Natural resources, institutional quality, and economic growth in China*

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Abstract: The resource curse has been mainly studied using cross-country samples. In this paper we analyze a cross-province sample from one country: China. We focus on the interplay between resource abundance, institutional quality, and economic growth, using two different measures of resource abundance (a stock: resource reserves; and a flow: resource revenues), and employing various econometric approaches including a panel-data time-varying coefficient model. We find that resource abundance has a positive effect on economic growth at the provincial level in China between 1990 and 2008, an effect that depends nonlinearly on institutional quality (1995 confidence in courts). The 'West China Development Drive' policy, initiated in 2000, caused substantial changes, which we investigate through a comparative panel-data analysis.

JEL Classification: O11, O13, O53, C21, Q0, Q33.

Keywords: Natural resource curse; Economic growth; China; Institutional quality; Resource abundance; Policy change; Functional effect.

1 Introduction

Since reformists within the Chinese Communist Party initiated a program of economic reforms in December 1978, China has been the world's fastest-growing major economy with consistent growth rates of around 10% over the past thirty years. China is also the largest exporter and second largest importer of goods in the world. At the same time the production of natural resources has increased sharply. These natural resources are not evenly distributed over China: the coal mines are primarily located in eight provinces, all in the North-East and North, while most natural gas reserves can be found in the Mid-West, especially in Sichuan province which accounts for almost 30% of the nation's production of natural gas. Regions with a high production of natural resources have generally developed slower than low-producing regions, a phenomenon which resembles the situation where resource-rich countries perform worse than resource-scarce countries, the so-called 'curse of resources'.

The 'curse of resources' hypothesis has been analyzed in many cross-country studies, both from empirical and theoretical viewpoints, but there have not been many within-country studies examining the relationship between natural resources and economic growth. A notable exception is the study by Papyrakis and Gerlagh (2007), who employed data from 49 states in the USA, and concluded that resource-scarce states outperform resource-rich states. Like the USA, China is endowed with several unique characteristics which make it suitable for testing the resource curse hypothesis. First, China has homogeneous constitution, law, and governance structures (but different institutions) across provinces. Second, there are significant differences between provincial economies, and substantial variation in resource endowments and development. Third, market reforms have lifted restrictions on the flows of products, labor, and capital (Zhang et al. 2008). In addition, the price reforms in China's natural resource sector between the late 1970s and the mid-1990s ensure that the resource prices largely reflect market supply and demand.

Recently, a number of studies have appeared on the relationship between resources and economic growth in China. Xu and Wang (2006) were the first to use panel-data methods, and they found evidence supporting the curse of resources at the provincial level. Shao and Qi (2009) confirmed these results and compared the resource effects before and after the 'West China Development Drive' in 2000, by estimating two samples (before and after the policy change) separately. Their results suggest that the 2000 policy change induced a resource curse. Zhang et al. (2008) employed a panel-data set at the provincial level and associated a slower growth rate of per capita consumption with rich resources, especially in rural regions. Fan et al. (2012) used city-level data to analyze the transmission mechanism of resource curse and diffusion processes of resources among cities. They found no evidence of a resource curse in China, and they showed that resources have a positive diffusion effect among neighboring cities within the same province.

Some caution is required in interpreting these results. First, no distinction is made between resource abundance and resource dependence. For example, Xu and Wang (2006) measured resource abundance by the proportion of mining workers or by the ratio of investment in the mining industry to total fixed asset investment. These measurements capture resource dependence rather than resource abundance, and the effect of these two concepts on economic growth is not necessarily the same (Brunnschweiler and Bulte 2008). In addition, the measurement of resource dependence suffers from endogeneity (Brunnschweiler and Bulte 2008, Norman 2009, Van der Ploeg and Poelhekke 2010). The current paper measures resource abundance rather than resource dependence, thus avoiding these problems. Second, the analysis of the critical role of institutions in the association between resource abundance and economic growth is not satisfactory. Not only is the measurement of institutional quality poor, but also important nonlinearities are ignored (Ross 2001). Finally, while panel-data methods capture short-run dynamics, they are typically not powerful in explaining the long-run effect of natural resources. Conventional panel-data models estimate constant slope coefficients, implicitly assuming that the resource effect does not change over time. This may, however, not be the case in China, especially for regions with significant structural breaks such as the West China Development Drive.

In this paper, we study the interplay between resource abundance, institutional quality, and economic growth in China. We also investigate whether the resource effect on economic growth varies over time. Our paper makes four main contributions in the context of provincial China. First, we propose several new measurements of resource abundance. These new measurements consider resource abundance either as a stock or as a flow, thus allowing a comparison between *in situ* resource reserves (a stock) and resource revenues (a flow, usually referred to as a 'windfall gain'). Second, we re-examine the role of institutional quality in the relationship between resource abundance and economic growth. Institutional quality is proxied by confidence in the courts, using data from the World Bank. We investigate whether and how the effect of resource abundance on economic growth depends on institutional quality, employing a functional-coefficient model. Our results show that the effect of resource abundance in China depends on institutional quality in a nonlinear fashion, which can not be fully captured using a linear model. More importantly, we find — in contrast to Mehlum et al. (2006) — that the effect of natural resources is more positive for provinces with poor institutional quality. Third, we consider the West China Development Drive as a significant policy shock that may influence the effect of resource abundance on economic growth. We employ both a standard panel-data model and a time-varying coefficient model to study whether and how the resource effect changes after the policy shock. Finally, our paper uses both cross-section and panel data to explore the effect of natural resource abundance on economic growth. The advantage of cross-section data is that they better capture the long-run effect, and reduce the possible bias caused by economic fluctuations. The advantage of panel data is that they contain more information on the dynamics.

We employ provincial data over the period 1990–2008. Our results are not in general agreement with most of the current literature. First, the cross-section benchmark model shows no evidence of a resource curse. Second, the difference-in-difference approach shows that the interaction effect of resource abundance and institutional quality is positive but not significant, suggesting that the interaction effect may not be linear. Third, extending the benchmark model, the functional-coefficient estimates indicate that resource abundance is strongly related to economic growth in regions where institutional quality is weak, and weakly related in regions where institutional quality is moderate. Fourth, both the standard panel-data approach and the time-variant model show that the West China Development Drive has had an important impact on the role of resources in the economy. By intensifying resource exploitation of the Western provinces, the Drive has led to an income rise in the West. This increased income helped the local economy for a short period, but not for long, possibly because an overemphasis on resource exploitation in some Western provinces crowded out other sectors to some extent.

The paper is organized as follows. In Section 2 we briefly review the theories relating resources and institutional quality, and formulate the questions raised in this paper. In Section 3 we describe the data, and present some characteristics and preliminary analysis. In Section 4 we present the cross-section analysis, and in Section 5 the panel-data analysis. Some conclusions are offered in Section 6.

2 Resources and institutional quality

Ever since the 1950s, economists have observed that resource-rich countries may grow slower than resource-scarce countries. Why do abundant resources tend to impede economic growth? Several theories have been developed, mainly Dutch disease models (Sachs and Warner 1995) and institutional explanations. Traditional Dutch disease explanations cannot be directly applied in the Chinese context, because most of China's exports are not expensive for other countries to buy because labor is inexpensive in China. While it is possible to study the 'Dutch disease' among provinces, an adapted definition and appropriate data would be required. Due to the data limitations, we focus here on institutional quality explanations.

Many papers have stressed the importance of institutions through which abundant resources may curse economic growth. From a qualitative point of view, resource revenues appear to be easily appropriable, thus leading to rent-seeking behavior and corruption. Also, more labor is attracted to seek revenues from other productive activities (Isham et al. 2005; Leite and Weidmann 1999; Norman 2009). Auty (2001) argued that resource wealth promotes the ascendance of the 'predatory state' over the 'development state', either by encouraging the former through corruption or by undermining the latter when revenues associated with resource extraction reduce the efficiency of policy and administration. The relationship between resources and institutions also depends on the type of resources. Many studies show that 'point' (concentrated) resources result in poor institutions, while 'diffuse' resources do not. This is because point resources (such as oil, minerals, and plantations) are extracted from a narrow geographic or economic base, and can be protected and controlled at a relatively modest cost. In contrast, diffuse natural resources (such as agricultural products) are spread in space and utilized by agents characterized by horizontal relationships (Bulte et al. 2005). The latter are therefore less correlated with institutional quality.

From a quantitative point of view, Leite and Weidmann (1999) were perhaps the first to demonstrate the effect of resource abundance on institutional quality. Mehlum et al. (2006) interacted natural resource abundance with institutional quality and found that the negative effect of natural resources on economic growth only occurs in countries with poor institutional quality. Ross (2001) argued that institutions themselves may also be endogenous and not invariant with respect to resource endowments. Some empirical studies claim that institutional quality alone can explain a great deal of cross-country differences in economic development, thus further questioning the role of natural resources in economic development (Acemoglu et al. 2001).

The economy of China is in transition, hence it is a mixture of a market economy and a planned economy. This mixture is also reflected in the resource market. Before 1990 the Chinese central government controlled the price of most natural resources. During the 1990s the pricing of resources was reformed, and the prices were adjusted to international levels. This is still the case today. In particular, the domestic oil price is adjusted based on the oil markets in Singapore, Rotterdam, and New York, and fluctuates with market demand. The domestic natural gas price is lower than the international price, but it is still determined by the market.

The quality of institutions in China varies significantly over provinces. Chinese provinces possess homogeneous constitutional and legal systems, but their institutional quality differs widely for historical, regional, political, and other reasons. For example, coastal provinces typically have better institutions than inland provinces, partly because they are more open, and partly because some coastal provinces enjoy preferential treatment since the 'reform and open policy' initiated in 1978. These special features help us to study the interplay of resource abundance, institutional quality, and economic growth.

We try to answer two questions. The first question is whether and how the effect of resource abundance on economic growth depends on institutional quality. It is, of course, possible that the resource effect on economic growth may also be dependent on some other variables besides institutional quality, such as manufacturing, R&D, education, and so on (see Fan et al. 2012). We shall focus on the interaction effect of institutional quality, and try to provide explanations how and why institutional quality influences the resource effect on economic growth. The second question is whether the association between resources and economic growth varies over time. Since the West China Development Drive had an emphasis on natural resources, the resources in the Western provinces were exploited more intensively. The economic growth rate in the Western provinces has indeed increased after the Drive was initiated. It is therefore possible that the association between resources and growth is different before and after the policy change, a hypothesis that will be formally tested.

3 Data and descriptive statistics

We consider 28 mainland 'provinces' in China, namely 22 provinces, 4 municipalities directly under the central government, and 2 autonomous regions. Three autonomous regions (Xinjiang, Inner Mongolia, and Tibet) are excluded because of lack of data. Each province is labeled either 'West' or 'East' depending on its geographic location; see Figure 1.

In studying natural resource abundance and its effect on growth, we distinguish between a stock measure (RA_s, resource reserves) and a flow measure (RA_f, resource revenues). Resource reserves are a measure of *in situ* resource wealth, while resource revenues measure the flow of income from extracting resource stocks at some point in time. Although the two measurements are likely to be highly correlated, the distinction is useful because some provinces may be rich in resource reserves, while their income does not depend

Figure 1: Map of China

Note: The provinces left of the black solid line are defined as Western regions, most of which are affected by the West China Development Drive policy. More precisely, the West China Development Drive policy covers Chongqing, Sichuan, Guizhou, Yunan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia, and Guangxi. Source: Chinasource website, http://www.chsource.org/site/index.php. Although Shanxi province is usually treated as a central region, it is grouped here as a Western region since its economic structure is more like the Western provinces and it is covered by the West China Development Drive policy. Guangxi province is defined here as a Western province for the same reason.

primarily on resource exploitation. Also, it is not clear whether resources in the ground have the same effect on economic growth as flows of resource revenues do (Norman 2009). Both measures differ from resource dependence, the typically used (though not very good) proxy for resource abundance.

The question whether resource abundance is exogenous or endogenous has been emphasized by Brunnschweiler and Bulte (2008). Van der Ploeg and Poelhekke (2010) pointed out that abundance may not be as exogenous as it seems, and suggested that the historic resource stocks used by Norman (2009) are less endogenous than other measures. We agree with this suggestion and follow Norman (2009) in measuring resource reserves as the recent (2003) observed level of reserves plus total production during the preceding years, including both energy and mineral resources. The energy resources include petroleum, natural gas, and coal mining. The mineral resources cover all major mineral resources in China and include iron ore, manganese ore, chrome ore, vanadium ore, native ilmenite, copper ore, lead ore, zinc ore, bauxite, magnesite, pyrite, phosphate ore, and kaolin. All resource data at the regional level are taken from the China Statistical Yearbook. Because of lack of data in the early years, we can only construct the stock values in 1999 using 1999 prices of resources. Stock values rather than physical quantities are used to enhance comparability across resources, as suggested by Norman (2009). Although stock values may vary a little depending on the price, exploitation technology, and other factors, values in the early years are preferred because they are likely to influence government behavior in later years (Norman 2009; Van der Ploeg and Poelhekke 2010). Measuring resource reserves in this way should mitigate (but not eliminate) the endogeneity.

Resource revenues are measured by sales income of resources (after adjusting for inflation), and also include energy and mineral resources. Besides the resources covered in the measure of resource reserves, resource revenues include additional resources such as subterranean heat (energy), nickel ore, tungsten ore, and tin ore (mineral). These additional resources account for less than 20% of sales income on average. (The sales income documented in the Yearbook is the sum of all types of resources, and there are no statistics that allow us to compute sales income covering exactly the same types of energy and mineral resources as the reserves measure.) Since reserves and revenues include almost the same types of resources, we largely rule out the possibility that their difference lies in the different types of resources that they measure.

Compared to other measures used in the literature, our resource abundance measures are less affected by other economic activities, and thus serve as better proxies of resource abundance. We are, however, aware of some weaknesses of our measures. For example, even resource reserves tend to be measured as economically recoverable reserves and are thus subject to changes in prices and technology. Besides, we cannot recover the resource stocks in some of the early years, e.g. 1990, due to lack of data. If these data were available, this would reduce the endogeneity of the resource reserves measure. As for resource revenues, one worry is whether our results will be affected by considering production cost. We check this by experimenting with different measures of revenues, in particular net profit of resources and gross industrial output of resources. Estimation results based on different measures are highly consistent. These measures are also highly correlated (correlation > 0.94), suggesting that production costs differ only marginally across provinces. Therefore we will present our results using sales income of resources, because it is the most complete measure without missing values. The resource revenues measure may be less exogenous than reserves due to market conditions, but the two measures are closely related since resource stocks can be converted into flows of money (Brunnschweiler and Bulte 2008). The time-varying feature of the revenues measure allows us to examine the short-run (dynamic) relation between resources and growth, while the reserves measure is time-invariant.

The economy-related variables include economic growth, institutional quality, R&D, industrial development, private sector employment, foreign investment, and initial economic level. All of these, except institutional quality and initial economic level, contain observations over several years for each province. The time span varies across variables.

We emphasize the role and measurement of institutional quality. This is a difficult concept to measure. In cross-country studies one typically uses systematic indicators such as the rule of law or government competitiveness (Knack and Keefer 1995). But within China the constitution and law in one province is the same as in another province. In Chinese studies, institutional quality is therefore often ignored or measured using dubious proxies, such as the ratio of total trade over GDP (Xu and Wang 2006; Shao and Qi 2009). We propose to use the confidence in courts surveyed in 1995 by the World Bank as a measure of institutional quality. This is a subjective measure, reflecting perceptions of people from 114 cities. Chinese courts are divided into four levels. The highest level is the supreme court in Beijing, and the other three levels are the so-called people's courts: high courts, intermediate courts, and basic courts. Appointments at the different levels of the people's courts are made by corresponding strata of the people's congresses. Therefore, unlike most of western countries where courts and government have independent power, local courts in China are often influenced by local power cliques. The confidence in courts therefore reflects not only the perceived justice of the courts but also the behavior of the government, and thus captures the essence of institutional quality. The subjectivity of the proposed measure is a potential weakness in that it sometimes differs from a objective measure and could be biased, as suggested by Olken (2009) in a different context. Such a difference or bias (if present) would however be largely averaged out, since we work with aggregated provincial data. An advantage of the subjective measure is that it is based on the perception of several aspects of government behavior, and thus reflects many aspects of institution. It is therefore more general than a specific objective measure, which typically captures only one aspect of government behavior, e.g. corruption, efficiency, or intervention in the economy. Our measure is also likely to be more stable, because it is formed over a period of time, and thus reflects underlying features of local institutions that are not easily changed in the short run. This is especially relevant in rural China, where people are not well-informed about the latest changes of government behavior, and therefore do not rapidly adjust their perceptions, once formed.

The measurement of all variables and their time span is briefly described below.

G Growth of real GDP per capita. In the cross-section analysis, growth is averaged between 1990 and 2008:

$$G = \frac{\log(\mathrm{GDP}_T/\mathrm{GDP}_{T_0})}{T - T_0},$$

where $T = 2008$ and $T_0 = 1990$. In the panel-data analysis, it is defined as the annual growth rate of real GDP per capita:

$$G_t = \log(\mathrm{GDP}_t/\mathrm{GDP}_{t-1}) \qquad (t = 1991, \ldots, 2008).$$

$\mathbf{RA}_s$ Log of resource reserves in Chinese Yuan per capita. The variable is constructed by first summing the per capita stock values of all types of resources, and then taking the logarithm. The stock value of a resource is the product of its reserves and its average market price in the corresponding year. The reserve values are constructed using an estimate of the reserves in 1999, obtained by adding extraction flows from 1999 to 2003 to the 2003 'reserve base'. The resource reserves cover energy resources and mineral resources (types of energy and mineral resources are given above).

$\mathbf{RA}_f$ Log of resource revenues in Chinese Yuan per capita. The resource revenues are measured by sales income of resources after adjusting for inflation, covering both energy and mineral resources, from 1999 to 2008.

INS Institutional quality, measured by confidence in the courts, which is a weighted average of city level data. The weights are given by the proportion of the city's GDP in the province. (We also used the proportion of a city's population as weights as a robustness check.) Only cross-section data in 1995 are available.

R&D Research and development, the ratio of government expenditure in R&D to total government expenditure, from 1995 to 2006.

IND Industrial development, ratio of value-added of industry to GDP, from 1992 to 2008.

PSE Private sector employment, also referred to as private economic activity, measured by the number of people in not-state-owned companies divided by the provincial population, from 1992 to 2008.

FI Foreign investment proportion, the ratio of the actual inflow of foreign investment over gross investment in fixed assets, from 1989 to 2003. This captures the importance of foreign investment in the local economy.

INIT Initial economic level in Chinese Yuan per capita, defined as the logarithm of real GDP per capita in 1989.

WEST Geographic dummy: WEST = 1 if the province lies in the Western region of China (as defined in Figure 1) and WEST = 0 otherwise.

The resource reserves data are taken from the China Statistical Yearbook (National Bureau of Statistics 2003–2004) and the China Economic Information Network (CEINET). Resource revenues data are taken from the China Land and Resources Statistical Yearbook (Ministry of Land and Resources 2000–2009). The economy-related variables are either from CEINET or from the World Bank.

Table 1 provides descriptive statistics of the economy-related and resource variables. By comparing the statistics of the East sample to the West sample, we see that the average growth rate in Eastern provinces is generally higher than in Western provinces. On the other hand, Western provinces have slightly higher resource reserves and revenues than Eastern provinces. The institutional quality is generally better in the Eastern provinces than in the Western provinces. Also, R&D, industrialization, private sector employment, and foreign investment in the East are all higher on average than in the West.

Table 1: Descriptive statistics of economy-related variables

	Entire sample (28 prov)		East sample (18 prov)		West sample (10 prov)	
Variable	Mean	Std	Mean	Std	Mean	Std
Growth	0.0394	0.0054	0.0411	0.0054	0.0364	0.0039
RA_s	4.4511	1.0375	4.3193	1.2015	4.8292	0.6398
RA_f	2.0758	0.3855	2.0238	0.4224	2.2522	0.3584
INS	58.146	13.321	62.009	11.758	51.199	12.963
R&D	0.0097	0.0046	0.0111	0.0053	0.0073	0.0013
IND	0.2875	0.0665	0.2973	0.0752	0.2698	0.0452
PSE	0.0655	0.0278	0.0763	0.0283	0.0461	0.0126
FI	0.0963	0.0928	0.1305	0.0991	0.0347	0.0266
INIT	3.1876	0.2068	3.2626	0.2118	3.0527	0.1100

4 Cross-section analysis

We analyze the data first as a cross section, and then, in Section 5, as a panel. We begin by reconsidering the classical growth regression

$$G = \beta_0 + \beta_1 \mathrm{RA} + \beta_2 \mathrm{INS} + \sum_{k=1}^{6} \theta_k x_k + \epsilon_1, \tag{1}$$

where G denotes economic growth, RA is resource abundance, INS represents institutional quality, and

$$\big(x_1, \ldots, x_6\big) = \big(\mathrm{R\&D}, \mathrm{IND}, \mathrm{PSE}, \mathrm{FI}, \mathrm{INIT}, \mathrm{WEST}\big)$$

contain auxiliary control variables: research and development (R&D), industrial development (IND), private sector employment (PSE), foreign investment (FI), initial economy level (INIT), and the Western dummy (WEST). The auxiliary variables affect the economy and are associated with resource abundance. Their inclusion will therefore reduce the omitted variable bias. For resource abundance, we always consider two variants: one where RA is measured as a stock (RA_s, resource reserves) and one where it is measured as a flow (RA_f, resource revenues).

The least-squares estimation results are presented in Table 2. Columns (a) and (b) show that the impact of resource abundance is very weak, both when measured as a stock (resource reserves) and when measured as a flow (resource revenues). The effect of institutional quality is strong and positive. If other explanatory variables are added (columns (c) and (d)), then the significance of institutional quality slightly decreases but it remains strong, while

Table 2: Economic growth: classical growth model

	(a)	(b)	(c)	(d)	(e)	(f)
RA_s	−0.0001		0.0002		−0.0037	
	(−0.22)		(0.26)		(−0.76)	
RA_f		0.0001		0.0006		−0.0099
		(0.08)		(0.26)		(−1.36)
INS	0.0002	0.0002	0.0001	0.0001	−0.0002	−0.0003
	(2.76)	(2.76)	(1.85)	(2.02)	(−0.52)	(−0.96)
R&D			0.3074	0.3011	0.3921	0.4391
			(1.87)	(2.03)	(1.74)	(1.96)
IND			0.0217	0.0210	0.0172	0.0194
			(1.96)	(1.92)	(1.32)	(1.76)
PSE			0.1359	0.1320	0.1583	0.1417
			(2.04)	(2.43)	(2.23)	(2.62)
FI			0.0258	0.0269	0.0284	0.0279
			(2.76)	(2.56)	(2.94)	(2.65)
INIT	−0.0053	−0.0051	−0.0304	−0.0296	−0.0345	−0.0328
	(−1.06)	(−0.99)	(−4.07)	(−4.68)	(−3.87)	(−5.39)
WEST	−0.0035	−0.0036	−0.0016	−0.0016	−0.0014	−0.0012
	(−1.29)	(−1.29)	(−0.62)	(−0.58)	(−0.52)	(−0.45)
RA × INS					0.0001	0.0002
					(0.82)	(1.39)
Constant	0.0465	0.0448	0.1089	0.1066	0.1392	0.1392
	(2.38)	(2.12)	(6.18)	(5.47)	(3.28)	(4.79)
R^2	0.4579	0.4574	0.6829	0.6832	0.6913	0.6996
p-value of F-test	0.0022	0.0022	0.0000	0.0000	0.0000	0.0000

Note: t-values are in parentheses. The number of observations in each column is 28.

the resource effect remains insignificant. Equation (1) seems to imply that resource abundance has no effect on economic growth, but such a conclusion would be premature and incorrect. Classical growth regressions cannot fully capture the resource effect in China, because the resource effect is likely to vary with institutional quality. It is possible that natural resources are important in provinces with poor institutional quality, but less important in provinces with strong institutional quality. Classical growth regressions ignore such provincial heterogeneity by assuming constant coefficients for each explanatory variable. The estimated coefficient in the presented classical growth regression is the 'overall' effect of resource abundance, and its insignificance does not imply that heterogenous effects are also insignificant for various levels of institutional quality. In fact, we shall see that provincial heterogeneity is essential in explaining the role of resource abundance.

Thus motivated, we extend the classical models by including an interaction term RA×INS, as suggested by Mehlum et al. (2006). We estimate the regression model

$$G = \beta_0 + \beta_1 \mathrm{RA} + \beta_2 \mathrm{INS} + \beta_3 \mathrm{RA}\times\mathrm{INS} + \sum_{k=1}^{6} \theta_k x_k + \epsilon_2. \tag{2}$$

The estimation results are given in columns (e) and (f) of Table 2. We see that the interaction term is positive, but not significant. This result weakly supports the argument by Mehlum et al. (2006) that resource abundance promotes the economy if institutions are producer-friendly. The insignificance of the interaction term suggests that the linear model may not fully capture the interaction effect of resources and institutional quality in China. Note that Equation (2) only provides a positive or negative (linear) interaction effect, and that this effect is the same for all institutional quality levels. However, if resource effects on growth depend *nonlinearly* on institutional quality, then (2) does not capture this.

In order to capture a possibly nonlinear relationship between resource abundance and economic growth, we consider the functional coefficient model

$$G = \delta_0 + \delta_1 \mathrm{RA} + \sum_{k=1}^{6} \gamma_k x_k + \epsilon_3. \tag{3}$$

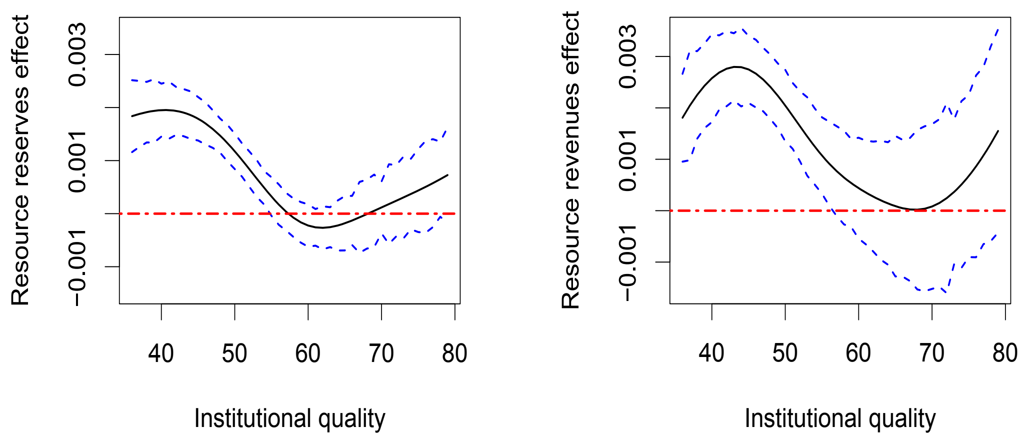
The same variables RA and $x_1, \ldots, x_6$ appear in Equation (3) as in Equation (1), except that institutional quality INS enters through the coefficients δ_0, δ_1, and γ_k $(k = 1, 2, \ldots, 6)$. Since there is no *a priori* reason why some of the coefficients would and others would not depend on institutional quality, we allow all coefficients to be functions of institutional quality. The advantage of a functional-coefficient model is that it provides information on how the interaction varies (possibly nonlinearly) across different levels of institutional quality. A second advantage is that it solves the potential reverse causality between institutional quality and growth, at least to some extent, because institutional quality enters the model as a smoothing variable instead of a control variable.

The parameters in this model are estimated by local linear estimation (Fan and Gijbels 1996; see also Cai et al. 2000). Thus, we specify

$$\delta_j = \delta_{Cj} + \delta_{Sj}(\text{INS} - u_0) \quad (j = 0, 1),$$
$$\gamma_k = \gamma_{Ck} + \gamma_{Sk}(\text{INS} - u_0) \quad (k = 1, 2, \ldots, 6),$$

where $\min(\text{INS}) \leq u_0 \leq \max(\text{INS})$. The parameters $(\delta_{Ck}, \delta_{Sk})$ and $(\gamma_{Ck}, \gamma_{Sk})$ are estimated nonparametrically. Various data-driven methods can be employed for selecting the bandwidth. We chose the bandwidth by minimizing the average mean squared error (Cai et al. 2000).

Figure 2: Marginal effect of RA_s and RA_f on economic growth as a function of institutional quality



In Figure 2 we show how the δ_1-parameter changes as a function of institutional quality. The solid line plots the estimate of δ_1, and the dashed lines are 5% confidence intervals based on jackknife standard errors. We see that resource reserves and resource revenues largely measure the same concept of abundance (when applied to growth regressions in China). The typical 'U-shape' in both subfigures shows strong and positive correlation between resource abundance and economic growth in provinces with weak institutional quality. As institutional quality improves, this correlation decreases and becomes statistically insignificant. These results provide an explanation of the insignificance of the resource effect in Equation (1). The reason for the insignificant 'overall' effect (columns (a)–(d) in Table 2) is that the resource effect varies with institutional quality and that this effect is weak in provinces with good institutional quality. The nonlinear behavior in both subfigures also explains the statistical insignificance of the interaction term (columns (e) and (f) in Table 2).

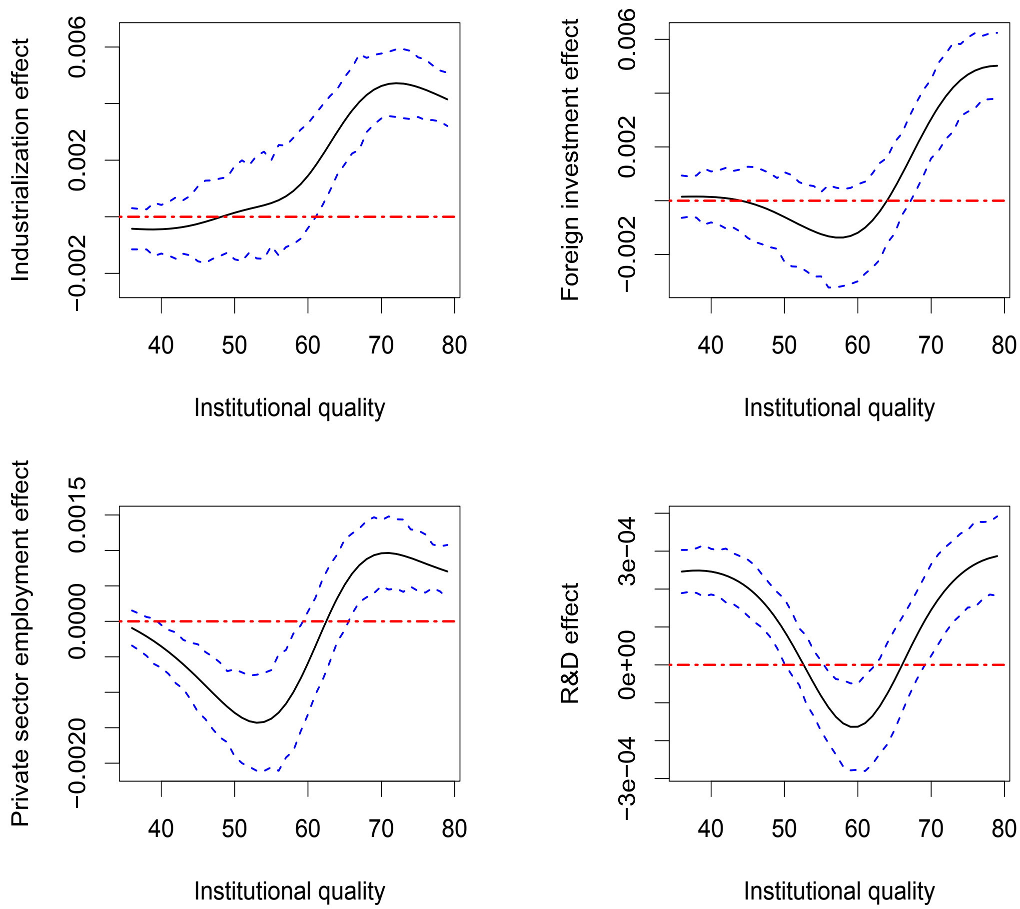
In general, resource abundance in China thus has a *positive* effect on economic growth. This evidence obviously challenges the existence of a resource curse. In fact it supports Brunnschweiler and Bulte's (2008) argument that resource abundance promotes economic growth, which they explain by the 'windfall' flow of income from resource extraction. This flow, they argue, has a direct effect on the economy as well as an indirect effect through improving institutional quality.

The positive effect of resource abundance is particularly strong in regions with weak institutional quality, and the effect decreases as institutional quality improves. This finding differs from the cross-country evidence reported by Mehlum et al. (2006), who find that worse institutions make the effect of natural resources more negative. A possible explanation is that regions with weak institutional quality are likely to rely more on their primary industries than regions with strong institutional quality, because the prosperity of many non-resource sectors is largely built on good institutional quality. For example, good institutions lead to more willingness of savers to invest in firms and to a higher effectiveness of corporate governance, thus associating good institutions with a healthy financial sector (Beck and Levine 2005). Nunn (2007) pointed out that better contract enforcement makes countries more specialized in the industries in which so-called relationship-specific investments play a dominant role.

Improvement of institutional quality helps the development of many non-resource sectors more than it helps the development of resource sectors, so that better institutions make resources become less important. The correlation between the economy and non-resource sectors is thus stronger than correlation between the economy and resource abundance, and indeed we observe a decreasing and insignificant effect of resource abundance when institutional quality increases.

To further strengthen this argument, we present the functional effects of some other control variables, namely industrialization, foreign investment, private sector employment, and R&D. Figure 3 shows the effects of industrialization, private sector employment, and foreign investment on economic growth all tend to be stronger and more positive in regions with better institutional quality. Typical examples are Qinghai, Guizhou, and Ningxia. These

Figure 3: Marginal effect of other control variables on economic growth as a function of institutional quality



provinces all suffer from weak institutional quality, and their economies therefore rely largely on resource abundance, while the non-resource sectors are poorly developed. In contrast, Guangdong, Jiangsu, Zhejiang, and Tianjing provinces are among the top ten provinces in terms of institutional quality, and their non-resource sectors, such as R&D, industrialization, and private sectors are among the best. Resources in these provinces play only a small role in promoting economic growth.

When institutional quality exceeds the median level (62 on the left, 68 on the right in Figure 2), the positive impact of resource abundance on economic growth increases (but remains insignificant) as institutional quality improves. Apparently, provinces with strong institutional quality *and* abundant natural resources are likely to make good use of these resources and revenues. Property rights on natural resources in China are owned by the government, and local residents therefore typically do not benefit much from revenues derived from resource extraction. Most income associated with resources goes to the government and to state-owned enterprizes. Hence, for provinces with weak institutional quality, rising revenues from the booming resource sectors are not used by the government to stimulate the economy, but often harm economic development, because they lead to increased prices for nontradable goods, thus lowering the competitiveness of local economies (Zhang et al. 2008). If institutional quality is strong, however, then revenues from resources may be used to boost economic development. This is because better property rights tend to improve asset allocation, leading to higher growth (Claessens and Laeven 2003). Examples include Shandong, Jilin, Liaoning, Tianjin, and Henan provinces, most of which are traditional industrial provinces in North-East China. These provinces are rich in natural resources (especially mineral resources), the institutional quality is high, and the exploitation and use of the resources is efficient. Booms in resource sectors thus do not impede the development of non-resource sectors, but instead stimulate industries that are indirectly related to resources such as the automobile, shipbuilding, and equipment manufacturing industries.

Our results are very robust to different measures of resource revenues and to different weights for institutional quality. Even when we take into account the possible influence of the 2000 policy shock and estimate the model with separate samples (before and after the shock), the results remain essentially unchanged. (Further details on the shock and its effects will be discussed in the next section.) We conclude that the effect of resources on the economy is highly and nonlinearly dependent on institutional quality, and that the correlation between resource abundance and economic growth is high and positive in provinces with weak institutional quality, but weakly negative in provinces with medium institutional quality.

5 A panel-data approach with time-varying resource effects

Cross-section models are useful in capturing long-run effects, but they do not identify resource effect fluctuations over time. In particular, they cannot identify the effects of a policy shock such as the West China Development Drive. This significant policy package was introduced by the Chinese central government in 2000 with the purpose of stimulating the economy of the Western regions. While the policy also involves non-resource projects (such as promoting infrastructure construction, protecting the ecology environment, and re-adjusting industrial structure), the emphasis is on intensifying natural resource exploitation. Several significant projects connected with natural resources in West-China have resulted from this initiative. For example, the West-East natural gas transmission project led to an increase of natural gas production in Sichuan and Qinghai provinces by more than 100% and 900%, respectively, between 2000 and 2007. Also, steel production in Yunan and Guizhou provinces increased by around 200% and 400%, respectively, since the Drive began. The economic growth rate in Western provinces has indeed increased since 2000. It is therefore to be expected that the relationship between resources and growth is different before and after the policy, and we shall test this hypothesis using both a standard and a time-varying coefficient panel-data approach. The availability of panel data is important because, by allowing not only variation over provinces but also over time, we are able to capture the short-run dynamic behavior of the resource effect as well as other impacts on economic growth. In addition, the use of panel data enlarges the sample size and hence improves the accuracy of the estimates. Since the stock measure of resource abundance is a historical variable that does not vary over time, we can only use the flow measure (resource reserves) in the panel-data analysis.

5.1 Standard panel-data approach

We first consider the standard panel-data model. To incorporate the policy shock in 2000, we introduce a policy shock dummy PD taking the value 0 before 2000 and 1 from 2000 onwards. Thus we have

$$G_{it} = c_i + \beta_0 + \beta_1 \mathrm{RA}_{f\,it} + \beta_2 \mathrm{PD}_{it} + \beta_3 \mathrm{RA}_{f\,it} \times \mathrm{PD}_{it} + \sum_{k=1}^{4} \theta_k z_{k,it} + \epsilon_{it},$$

where $i = 1, \dots, N$ and $t = 1, \dots, T$, and we allow for the possibility of an interaction term $\mathrm{RA}_f \times \mathrm{PD}$. Here G_{it} denotes the growth rate of real GDP per capita in province i at year t, c_i is a province-specific effect, and PD and $\mathrm{RA}_f \times \mathrm{PD}$ capture the policy effect. The auxiliary control variables in this case are $(z_1, \ldots, z_4) = (\mathrm{R\&D}, \mathrm{IND}, \mathrm{PSE}, \mathrm{FI})$. The idiosyncratic error ϵ_{it} is assumed to be independent of x_{it}. Since province-specific effects are correlated with the regressors, we employ a fixed-effect estimation method. The time-invariant variables INS, INI, and WEST are excluded as explanatory variables, because they cannot be identified in a fixed-effect method. Since our measure of institutional quality varies only slightly in our observed time period (see Section 3), the exclusion of INS will only have a slight effect on the results. We only use resource revenues (the flow) as a measure of resource abundance, because our measure of resource reserves (the stock) does not vary over time.

Table 3: Economic growth: standard panel-data model

	(a)	(b)	(c)	(d)	(e)
RA_f	0.0187	0.0132	0.0072	0.0128	0.0107
	(5.51)	(4.16)	(2.16)	(4.38)	(4.94)
R&D	−0.9825	−0.9486	−0.8366	−0.8938	−0.9166
	(−3.80)	(−4.83)	(−3.42)	(−3.72)	(−3.91)
IND	0.0854	0.0734	0.0635	0.1039	0.1063
	(5.66)	(5.00)	(3.86)	(8.14)	(8.18)
PSE	0.0283	0.0170	0.0305	0.0179	0.0293
	(0.57)	(0.33)	(0.81)	(0.35)	(0.67)
FI	−0.0510	−0.0216	−0.0214	−0.0282	−0.0276
	(−1.84)	(−0.92)	(−1.07)	(−1.17)	(−1.17)
PD		0.0105	−0.0059		
		(5.08)	(−0.57)		
$\mathrm{RA}_f \times \mathrm{PD}$			0.0091		
			(1.67)		
D_{0304}				0.0154	−0.0106
				(3.55)	(−0.48)
$\mathrm{RA}_f \times \mathrm{D}_{0304}$					0.0124
					(1.10)
Constant	−0.0050	−0.0004	0.0108	−0.0034	−0.0064
	(−0.66)	(−0.07)	(1.40)	(−0.54)	(−0.11)
overall R^2	0.1534	0.2163	0.2279	0.2468	0.2547
p-value of F-test	0.0000	0.0000	0.0000	0.0000	0.0000
ρ	0.2772	0.2026	0.1948	0.2349	0.2432

Note: t-values are in parentheses. ρ is the fraction of variance due to the individual-specific effect. The number of observations in each column is 308.

Table 3 presents the standard fixed-effect estimation results. Column (a) is the benchmark, including only resource revenues and auxiliary control variables. The association between resource revenues and growth is positive and strong in the short-run dynamics, contrasting sharply with the insignificant long-run relationship. This discrepancy between short-run and long-run effect is in line with Collier and Goderis (2008) who find similar differences in a cross-country framework. One explanation of this positive association is the income effect that the 'windfall gain' from resources stimulates consumption and further prompts economic growth. As expected, R&D and foreign investment have different short-run and long-run effects; these are long-run investments having little effect in the short run. To study whether the 2000 policy shock affects economic growth, column (b) includes the policy shock dummy PD. Its coefficient is strongly significant, showing, as expected, that the new policy has led to higher growth. If we include both PD and the interaction term $\mathrm{RA}_f \times \mathrm{PD}$, then we obtain column (c). The interaction term is positive and weakly significant (p-value is 9.5%), suggesting the possibility that the resource effect is different before and after the policy shock. The result is not conclusive however, because a standard panel-data model can only measure the linear difference between before and after the shock, thus capturing the average change. If the resource effect contains nonlinear dynamics, then these are not captured by the standard panel-data model. This leads us to the time-varying coefficient model, where possibly nonlinear resource effects can be investigated. This model and the resulting columns (d) and (e) are discussed in the next subsection.

5.2 Time-varying coefficient approach

The standard fixed-effect approach reveals different resource effects before and after the policy shock. This approach can not, however, describe how the resource effect changes after the policy shock. We expect that the effects of other variables are also influenced by the policy. This could lead to a strengthening of the effects, because the policy also involves non-resource projects and these non-resource industries may grow faster after 2000. But it could also lead to a weakening, because the emphasis on resource exploitation strengthens the association between resources and economic growth, and also because an over-emphasis on resources crowds out the non-resource sectors, leading to a weaker correlation between non-resource sectors and growth.

We extend the standard panel-data model by allowing the coefficients to be time-varying, and consider the time-varying coefficient model

$$G_{it} = c(t) + x_{it}'\tau(t) + \epsilon_{it} \qquad (i = 1, \dots, N, \;\; t = 1, \dots, T),$$

where x_{it} are the explanatory variables: RA_f, R&D, IND, PSE, and FI, all in province i at year t. The dummy PD is excluded because the policy effect can now be captured by the model parameters which are smooth functions of t. The parameter vector $\tau(t) = \{\tau_1(t), \tau_2(t), \ldots, \tau_k(t)\}'$ contains the coefficients for the $k = 5$ control variables. This is a typical time-varying coefficient model for panel data (Hoover et al. 1998). Unlike the standard panel-data model, no within-transformation or first-difference transformation is needed when estimating the model, because no incidental parameter problem occurs in this case.

To estimate $\tau(t)$, we employ the method proposed by Hoover et al. (1998). The local polynomial estimator of $\hat{\tau}_l(t)$ for each $l \in \{1, \ldots, k\}$ can be obtained by estimating the local polynomial fit $\hat{\tau}_l(t) = (\hat{\tau}_{1l}(t), \ldots, \hat{\tau}_{dl}(t))'$, where $d \geq 1$ is finite. This can be done by minimizing an appropriate locally-weighted sum of squares:

$$\hat{\tau}_l(t) = \underset{\hat{\tau}_l(t)}{\operatorname{argmin}} \sum_{i=1}^{N} \Big(G_i - \sum_{l=1}^{k} X_{i.l}\mathscr{B}_i\tau_l(t)\Big)' \mathscr{W}_i(t) \Big(G_i - \sum_{l=1}^{k} X_{i.l}\mathscr{B}_i\tau_l(t)\Big),$$

where $\mathscr{B}_i$ is the $T \times d$ basis matrix with typical element $\mathscr{B}_{i,mn} = (m_i - t)^{n-1}$ ($m \in \{1, \ldots, T\}$; $n \in \{1, \ldots, d\}$), and

$$\mathscr{W}_i = \operatorname{diag}\big(W_{i1}(t), \ldots, W_{iT}(t)\big)$$

is a $T \times T$ weight matrix. We estimate the coefficients using a special case of the local polynomial estimator with $d = 1$, that is, a local constant fit in which the weight is selected as the kernel function $K\left((t - t_0)/h\right)$ with bandwidth h. In that case, the kernel estimator of $\tau(t)$ is

$$\hat{\tau}(t) = \left(\sum_{i=1}^{N} X_i' K(t) X_i\right)^{-1} \left(\sum_{i=1}^{N} X_i' K(t) G_i\right),$$

where $K(t) = \operatorname{diag}\left(K((t-1)/h), \ldots, K((t-T)/h)\right)$,

$$X_i = \begin{pmatrix} x_{i,11} & \ldots & x_{i,1k} \\ \vdots & & \vdots \\ x_{i,T1} & \ldots & x_{i,Tk} \end{pmatrix},$$

and $G_i = (G_{i1}, \ldots, G_{iT})'$. The bandwidth is selected following Hoover et al. (1998) by minimizing the average predictive squared error with 'leave-one-out' cross-validation.

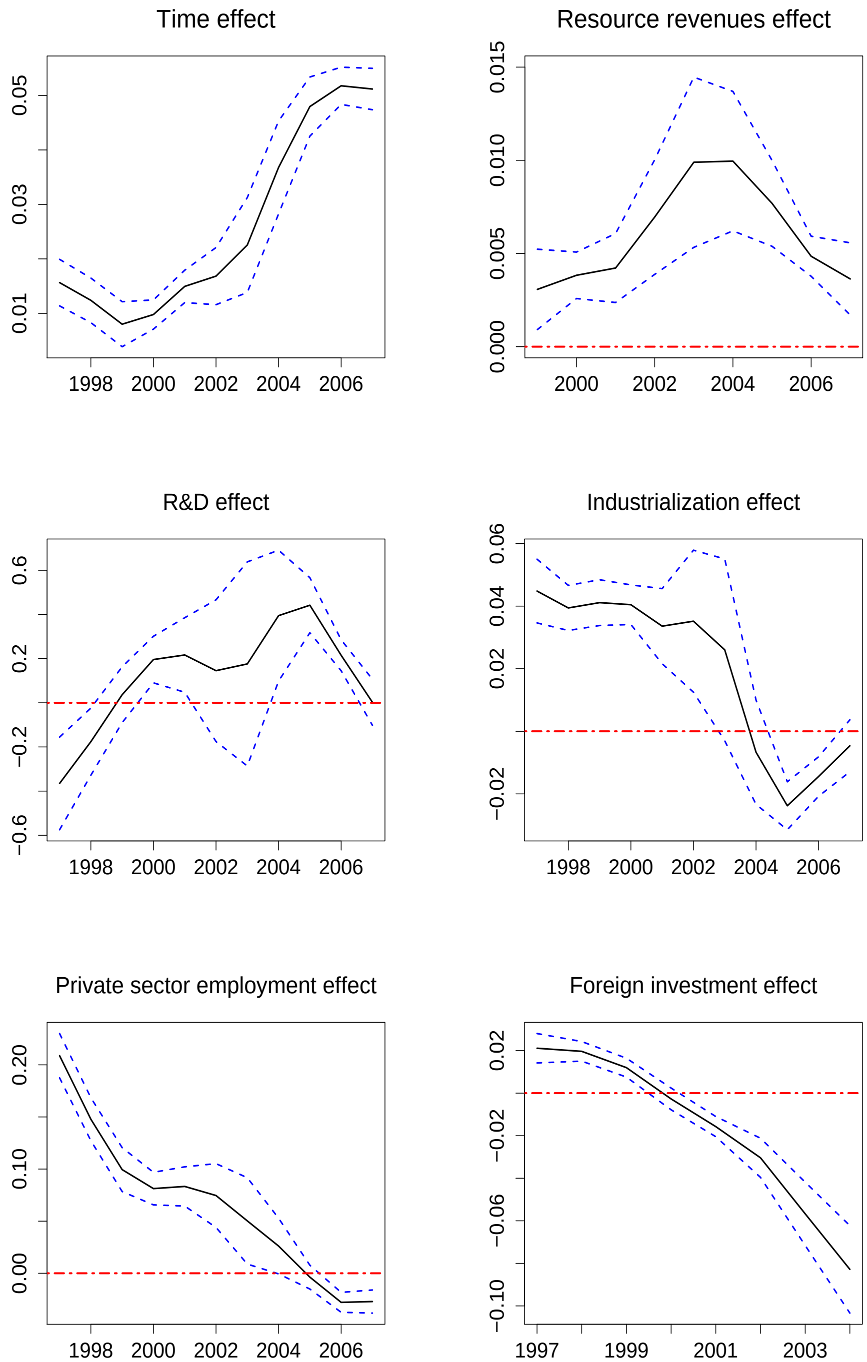
The kernel estimator $\hat{\tau}(t)$ can be thought of as a generalized least-squares estimator with weight matrix $K(t)$. Rather than running a cross section for every time period, the kernel estimator employs not only the information at time t but also the neighboring information, and its smoothness depends on the choice of bandwidth. By selecting an optimal bandwidth, we minimize the average predictive squared error, and obtain estimators with appropriate smoothness. The kernel estimator has also attractive asymptotic properties (Hoover et al. 1998), but whether these properties apply here is somewhat dubious because of the small number of provinces.

Figure 4 shows the results using the entire sample (all provinces). All coefficients vary over time. The coefficient of resource revenues is positive and increasing from 2000–2004, and decreasing from 2005–2007. The R&D effect is increasing from 1997–2000, fluctuating a little during 2001–2005, and decreasing after 2005. The coefficients of industrialization, private sector employment, and foreign investment are generally decreasing from 1997–2004. The estimated time-varying estimates are generally in line with the standard panel-data results (except R&D). In particular, the nonlinearly dynamic resource effect explains the positive but weakly significant coefficient of the interaction term $\mathrm{RA}_f \times \mathrm{PD}$ (column (c) in Table 3). Since the resource effect first increases and then decreases after the shock, the before-and-after difference is partially offset and thus not strongly significant *on average*. But, in general, the resource effect did change after the policy shock, and became considerably stronger immediately after 2000, implying that the correlation between resource revenue and economic growth is stronger after than before 2000. This is not surprising because the emphasis of the West China Development Drive was on exploiting the resources in the Western provinces more intensively and efficiently. Income in these regions has increased, stimulating economic growth, but not equally in all regions. The decreasing coefficients of the other variables suggest that the negative impact of the policy on non-resource effects dominates the positive impact.

In the period 2003–2004 the impact of resource revenues was particularly strong, be it with relatively large standard errors. To confirm this result in the standard fixed-effect model we included a time dummy D_{0304} for 2003–2004, and an interaction term $\mathrm{RA}_f \times \mathrm{D}_{0304}$. Columns (d) and (e) in Table 3 show that D_{0304} is significantly positive, confirming that the economic growth rate was particularly high in 2003–2004. The interaction term $\mathrm{RA}_f \times \mathrm{D}_{0304}$ is positive, though not very precise, suggesting that the resource effect increased during the period. In contrast, industrialization, private sector employment, and foreign investment effects experienced a drop in these two years.

Apparently the economic situation in China was different in 2003 and 2004 than in other years, and growth determinants had different effects during this period. This is indeed the case. The economic growth rate was particularly high in 2003 and 2004, mainly due to a high demand for investment. The

Figure 4: Time-varying coefficients: entire sample



Note: The solid curve is the estimated coefficient of each regressor, and the two dashed curves represent ±1.96 jackknife standard error bands. The jackknife standard errors are computed by leaving out one individual at a time from the sample.

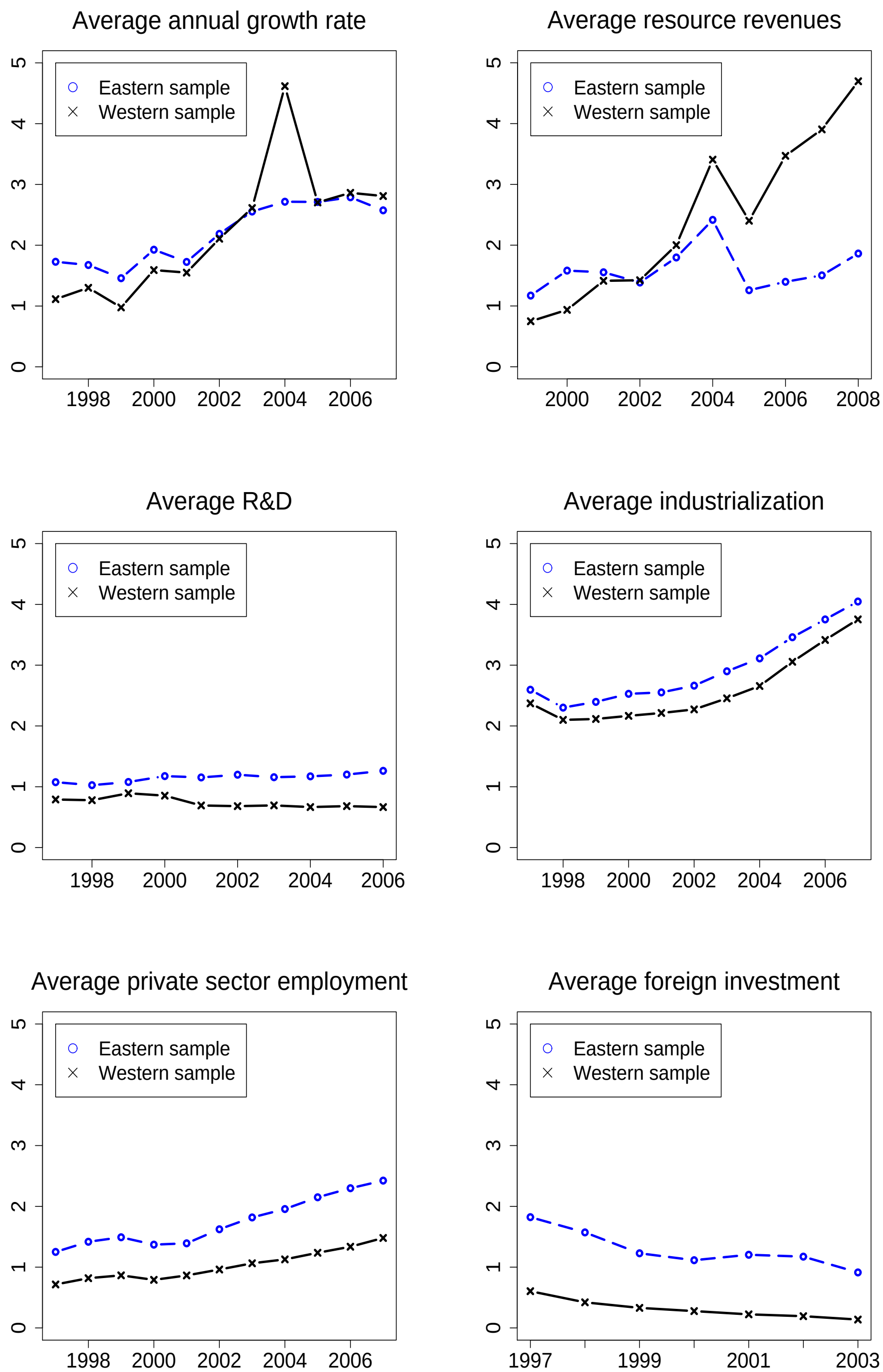
annual growth rates of fixed asset investment in 2003 and 2004 were 27.7% and 26.6%, respectively. One reason for such high investments was an increasing demand for housing and automobiles. This demand directly stimulated the investment in the realty business and the automotive industry, and also indirectly in related industries (e.g. steel, building materials, power sector). The additional investments, in turn, stimulated energy and mineral resources production. In addition, several great projects in the Western provinces were initiated in this period: the West-East natural gas transmission project, the West-East electricity transmission project, and the Western coal mining project. These projects led to a large increase in resource production with an associated increase in income. These two reasons explain the strong correlation between resource revenues and economic growth in the period 2003–2004, while the effects of other explanatory variables are relatively weak.

To avoid overcapacity in the future, the government proposed policies to restrain investment. As a result, fixed asset investment largely decreased in 2005 and 2006, and economic growth slowed down. However, resource exploitation did not slow down, and resource revenues kept on increasing, especially in the Western provinces. This is why we observe a decreasing correlation between resource revenues and economic growth rate after 2004.

To understand this from another viewpoint, we plot annual economic growth and its determinants in Figure 5. All variables are averaged over Eastern and Western provinces, respectively, and scaled to facilitate comparison. We observe a positive jump in the growth rate in 2004, especially in the Western provinces, and a return to a lower level in 2005. We also observe a jump in resource revenues in both Eastern and Western provinces in 2004. The co-movement of economic growth and resource revenues provides further evidence of the strong correlation between resource revenues and economic growth in 2003–2004. When the economic growth rate returned to a lower level after 2004, resource revenues in the Western provinces were still increasing at a high speed from 2006 to 2008. This explains the decreasing correlation between economic growth and resource revenues after 2004.

The decreasing correlation between economic growth and resource revenues after 2004 shows that increased resource exploitation did not promote the development of other industries and sectors typically regarded as engines of economic growth. As exemplified in Figure 5, average R&D, industrialization, private sector employment, and foreign investment all changed relatively little as resource revenues increased sharply. Typical examples are Ningxia and Gansu provinces, where resource revenues increased significantly after 2000, but most of the other sectors were still underdeveloped. The

Figure 5: Time series plot of growth and its determinants



economies of the Western provinces still relied much on primitive sectors, and the industrial structure of the Western provinces failed to modernize. The emphasis on resource exploitation brought extra income in the short run, but it did not narrow the gap between West and East China. In addition, only part of the resources produced by the Western regions was used to improve the local economy. The larger part was transported to the Eastern regions to meet the large demand for energy and resources there. For example, the most important gas field in Sichuan province transmitted more than 70% of its natural gas to Eastern provinces. This may also have resulted in enlarging the gap between Eastern and Western provinces. In summary, the intensification of resource exploitation in the Western provinces helped the local economy to some extent, but the positive effect was short-run and not long-run.

6 Conclusions

In this paper we have re-examined the effect of natural resource abundance on economic growth at the provincial level in China. We emphasize four features of our analysis. First, we employ new data on natural resource abundance and institutional quality to study the association between resource abundance, institutional quality, and economic growth. We compare two types of resource abundance measures: a stock measure and a flow measure. The new measures of resource abundance are considered to be more exogenous than the conventional resource dependence measure. Institutional quality is measured by a subjective measure of confidence in courts, and it is shown to be theoretically and empirically related to resource abundance and economic growth.

Second, we model a nonlinear resource effect on economic growth. Classical growth regressions cannot fully capture the resource effect on economic growth in China because the resource effect is (nonlinearly) dependent on institutional quality. Thus we employ a functional-coefficient model and we find that the effect of resources on the economy is a nonlinear function of institutional quality, and that the correlation between resource abundance and economic growth is strong and positive in provinces with weak institutional quality, but relatively weak in provinces with strong institutional quality. This finding partially supports the argument in Mehlum et al. (2006) that the resource effect depends on institutional quality, but it suggests that such dependence may not be captured satisfactorily by the linear model considered by them. More importantly, the conclusion that worse institutions make the effect of natural resources more positive (rather than more negative) in

China also contrasts with the cross-country evidence in Mehlum et al. (2006).

Third, we study the different roles of resources on economic growth before and after the 2000 policy shock, and find that the association between resources and economic growth is not constant over time if we consider short-run dynamics. Immediately after the 2000 policy shock, the positive correlation between economic growth and resource revenues was increasing, but this did not last long. After 2004 economic growth slowed down while resource revenues kept increasing, leading to weak correlation.

Finally, we analyze the resource effect using both cross-section and panel data. The cross-section model typically captures the long-run effect, and the panel-data model the short-run effect. Abundant resource revenues are positively correlated with economic growth in the short-run, and their long-run correlation is positive in provinces with weak institutional quality.

Although our paper is a cross-province study in China, some ideas can be applied to more general cross-country studies. Our paper suggests that the classical growth model is not always satisfactory in studying resource effects, because it fails to capture a possibly nonlinear influence of institutional quality. It is likely that institutional quality is also relevant in other countries. This is also the case with our finding that the resource effects in China change over time. This is likely to be true in other countries. For example, evidence before World War II tends to support a positive effect of resources on growth (Habakkuk 1962), while most empirical studies using data after World War II report a negative effect.

Further research is still needed in at least three directions. First, economic growth just measures one aspect of economic development. Economic development also includes *inter alia* a decrease in poverty and infant mortality, and better nutrition (Bulte et al. 2005). In many countries with high growth rates there is poverty and basic nutritional needs are not met. Therefore, the effect of natural resources on economic growth is not necessarily the same as the effect of natural resources on economic development (Zhang et al. 2008). Second, the exogeneity of resource abundance deserves more investigation, and the quality of resource abundance measures may be further improved by using stock values of earlier years. Third, while a more general institutional indicator has been used in cross-country studies, there are no systematic indicators on institutional quality in China. Since institutional quality appears a key variable, more accurate measures would sharpen the analysis and improve the estimates.

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