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Business output and business experience: Evidence from China's nongovernmental businesses

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Business output and business experience — Evidence from China's nongovernmental businesses

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We study the application of the Solow growth model in China's non-governmental businesses and propose a reasonable modification for it. Our analysis indicates that business experience is closely tied to the output of China's non-governmental businesses. Our major findings include: (1) the business experience has little overall impact on the elasticity of output with respect to labour; (2) the business experience has a large impact on the elasticity of output with respect to capital and the elasticity increases as the business experience increases; (3) the adjusted Solow residual that reflects technological progress exhibits a negative relationship with the business experience, indicating that a newly established business tends to have higher technology content than others.

I. Introduction

Since the seminal work of Solow (1956, 1957), Solow growth model has been widely used in analysing economic growth in various countries across the world and extended in several important works such as Mankiw *et al*. (1992) and Hall and Jones (1999). It has also been adapted to the study of the determining factors of output at the business or firm level (e.g. Zheng *et al*. (1995)).

In addition to the fundamental assumption of perfect competition, Solow (1957) also made some other key assumptions in order to derive his growth accounting equation and estimate the total factor productivity (TFP): (1) only capital and labour are used in the production; (2) the technical change is Hicks neutral; (3) the production exhibits constant returns to scale (CRS). Nevertheless, these assumptions are hardly met in developing countries like China. When we use the Solow growth model to analyse the output at the business level, we have to make some adjustments.

First of all, inputs include not only such hard inputs as capital and labour, but also soft inputs that are immaterial but contribute to the business output. The latter include the geographic, institutional and industrial natures of the business. In particular, we emphasize in this article that business experience is a key soft input that affects the business output. Moreover, neither the neutral assumption nor the CRS assumption is necessary in analysing the output of a business. They are inconsistent with the economic experience in many countries and too stern at the business or industry level. For example, using NBER panel data on 450 US manufacturing industries for the period 1959 to 1992, Kumbhakar (2003) found that technical change cannot be characterized by Hicks, Harrod or Solow neutral form. For this reason, Fu (2005) adopted a nonparametric programming method to estimate TFP, which does not require the assumption of the Solow method.

In this article, we will build our output model on the Cobb–Douglas production function. In contrast with the conventional growth model, our model is novel in three aspects. First, we will consider the impacts of both hard and soft inputs on the output. Recently, Honjo (2004) found that not only firm-specific characteristics but also entrepreneur-specific, industry-specific and local characteristics of firms have impacts on the output. He also found younger and small-sized firms are more likely to grow among the start-ups. The input examined in this article will include all of these aspects. In particular, we will focus on one special soft input: business experience, i.e., the age of the business. We conjecture that the experience will contribute to the output both directly and indirectly. By directly, we mean that the business experience directly affects the business output as it stands for some implicit technological progress: a newly established firm tends to have higher technology content than others and thus experience in this sense affects the output negatively. By indirectly, we mean that experience affects the output indirectly through its influence on the elasticity of output with respect to either capital or labour or both. As we will see, we don't need to make any aforementioned assumptions.

Second, to analyse the complicated effects of experience on output, we advocate to use a totally new econometric model, which has, to our best knowledge, not been applied to analyse any economic problems in real applications. It is a mixture of partially linear additive models and functional coefficient models. Third, we apply our model to the data on China's nongovernmental businesses and find evidence in favour of our conjecture. Since the open-up policy in 1978, the nongovernmental businesses have grown to be an indispensable force for the economic growth in China. The share of nongovernmental businesses output in the industrial sector has increased from 0.5% in 1980 to 54.35% in 2002. Much research has been done on nongovernmental businesses, but most of which is descriptive. Our econometric analysis will shed some new light on the further development of the businesses in China.

The article is structured as follows. In Section II, we introduce the theoretical framework of our analysis. We estimate our model using China's data on nongovernmental businesses in Section III. Section IV concludes.

II. A Semi Parametric Model for Business Output and its Estimation

In this section, we first state our model and then explain some hypotheses we are interested in. We will also briefly introduce the methodology to estimate our model in practice.

A semi parametric model for business output

We start with a semiparametric model for the business output that extends the Cobb–Douglas production function:

$$\ln(Y) = g_0(Experience) + g_1(Experience)\ln K + g_2(Experience)\ln L + \sum_{j=1}^{p} \beta_j Dumm_j + \varepsilon \quad (1)$$

where the notation is standard: ε is the error term, Y output, K capital, L labour, *Experience* the business experience and $Dumm_j^0$'s are some dummy variables that reflect the soft inputs for the production function. The functional forms of g_j, $j = 0, 1, 2$, are unknown except that we assume that it is piecewise smooth and twice differentiable.

In comparison with the conventional output function, our model allows the appearance of some soft inputs. Besides, we allow the important variable *Experience* to affect the output in various ways. Note the negative relationship between *Experience* in Equation 1 and the time variable t in Solow (1957). So there is an analogue between $g_0(Experience)$ in Equation 1 and $A(t)$, the technological progress factor in Solow (1957). We will not assume any functional restriction between g_1 and g_2. By specifying the coefficients of $\ln K$ and $\ln L$ as unknown functions of *Experience*, we allow *Experience* to influence the output indirectly through its influence on the marginal products of and the elasticity of output with respect to capital and labour.

Three basic hypotheses

We now make some basic hypotheses about Equation 1.

Hypothesis 1: g_0(*Experience*) decreases as *Experience* increases. The conventional output or growth model ignores the direct impact of experience on the output. g_0 is included as a part of the technological progress. It is a 'part' because some other parts of the technological progress have been contained in K and L through the employment of high-tech machine, equipment and technicians etc. So we think g_0 represents some implicit part of the technology content the business has. As technology progresses, a newly established business tends to have higher such content than others.

Hypothesis 2: g_1(*Experience*) increases as *Experience* increases. g_1 embodies the changing trend for the elasticity of output with respect to capital. A newly established business can hardly make the most of its capital. As the business progresses, capital becomes more and more fully utilized.

Hypothesis 3: g_2(*Experience*) may increase or decrease as *Experience* increases. g_2 embodies the changing trend for the elasticity of output with respect to labour. *Experience* can play two opposite roles here. One is to help workers to improve their skills and become more productive and the other is to potentially make the business more and more overstaffing and less efficient. The overall effect is unknown. Only when the two effects become a fine match or negligible, can g_2 be insensitive to *Experience*.

Estimation method

Model Equation 1 is a mixture of a partially linear additive model (e.g. Robinson (1988)) and a functional coefficient model (e.g. Cai *et al*. (2000)) and thus we term the model as a partially linear functional coefficient additive model. We propose to estimate the model by a local linear approach adapted from Zhang *et al*. (2002). For the basics of local linear fitting, see Fan and Gijbels (1996).

To facilitate the presentation, we write the model as

$$y = z^{0\prime}\beta + \sum_{j=0}^{q} g_j(t)x_j + v, \quad E(v|z, t, x_0, \ldots, x_q) = 0 \tag{2}$$

where the notation is standard, e.g. t is a $k \times 1$ random vector and g_j^0's are unknown functions. In our application, t standards for *Experience*. So we assume that $k = 1$.

Given data $\{y_i, x_{0i}, \ldots, x_{qi}, z_i, t_i\}_{i=1}^n$, we can estimate both the parametric and nonparametric components by choosing $\{\beta, b_j, c_j\}$ to minimize

$$\sum_{i=1}^{n}\left[y_i - z_i^{0\prime}\beta - \sum_{j=0}^{q}\{b_j + c_j(t_i - t)\}x_{ji}\right]^2 K_h(t_i - t) \tag{3}$$

where K is a kernel function on $\mathbf{R}$, $h = h(n) \to 0$ the bandwidth parameter and $K_h(u) = K(u/h)/h$. The solution $\hat{g}_j(t)$ to b_j in Equation 3 is the local linear estimate of $g_j(t)$ and the solution $\hat{\beta}(t)$ to β in Equation 3 is also t-dependent. So we estimate β by $\hat{\beta} = \sum_{i=1}^{n}\hat{\beta}(t_i)$. For details about other aspects of Equation 3, see Zhang *et al*. (2002).

III. An Application to China's Nongovernmental Businesses

In this section we estimate the Equation 1 using real data in China and then reveal our major interesting findings.

Data

We estimate the Equation 1 by using data for China's nongovernemental businesses. We obtain the data from the National Federations of Industry and Commerce which include 1911 valid observations on Y, K, L, *Experience* and six dummy variables for nongovernmental businesses established since 1980. The dummies are: (1) Province (= 1 if the business is located in a costal province), (2) Ownership (= 1 if the business is totally private), (3) Industry3 (= 1 if the business belongs to the third industry), (4) Industry1 (= 1 if the business is agriculture-based), (5) List (= 1 if the business is a listed company), (6) Scale (= 1 if the business is of large scale with total asset larger than 0.4 billion RMB yuan in 2003). There are about 75% of the businesses that are in the costal provinces, 49.3% privately owned, 12.7% in the third industry, 25.4% in agriculture, 32.2% large scale and 4.5% listed companies.

Estimation results

We estimate Equation 1 by using the above data set. We use the Gaussian kernel. The bandwidth parameter is chosen by leave-one-out cross validation. The estimation results include two parts, one is for the finite dimensional parameters in Equation 1 and the other is for the unknown functions g_j, $j = 0, 1, 2$.

Table 1 report the regression results for the parameters in comparison with the OLS regression results when *Experience* is taken as a fixed constant in Equation 1 so that g_0 becomes the conventional intercept and g_1, g_2 become the usual coefficients of $\ln K$ and $\ln L$, respectively. From Table 1 we see that the two estimates for the finite dimensional parameters are similar but their t-values are sometimes quite different, indicating the inference based upon the OLS results may be wrong. As expected, the R^2 increases by about 11% from the OLS case to the semiparametric estimation.

Figure 1(a) plots the functional coefficient g_0 (*Experience*). It indicates the direct impact of experience on the business output. Since g_0 represents some part of the technological progress that is not reflected in capital and labour and it is basically negatively sloped, it verifies our first hypothesis. Figure 1(b) plots the functionals g_1 (*Experience*), g_2 (*Experience*) and g_1 (*Experience*) + g_2 (*Experience*). We see the deep impact of *Experience* on the elasticity of output with respect to capital but not on the elasticity of output with respect to labour. The former elasticity is much larger than the latter and the summation of the two is always smaller than 1. These verify Hypothesis 2 and strengthen Hypothesis 3.

Table 1. Estimation results (dependent variable: ln(Y), n = 1911)

	OLS results		Semiparametric results	
Variables	Coefficients	t-values	Coefficients	t-values
C	4.521	23.380		
Province	0.325	9.812	0.336	9.197
Ownership	−0.008	−0.289	−0.004	−0.141
Industry3	0.355	7.884	0.348	5.878
Industry1	0.028	0.838	0.026	1.005
List	0.117	1.677	0.095	1.413
Scale	0.226	4.744	0.209	4.309
ln(K)	0.466	21.937		
ln(L)	0.120	8.373		
R^2	0.591		0.655	

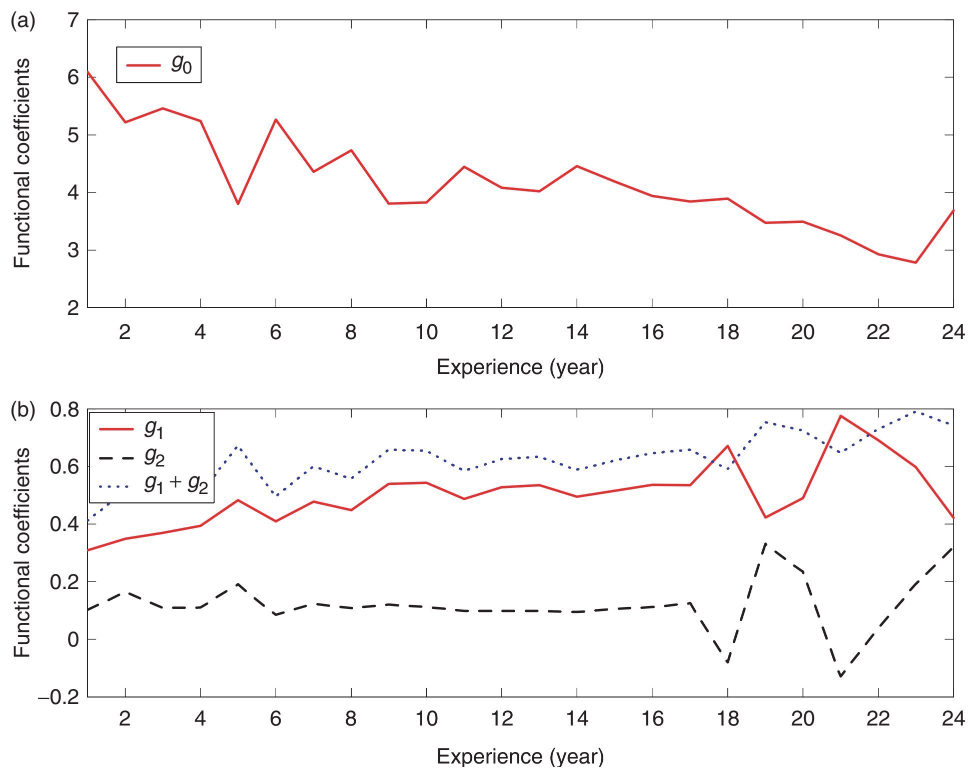

Fig. 1. Estimates for functional coefficients

Also, our findings are consistent with the actual state of the nongovernmental businesses in China, mainly, there exists a large surplus of labour and a lack in capital.

IV. Conclusion

We study the application of the Solow growth model in China's nongovernmental businesses and propose a reasonable modification for it. Our analysis indicates that business experience has a large impact on the output of China's nongovernmental businesses.

Due to the short history of the open-up policy in China and the fact that all the businesses in our data set were established after the open-up policy, a longer analysis of potential impact of experience on business output is impossible. Even so, we find the experience helps to explain the output variation nonlinearly and it influences the output mainly through two channels. One is through the elasticity of the business output with respect to its capital and the other is done directly as business experience is inversely related to the technological progress factor. Comparatively speaking, the overall effect of experience on labour is negligible.

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