 0.0010 (0.96)	0.1260 (0.00)	− 0.0617 (0.01)	0.4914 (0.00)	− 0.2421 (0.00)	
14	Capital	− 0.0722 (0.00)	− 0.0348 (0.13)	0.5822 (0.00)	0.7853 (0.00)	0.6876 (0.00)	0.7466 (0.00)	− 0.1245 (0.00)	− 0.1063 (0.00)	0.0068 (0.76)	0.0340 (0.14)	− 0.3293 (0.00)	0.5012 (0.00)	− 0.0623 (0.01)	0.4149 (0.00)

Table 6 shows that the coefficient on transportation infrastructure becomes insignificant after including legal, government and market development measures. This might be caused by high correlation between transportation infrastructure and institution variables. To the extent that transportation infrastructure is poor in underdeveloped regions, the variable may capture the regional institutional environment instead of transaction difficulties from asset specificity.

All the specifications in Table 6 control for the per capita GDP of the province in which the firm is based. This control is significantly positive, indicating that firms are more vertical integrated in the regions of higher living standards. Further, the results show that larger firms are more vertically integrated than smaller ones, but older firms are less vertically integrated than younger ones.

5. Robustness

As robustness checks, we apply an inverse logistic transformation to our vertical integration measure, mapping V_{max} into $V_{max}' = \ln[1 / (1 - V_{max})]$. We then regress the transformed measure on the variables in the Table 6, using either a Tobit or least squares regression, again with standard errors clustered by firm and year, and again get similar results to those shown.

The input–output statistics of the "wholesale" and "retail" sectors are aggregated and labeled "commerce" in Table 2. These input and output flows may be excessively aggregated, and thus qualitatively different from other sectors (Acemoglu et al., 2009;

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Table 6
Tobit regressions of determinants of vertical integration. Tobit regressions explain vertical integration with *price uncertainty* in the firm's primary industry, the quality of the *transportation infrastructure* of the province in which it is located, province-level indexes of *legal development*, *government development*, and *market development*, our *apparatchik CEO* dummy for a politically well-connected CEO, our *business privilege* indicator that the firm operates in a heavily regulated sector, a *high leverage* indicator, firm size (log of total assets), *years listed* (years since the firm's IPO), and the *per capita* GDP of the firm's province. A firm is assumed to be located in the province containing its head office. Standard errors are clustered at the firm and year level, with Z statistics are in parentheses. One, two, or three asterisks denote significance at 10%, 5% and 1% levels, respectively.

Regression	6.1	6.2	6.3	6.4	6.5
Asset specificity & uncertainty					
Price uncertainty	0.0432***	0.0458***	0.0467***	0.0280***	0.0454***
	(4.20)	(4.46)	(4.54)	(2.70)	(4.42)
Transportation infrastructure	−0.0080***	−0.0027	−0.0027	−0.0017	−0.0026
	(4.07)	(1.30)	(1.27)	(0.83)	(1.24)
Institutional development					
Legal development		−0.0181**	−0.0183**	−0.0183**	−0.0184**
		(2.15)	(2.18)	(2.18)	(2.19)
Government development		−0.0122***	−0.0116***	−0.0138***	−0.0117***
		(2.85)	(2.70)	(3.22)	(2.73)
Market development		−0.0010***	−0.0010***	−0.0009***	−0.0011***
		(3.31)	(3.30)	(2.92)	(3.38)
Political connection					
Apparatchik CEO			0.0058***		
			(3.06)		
Business privilege				0.0160***	
				(9.91)	
High leverage					0.0047***
					(3.53)
Other controls					
Firm size	0.0043***	0.0043***	0.0042***	0.0027***	0.0035***
	(7.87)	(7.78)	(7.65)	(4.80)	(5.98)
Years listed	−0.0003*	−0.0002	−0.0002	−0.0002	−0.0002
	(1.71)	(1.32)	(1.40)	(1.14)	(1.44)
Per capita GDP	0.0003	0.0017***	0.0018***	0.0019***	0.0018***
	(0.59)	(2.85)	(2.93)	(3.11)	(3.00)
Cluster by firm and year	Yes	Yes	Yes	Yes	Yes
Observations	11,563	11,563	11,563	11,563	11,563
Log likelihood	8269	8293	8298	8342	8299

Fan and Lang, 2000). As a further robustness check, we therefore reestimate our regressions excluding these sectors. This cuts about 1250 firm-year observations from the panel, but yields qualitatively similar results to those shown.

To control for panel persistence, we cluster residuals by firm and time. An extremely conservative robustness check collapses our 2002 through 2010 panel into a single cross-section of time-series averages. Running regressions analogous to those in Table 6 on this cross-section, Table 7 reveals qualitatively similar results to those shown, except that the "legal development" variable becomes insignificant.

Overall, we interpret these results as consistent with vertical integration being linked to asset specificity and price uncertainty, and with these factors encouraging vertical integration as an organizational response to weak property rights protection, poor quality government, and ill-developed market economies. These results are also consistent with a link between vertical integration and political rent-seeking.

5.1. Vertical integration and economy performance

We now examine the relationship between vertical integration and regional economy development. Vertical integration as a second best response to arm's length transaction difficulties amid a weak legal system and weak market forces could correlate with elevated per capita GDP levels and growth rates. In contrast, vertical integration undertaken to magnify the returns to political rent-seeking has a less certain impact. As a first pass investigation of this issue, we turn to a set of province level regressions.

We first classify each firm as either *politically connected* or not according to each of our three political connection indicator variables — having an apparatchik as a CEO, operating in a restricted industry, and obtaining higher than median leverage from state banks. Next we calculate the average value of our vertical integration measure across all politically connected firms in each province. This yields three measures of the *intensity of vertical integration among politically connected firms* in each province, one for each of our political connection variables. We then repeat this procedure for politically unconnected firms, and obtain three analogous measures of the *intensity of vertical integration among politically unconnected firms* in each province, one for each of our political connection variables. We do this for all 31 provinces each year from 2002 to 2010.

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Table 7
Cross-section regressions of determinants of vertical integration. Tobit regressions in Table 6 are repeated on a single cross-section of data, constructed by time-averaging the panel of data from 2002 to 2010 used in Table 6. Variables are as in that table, and are defined in detail in Table 3. Z statistics are in parentheses. One, two, or three asterisks denote significance at 10%, 5% and 1% levels, respectively.

Regression	7.1	7.2	7.3	7.4	7.5
Asset specificity & uncertainty					
Price uncertainty	0.0637**	0.0629**	0.0617**	0.0351	0.0601**
	(2.31)	(2.30)	(2.26)	(1.25)	(2.20)
Transportation infrastructure	−0.0062	0.0002	0.0003	0.0005	0.0003
	(1.50)	(0.04)	(0.06)	(0.11)	(0.07)
Institutional development					
Legal development		−0.0125	−0.0131	−0.0102	−0.0132
		(0.44)	(0.46)	(0.36)	(0.46)
Government development		−0.0267***	−0.0264***	−0.0267***	−0.0269***
		(3.29)	(3.26)	(3.30)	(3.32)
Market development		−0.0014*	−0.0014*	−0.0013*	−0.0014*
		(1.71)	(1.73)	(1.69)	(1.75)
Political connection					
Apparatchik CEO			0.0104*		
			(1.87)		
Business privilege				0.0147***	
				(3.84)	
High leverage					0.0078*
					(1.95)
Other controls					
Firm size	0.0056***	0.0052***	0.0050***	0.0038***	0.0041***
	(4.75)	(4.36)	(4.22)	(3.04)	(3.09)
Years listed	0.0008***	0.0002	0.0002	0.0003	0.0002
	(2.66)	(0.71)	(0.46)	(0.88)	(0.75)
Per capita GDP	−0.0015	0.0005	0.0006	0.0008	0.0006
	(1.21)	(0.33)	(0.43)	(0.57)	(0.44)
Observations	1912	1912	1912	1912	1912
Log likelihood	1942	1957	1958	1964	1959

Our left-hand side variable measures economy performance as either annual per capita GDP level or annual per capita GDP growth. We regress these on the integration intensity of the province's politically connected and unconnected firms and on our institutional variables — *legal development*, *government development*, and *market development*. Following Petersen (2009) we cluster the standard errors by province.

We supplement these with a few other controls. Physical and human capital are known to be a first-order determinants of economic growth (see, e.g., Barro and Sala-i-Martin, 1995). We measure a province's physical capital, denoted as *capital*. To estimate *capital*, we use a perpetual inventory model that sums the annual provincial capital investment from 1984 with a depreciation rate of 7%.[13] Human capital is measured as the fraction of each province's population classified by the National Bureau of Statistics of China as "literate", which is denoted as *education*. Standard growth theory also implies a convergence effect: economies with lower initial levels of per capita GDP can grow faster than those already sustaining high incomes (Barro and Sala-i-Martin, 1995). We therefore include the logarithm of lagged per capita GDP as a control variable in our growth regressions.

Table 8 displays the results. The vertical integration among politically unconnected firms attracts positive coefficients in the regressions of both per capita GDP level and growth, but the vertical integration among politically connected firms generates insignificant coefficients.

These results are economically significant too. Consider the GDP growth regression using an apparatchik CEO to gauge political connection. All else equal, a province whose apparatchik-free firms have a mean vertical integration intensity one-standard deviation greater reaps 0.54 extra percentage points of additional per capita GDP growth annually. The effect is clearly large enough to matter, almost four percent of the mean GDP growth rate.

These results are robust. We use medians to generate our vertical integration intensity measures, and our findings are qualitatively unchanged. Employing asset-weighted means generates qualitatively similar results.

Although we find that the positive association between vertical integration and economic value concentrates in politically unconnected firms/regions, some caveats arise in drawing conclusions. First, our data are for listed firms, which account for only a fraction of provincial economic output. Second, we leave the direction of causality unproven in that both economy growth and vertical integration might be endogenously determined by latent factors. Thus, while our analysis suggests that vertical integration among politically unconnected firms has a positive association with local economy development, the result could reflect omitted factors and therefore be open to other interpretations.

[13] The calculation formula is $Capital_{i,\,t+1} = Capital_{i,\,t} + I_{i,\,t} - \delta Capital_{i,\,t}$, where $I_{i,t}$ is annual capital investment for province i in year t, and δ is a depreciation rate of 7% following King and Levine (1994) and Fogel, Morck and Yeung (2008).

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Table 8
Regressions of economy performance on vertical integration. Dependent variables are either provincial per capita GDP level or growth rate. Connected firms are defined, alternatively, by having political apparatchiks as CEOs, operating in restricted industries, or having above median loans from banks. Vertical integration intensity among politically connected firms is the mean value of vertical integration of politically connected firms in each province. Vertical integration intensity among politically unconnected firms is defined analogously. Legal, government, and market development are defined as in Table 3, capital is cumulative annual capital investment from 1984 with a depreciation rate of 7%, education is literate population as a fraction of the total, and per capita GDP denotes the regional per capita GDP. Standard errors are clustered at the province level, with T statistics in parentheses. One, two, or three asterisks denote significance at 10%, 5% and 1% levels, respectively.

Regression	8.1	8.2	8.3	8.4	8.5	8.6
Connection defined as:	Apparatchik CEO		Business privilege		High leverage	
Performance defined as:	GDP level	GDP growth	GDP level	GDP growth	GDP level	GDP growth
Vertical integration						
Intensity among connected firms	0.0662	−0.0022	0.4207	0.0076	0.0686	−0.0513
	(0.10)	(0.03)	(0.36)	(0.07)	(0.08)	(0.44)
Intensity among unconnected firms	5.2742***	0.3434**	3.6158*	0.3778**	6.1610***	0.5952**
	(3.09)	(2.45)	(1.86)	(2.61)	(3.07)	(2.26)
Institutional development						
Legal development	0.4934	−0.0232	0.5003	−0.0188	0.4384	−0.0274
	(1.13)	(0.39)	(1.13)	(0.31)	(1.03)	(0.46)
Government development	0.4898**	0.0323	0.5065**	0.0346	0.5041**	0.0333
	(2.07)	(1.53)	(2.14)	(1.56)	(2.25)	(1.51)
Market development	0.1288***	0.0052*	0.1256***	0.0050	0.1264***	0.0051*
	(5.39)	(1.78)	(5.25)	(1.69)	(5.34)	(1.78)
Controls						
Capital	−0.0483	0.0018	−0.0372	0.0019	−0.0371	0.0024
	(0.57)	(0.27)	(0.44)	(0.28)	(0.47)	(0.41)
Education	1.7360	0.0490	1.6682	0.0452	1.5687	0.0351
	(1.36)	(0.90)	(1.30)	(0.81)	(1.30)	(0.70)
Per capita GDP		−0.0211***		−0.0210***		−0.0213***
		(3.74)		(3.64)		(3.90)
Observations	279	279	279	279	279	279
Adjusted R^2	0.70	0.05	0.69	0.05	0.70	0.06

6. Conclusions

Patterns of vertical integration in China correspond well to likely regional transaction cost differences. Firms are more vertically integrated in provinces with weaker property rights protection, worse government, and laggard market reforms. These observations are consistent with vertical integration being used to overcome transaction difficulties where property rights protection and market disciplinary forces are weak. They are also consistent with vertical integration being used to overcome impediments to doing business posed by overly bureaucratic governments that are disinclined to respect private property rights. These results persist after controlling for local transportation infrastructure, input price uncertainty, firm size, age as a listed firm, and regional economic development.

Firms whose managers have closer ties to bureaucrats are also more vertically integrated. Provinces where market institutions are weak are likely also places where political rent-seeking pays a high return. If political rent-seeking helps firms gain state enforced monopoly power, rent-seekers should direct their lobbying towards gaining vertically integrated monopolies. This is because a vertically integrated monopoly can extract unambiguously higher profits than a string of vertically related single-market monopolies (Spengler, 1950). This suggests a less laudable use of vertical integration to magnify the returns to political rent seeking by foreclosing competition along broader swathes of a value chain.

Our further finding is that more extensive vertical integration in politically unconnected firms is associated with elevated provincial GDP levels and growth rates, while more extensive vertical integration in politically connected firms is not. These findings support the property right (Alchian, 1965) and transaction costs (Klein et al., 1978) explanations of vertical integration. But they also point to a parallel political economy explanation of vertical integration that is relevant in China. Our finding of no improvement in provincial economy performance where vertically integrated firms are politically connected suggests this alternative possibility at least be taken seriously.

Further work is needed to test this possibility more thoroughly and discount alternative explanations of our findings, and numerous caveats apply. Certainly, China's experience may, but need not, extend to other economies. Nonetheless, the evidence here provides a benchmark for comparison with other emerging and transition economies with similar institutional asthenia.

In China, successive reforms are progressively separating business from government, but at markedly different paces in different provinces. Where that separation is least advanced, state and Party officials are also freest to prey upon private businesses. Perhaps the only viable businesses in such regions are those run by the potential predators, either de jure via direct state control or de facto via their cronies.

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Since the most politically connected may not be the most creative entrepreneurs, growth in these regions may well be triply impeded — by weak institutions forcing greater vertical integration; by entrusting corporate decision-making to the politically connected, rather than the most able entrepreneurs; and by large vertically integrated monopolies capable of inflicting worse overall welfare losses than separate single-market monopolies could manage. The potential costs of such a threefold self-reinforcing drag on economic growth should be of concern to Chinese policy-makers if increasing interregional inequality is viewed as a potentially serious source of social instability.

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