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An Application of Kalman Filter Algorithm for Measuring Total Factor Productivity in Industry Sector of Iran

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ABSTRACT

The term productivity has been a key concept for national development strategy due to its impact on economic and social development. The aim of this paper is measuring TFP in Industry sector of Iran at 1960-2007 period, we have used Kalman Filter approach to estimate TFP based on a Cobb-Duglas production function. Results indicate that TFP series has decreased at 1960-2007 period.Also, TFP growth has a high volatility in this period.
KEYWORDS: Kalman Filter, Total Factor Productivity, Industry Sector, Iran.

1. INTRODUCTION

The term productivity has been a key concept for national development strategy due to its impact on economic and social development. Today, the concept is not only known by economists and managers, but has all been involved in economic activity. Productivity is a notion that has profound importance in our lives. It can have major effects at the national, industrial and individual levels.
The equation below (in Cobb–Douglas form) represents:

$$Y = AK^{\alpha}L^{\beta}$$

where Y is total output, A is total-factor productivity, K is capital input, L is labor input, and the α and β are the capital input share of contribution for K and L respectively.

Several researchers used econometric approaches to estimate the level of TFP and growth rate of TFP in manufacturing. In this approach, the growth rate of TFP is measured as the residual growth in value added in manufacturing, after accounting for the contribution of input growth to value added. Lach (1995), Windle and Dresner (1992), Rushdi (2000), Eslava et al (2004), Lam and Lam (2005) and Mollick and Cabral (2009). In these researches, Translog production function and Cobb-Douglas production function form have been applied to estimate TFP growth and estimate the share of production inputs that utilized in index method.

Jorgenson, Ho and Samuels (2010) found that, post 2000, TFP originating from the IT-Producing sector decelerated relative to the IT boom, but still accounted for 40% of aggregate productivity growth. This deceleration was counterbalanced by the contribution from IT-Using sectors, which buoyed aggregate TFP growth to almost the same rate as the 1995–2000 period. For aggregate GDP, the contributions to the growth rate of 2.8% during 2000–2007 were: capital input (1.7% points), labor input (0.4) and TFP (0.7).
The aim of this paper is measuring TFP in Industry sector of Iran at 1960-2007 period, we have used Kalman Filter approach to estimate TFP based on a Cobb-Duglas production function.

2. RESEARCH METHOD

We have used the Cobb-Duglas production function as following:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} e^{U_t} \qquad (1)$$

Where, total output (Y) as a function of total-factor productivity (A), capital input (K), labor input (L), and the two inputs' respective shares of output (α and β are the capital input share of contribution for K and L respectively. U_t is residual.
We have used this model as logarithm form in a state-space system as following:

$$ln(Y_t) = \ln(A_t) + \alpha\, ln(K_t) + \beta\, ln(L_t) + U_t$$

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$$\ln(A_{t+1}) = \gamma \ ln(A_t) + \varepsilon_{t+1} \qquad (2)$$

Where $\ln(A_t)$ is a $T \times 1$vector of possibly unobserved state variables. The unobserved state vector is assumed to move over time as a first-order autoregression.

There are two main benefits to representing a dynamic system in state space form. First, the state space allows unobserved variables (known as the state variables) to be incorporated into, and estimated along with, the observable model. Second, state space models can be analyzed using a powerful recursive algorithm known as the Kalman Filter. The Kalman Filter algorithm has been used, among other things, to compute exact, finite sample forecasts for Gaussian ARMA models, multivariate (vector) ARMA models, MIMIC (multiple indicators and multiple causes), Markov switching models, and time varying (random) coefficient models. The Kalman Filter is a recursive algorithm for sequentially updating the one-step ahead estimate of the state mean and variance given new information. Details on the recursion are provided in the references above is a recursive algorithm for sequentially updating the one-step ahead estimate of the state mean and variance given new information.

Kalman filters are based on linear dynamic systems discretized in the time domain. They are modelled on a Markov chain built on linear operators perturbed by Gaussian noise. The state of the system is represented as a vector of real numbers.

We have used the annual data report from Central Bank of Iran. Data have been used at 1960-2009 period.

3. EMPIRICAL RESULTS

Table 1 indicates Kalman Filter estimation of TFP in agricultural sector in Iran during 1980 to 2009 periods.

Table 1.Kalman Filter Estimation

		Included observations: 34		
Prob.	z-Statistic	Root MSE	Final State	
0.0000	29171.15	0.084786	2473.292	SV1
7.60E+10	Akaike info criterion		-1.29E+12	Log likelihood
7.60E+10	Schwarz criterion		0	Parameters
7.60E+10	Hannan-Quinn criter.		0	Diffuse priors

Final state is 2473 that is significantly in 99% confidence level. We have shown TFP series in Table 2 and Figure 1.

Table 2. TFP

Year	TFP	Year	TFP	Year	TFP
1980	11882.77994407864	1991	3972.300586441526	**2002**	4839.21271461705
1981	11233.05293539971	1992	2606.461320820011	**2003**	5019.347716466085
1982	10570.10602959265	1993	3726.751048523101	**2004**	4523.958455672555
1983	10349.01252930301	1994	4831.599943072996	**2005**	4554.688239206231
1984	9493.686016791191	1995	4560.073766477118	**2006**	3587.346498504724
1985	8896.495015760978	1996	4755.444080675405	**2007**	3083.499179081286
1986	8587.066405269288	1997	2917.062578622593		
1987	7969.712908766944	1998	2194.050936514051		
1988	6783.791109693037	1999	4691.7857314404		
1989	6328.235741696527	2000	5053.796676581982		
1990	6185.833504886994	2001	4961.787128311737		

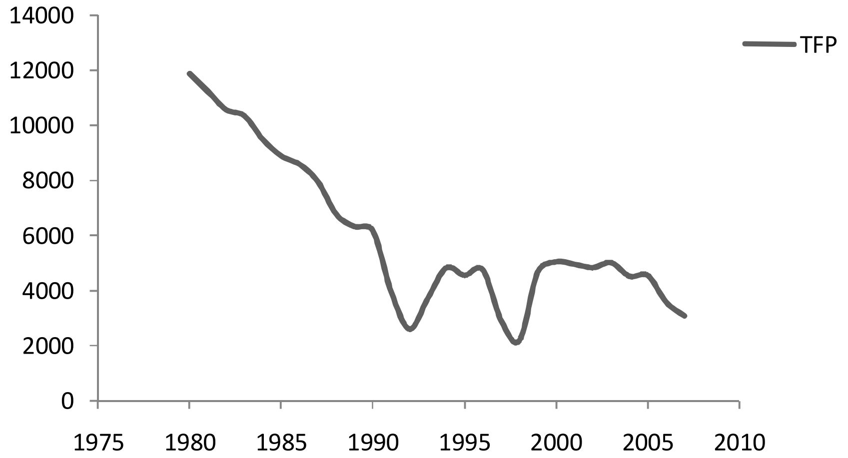

Figure 1. TFP Series

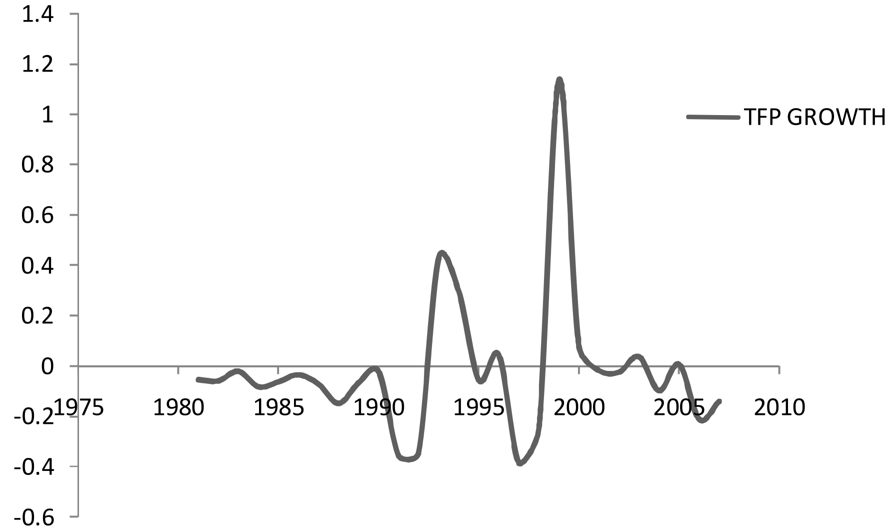

Figure 2. TFP Growth

Results indicate that TFP series has decreased at 1980-2007 periods. Also, TFP growth has a high volatility in this period. Political instability is one of the mostimportant reasons for this volatility and deceasing TFP. War between Iraq-Iranandrevolution in Iran caused an unsecure condition for economic activities. Many of the investors escape to foreign countries. Many of industries had bankruptcy.After the end of hostilities with Iraq, the government of Iran implemented a series of five-year plans to promote economic reconstruction and growth. Under these plans, the government has rebuilt the war-devastated regions in the west and improved or built infrastructure projects such as dams, electric power plants, hospitals, highways, port facilities, railroads, and schools.

Development program increased TFP at 1990-1995 period. However, institutions in Iran did not help to TFP growth as a stability condition. Intellectual property right and political stability could help to increase TFP.

4. **Conclusion**

The aim of this paper is measuring TFP in Industry sector of Iran at 1960-2007 period. We have used Kalman Filter approach to estimate TFP based on a Cobb- Duglas production function. Results indicate that TFP series has decreased at 1980-2007 periods. Also, TFP growth has a high volatility in this period.Political instability is one of the most imprtant reasons for this volatility and deceasing TFP.Intellectual property right and political stability could help to increase TFP.

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