Productivity Cycles in Public and Private Manufacturing Sectors: Evidence from Turkey

Hakan Yilmazkuday*
Temple University

Abstract This paper compares the productivity cycles of public and private manufacturing sectors in Turkey by using a regime shifting model applied through the multimove Gibbs-sampling approach over the quarterly period 1988Q1:2006:Q4. By considering timing of the business cycles for the sample period, it is shown that: 1) the public sector has higher productivity growth rates compared to the growth rates of private sector and total productivities, in both low and high productivity growth regimes; 2) the productivity in public sector is procyclical in periods of real shocks, such as stagnation or earthquakes (i.e., 1989 and 1999 crises); 3) the productivity in private sector is procyclical in periods of financial shocks (i.e., 1994 currency crisis, 1998 Russian crisis and 2001 financial crisis); 4) the productivity in the public sector has a smoothing effect in terms of reducing the effects of private sector productivity cycles.

Keywords: Regime-Shifts; Productivity Cycles; Private Sector; Public Sector; Turkey

JEL Classification: E32, E44

1. Introduction

Productivity is a measure relating a quantity or quality of output to the inputs required to produce it. Since business cycles have been one of the most attractive sources of study for economists, for both developed and developing countries (see Kim and Nelson, 1999, for an extensive number of business cycle analyses), the relation between the business cycles and the productivity growth has an important role in explaining the specifics of the cycles (see Hall, 1990; Caballero and Lyons, 1992; Basu and Fernald, 1995, 2000; Burnside, 1996; Burnside et al., 1996; Vecchi, 2000; Hayashi and Prescott, 2002; Basu et al., 2004; Miyagawa et al., 2005). Most of the related studies, such as Hulten and Schwab (1991); Morrison and Schartz (1996); Boisso et al. (2000), focus on the effects of business cycles on the productivity for developed countries. Nevertheless, there is less evidence on the developing countries.

This study bridges the gap by considering the experience of the Turkish economy over the quarterly period 1988Q1:2006Q4. In order to find the productivity cycles of Turkey, we apply a univariate Markov regime switching model originally introduced by Albert and Chib (1993). We also consider the distinction between the productivities of public and private manufacturing
sectors in our analysis. In the related literature, studies such as Davies (1971, 1977), Boardman and Vining (1989), Galal et al. (1994), Dewenter and Malatesta (1998), Megginson et al. (1994), Majumdar (1996) have found private sector to be more productive, while studies such as Tyler (1979), Caves and Christensen (1980), Millward (1988), Nelson and Primeaux (1988), Bruggink (1982), Parker and Wu (1998) have found public sector to be more productive or no statistically significant differences between two sectors.1

For the Turkish economy, there have been also studies to compare public and private sector productivity levels: Cakmak and Zaim (1992) compare the productivity of the two sectors for the Turkish cement industry, and they find that there is no significance difference between them; Bagdadioglu et al. (1996) compare the productivity of the two sectors for the Turkish electricity distribution, and they find that private sector is more productive; Ozmucur (2003) compares the wage and productivity differentials in Turkish public and private manufacturing over the annual period 1950-1998, and he finds that labor productivity is higher in the private sector; Zaim and Taskin (1997) extensively compare the rate of change in productivity of Turkish public and private sectors over the annual period 1974-1991, and they find that public sector has performed worse compared to the private sector; Turut and Becker (2000) compare the productivity levels of public and private sector, and they again find that productivity is higher in the private sector; Karadag et al. (2005) compare the total factor productivity (TFP) changes between Turkish public and private sectors over the annual period 1990-1998, and they find that while there is no evidence for TFP growth in the private sector, there is evidence for it in the public sector.2

Instead of the studies mentioned above, which mostly compare the annual productivity levels of public and private sectors (except for Zaim and Taskin, 1997, and Karadag et al., 2005, who compare the annual rate of change in productivity), this paper compares the productivity growth rates and cycles of these sectors by using quarterly data. This comparison is important to figure out the trend in productivity series and to depict the relation between productivity and business cycles in sectoral terms. In technical terms, the aim of our related model is to generate regime probabilities for different average (mean) growth measures of the productivity in public and private manufacturing sectors, by applying a Gibbs-sampling approach. As we talk in more details in the text, our methodology has important advantages over the maximum likelihood fitting approach of Hamilton (1988). First, the messy calculations entailed in the direct calculation of the likelihood function are avoided, thus, the simulation algorithm is relatively easy to implement. Second, posterior distribution of all unknown parameters and functions thereof are obtained by simulating standard distributions, such as the multivariate normal and inverted gamma. These posterior distributions convey much more information than the mode and curvature summaries that arise from the maximum likelihood framework.

Our main findings for the Turkish economy can be listed as follows: 1) the public sector has higher productivity growth rates compared to the growth rates of private sector and total productivities, in both low and high productivity growth regimes; 2) the productivity in public sector is procyclical in periods of real shocks, such as stagnation or earthquakes (i.e., 1989 and 1999 crises); 3) the productivity in private sector is procyclical in periods of financial shocks (i.e., 1994 currency crisis, 1998 Russian crisis and 2001 financial crisis); 4) the productivity in the public sector has a smoothing effect in terms of reducing the effects of private sector productivity cycles.
The rest of the paper is organized as follows: Section 2 introduces the model, while Section 3 introduces data and our motivation. Section 4 depicts the Gibbs-sampling results for public and private manufacturing sectors of Turkey. Section 5 concludes.

2. The Model

We use an approach which is originally introduced by Albert and Chib (1993), and then has been modified by Kim and Nelson (1999, pp.218-219). This is a Bayesian Gibbs-sampling approach applied to a Markov-switching model. In particular, we consider the following model with Markov-switching mean:

\[ y_t = \mu(S_t) + e_t \quad (1) \]

\[ e_t \sim N(0, \sigma^2) \quad (2) \]

\[ \mu(S_t) = \mu_0 + \mu_1 S_t \quad (2) \]

where \( y_t \) the annual change in productivity; \( \mu(S_t) \) is the state-dependent (mean) growth rate in productivity; \( e_t \) is the error term with homoscedastic variance; and \( S_t \in \{0,1\} \) is the unobserved two-state Markov-switching variable evolving according to the transition probabilities given below:

\[ p = \begin{pmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{pmatrix} \quad (3) \]

where

\[ p_{00} = \Pr[S_t = 0 | S_{t-1} = 0] \]

\[ p_{01} = \Pr[S_t = 0 | S_{t-1} = 1] \]

\[ p_{10} = \Pr[S_t = 1 | S_{t-1} = 0] \]

\[ p_{11} = \Pr[S_t = 1 | S_{t-1} = 1] \quad (4) \]

and

\[ p_{00} + p_{10} = 1 \]

\[ p_{01} + p_{11} = 1 \quad (5) \]

According to our setting, we can determine the annual (mean) productivity growth trends for two different regimes, namely high productivity growth and low productivity growth, by using the Markov-switching nature of the model.
3. Data and Motivation

In our analysis, we use the quarterly data of partial productivity of labor covering the period 1988:Q1-2006:Q4, for both public and private manufacturing sectors of Turkey together with the total productivity data. From now on, we will use public, private and total for these productivity series. For all the series, we use the data obtained from the Central Bank of the Republic of Turkey (CBRT). These series are depicted in Figure 1.

As is evident by Figure 1, the public seems to have a higher productivity growth compared to private and total. To see the specifics of the data, consider Figure 2 which shows the annual growth of productivity for each of the series. The shaded areas of Figure 2 show the recessionary periods determined by the OECD. These are: the 1988-89 stagnation that signaled the shortcomings of the export-led growth strategy adopted during 1980s, the 1990-91 recession caused by the Gulf War, the 1994 recession that followed the financial crisis in the same year, the 1998 recession triggered by the Russian Crisis and the 1999 recession due to the earthquake, and finally, the 2001 recession that followed the financial and currency crises that took place in November 2000 and February 2001.

Figure 2 suggests that the growth in the productivity of public and private manufacturing sectors have different patterns. In particular, the correlation coefficient between public and private productivity growth rates is -0.16; it is 0.10 between public and total productivity growth rates; and it is 0.96 between private and total productivity growth rates. In other words, public sector productivity growth has almost no relation with either private or total productivity growth rates. As Vickers and Yarrow (1988); Martin and Parker (1997); and Willner and Parker (2007) suggest, this may be due to the differences in the structures of competition in these sectors as well as the type of owners (i.e., active or passive) that determine how these sectors are managed. Another complementary explanation can be the ongoing process of privatization in Turkey that has started extensively from 1985. In particular, there are 186 different public companies that have been privatized with different percentage of shares sold. As it is put by the Privatization Administration of Turkey, the philosophy of privatization is as follows:

“The main philosophy of privatization is to confine the role of the state in the economy in the areas like health, basic education, social security, national defense, large scale infrastructure investments; provide legal and structural environment for free enterprise to operate and thus to increase the productivity and the value added to the economy by ensuring more efficient organization and management in the enterprises that should be commercialized to be competitive in the market.”

Thus, to increase the productivity and efficiency in the economy is one of the main objectives of privatization in Turkey. Due to this objective, it may be the case that after the privatization of 186 public companies, the public sector has now companies with higher productivity growth rates compared to private sector companies.

Figure 3 depicts the level of privatization in terms of the percentage of Turkish GDP. As is evident, the privatization has increased dramatically starting from late 1990s, which is consistent
with our view that privatization may have led to higher productivity growth rates in the public sector.

Although the reasons for the difference in productivity growth rates between public and private sectors are very important in terms of privatization process and competition policies, they are beyond the scope of this empirical paper. Instead of focusing on these reasons empirically, this paper attempts to put together the stylized facts of the productivity growth rates and cycles in the public and private sectors. Related to our main objective, according to Figure 2, the growth of the productivity series behave in a different manner in distinctive recessionary periods. In particular, the public sector productivity seems to be procyclical in 1988-1989 and 1999 recessions while the private sector productivity seems to be procyclical in 1994, 1998 and 2000-2001 recessions. In other words, the public sector productivity seems to be procyclical in periods of real shocks and the private sector seems to be procyclical in periods of financial shocks. To test our observation, we apply our Markov-switching model in the next section by using the same data as in Figure 2. Notice that by using the fourth log difference of the quarterly productivity series as our growth measure, we also control for seasonality.7

4. Gibbs-Sampling Results

We use the Bayesian Gibbs-sampling approach to find the marginal posterior distributions of the parameters of the model given by Equations (1)-(5). In particular, Gibbs-sampling is a Markov chain Monte Carlo simulation method for approximating joint and marginal distributions by sampling from conditional distribution. Selected studies on the Gibbs sampling are Albert and Chib (1993); Casella and George (1993); Geman and Geman (1984); Gelfand and Smith (1990); and Gelfand et al. (1990). In this paper, we use the one originally introduced by Albert and Chib (1993). The main idea behind the method of Albert and Chib (1993) is that the unobserved states, one for each time point, can be treated as missing data and then analyzed, along with the other unknown parameters, via the simulation tool of Gibbs sampling.

In this sense, this methodology has two important advantages over the maximum likelihood fitting approach of Hamilton (1988). First, the messy calculations entailed in the direct calculation of the likelihood function are avoided, thus, the simulation algorithm is relatively easy to implement. Second, posterior distribution of all unknown parameters and functions thereof are obtained by simulating standard distributions, such as the multivariate normal and inverted gamma. These posterior distributions convey much more information than the mode and curvature summaries that arise from the maximum likelihood framework.

Moreover, the Gibbs sampling provides the posterior distributions of the states, and of future observations, marginalized over all of the unknown parameters. This improves on plug-in approaches in which unknown parameters are replaced by sample estimates. Finally, residual analysis proceeds in a straightforward fashion by using the distribution of generated states to compute the posterior distribution of the model residual.

Instead of the single-move Gibbs sampling of Albert and Chib (1993), we apply the multimove Gibbs-sampling, originally motivated by Carter and Kohn (1994) in the context of a state-space
model and implemented by Kim and Nelson (1998) in a Markov-switching model, to obtain the marginal posterior distributions of the parameters. Gibbs-sampling is run such that the first 2,000 draws are discarded and the next 10,000 are recorded. Following Kim and Nelson (1999), we employ almost non-informative priors for all the model’s parameters. Specifically, for all of the Gibbs-samplings that we run, we employ the priors that given in Table 1.

The estimation results are given in Table 2. According to Table 2, when the annual growth trends are taken into account, the low (mean) annual growth rate of the productivity in the public sector is around 2.40%, and the high (mean) annual growth rate is around 6.63%. Similarly, the low (mean) annual growth rate of the productivity in the private sector is around 2.05%, and the high (mean) annual growth rate is around 5.06%. Note that the public sector has higher productivity growth rates compared to both private sector and total in both low and high productivity regimes. This result is consistent with Karadag et al. (2005) and our observation through Figure 1 in which we depict all of our series. As we have discussed in details above, this results may be due to the differences in competition structures of the two sectors as well as due to the privatization process in Turkey that have privatized 186 different companies since 1985. We also provide additional explanations for this result below.

The results in the first two rows of Table 2 are also interesting for us. Note that, given that the economy is in state 0 in the previous period, \( p_{00} \) is the probability of being in state 0 in the current period. Similarly, given that the economy is in state 1 in the previous period, \( p_{11} \) is the probability of being in state 1 in the current period. By using these Gibbs-sampling results, we can calculate the expected duration of a high-productivity-growth state and the expected duration of a low-productivity-growth state. As shown by Kim and Nelson (1999, pp.71-72), the expected duration formula is given by:

\[
E(D_j) = \frac{1}{1 - p_{jj}}
\]  

(6)

where \( E(D_j) \) represents the expected duration of state \( j \). For different manufacturing sectors of the Turkish economy, the expected durations of state 0 and state 1 are given in Table 3.

Note that, since we work with quarterly data, the durations represented in Table 3 are in quarterly terms, regardless of the growth measure that is used. According to Table 3, the expected duration of the low (mean) productivity growth rate of 2.40% in the public sector is around 5 quarters; while the expected duration of the high (mean) productivity growth rate of 6.63%, is around 26 quarters. Similarly, the expected duration of the low (mean) productivity growth rate of 2.05% in the public sector is around 4 quarters; while the expected duration of the high (mean) productivity growth rate of 5.06%, is around 17 quarters. Finally, the expected duration of the low (mean) productivity growth rate of 2.33% in the total is around 4 quarters; while the expected duration of the high (mean) productivity growth rate of 5.74%, is around 18 quarters. These figures suggest that the public sector productivity has longer durations compared to other two series. Depending on the turning points of the productivity cycles, this difference in the durations may be a signal for the smoothing effect of the public sector productivity on the
productivity of other series. To investigate this possibility, we consider the probabilities of low-productivity for each sector in Figure 4.

Figure 4 supports us for the smoothing feature of the public sector. In particular, the public sector behaves countercyclical to the private sector and the total in almost all recessionary periods. Figure 4 also supports our motivation that the public sector productivity drops seem to be related to the real shocks (i.e., 1989 and 1999 crises), and the private sector productivity drops seem to be related to financial shocks (i.e., 1994 financial crisis, 1998 Russian financial crisis and 2001 financial crisis).

In addition to the explanations that we have given in Section III for the difference between public and private productivity cycles (i.e., the type of owners or the process of privatization), another possible explanation for our empirical results may be the capital and finance structures of the two sectors. In particular, while the private sector mainly finances its capital from financial institutions, which are directly affected through financial crises, the public sector is mainly financed by the government, which is directly affected through real shocks. Another complementary possible explanation may be the export oriented private sector. More specifically, while the public sector mostly serves to the domestic market, the private sector serves to the foreign markets as well. This fact may give rise to productivity drops in private sector due to the terms of trade effects of the financial crises. In particular, a private company that cannot sell its product adds its production to its inventory instead of selling it, which, in turn, leads to underproduction of the firm with the very same capacity after some while. Similarly, the public sector is mostly affected through the demand shocks in the domestic economy. By the same token, the public sector may also end up with underproduction due to the underused capacity.

These results may also be connected to the traditional business cycle literature where labor hoarding is one of the key components. In the traditional literature, a small role is attached to monopoly power and increasing returns to explain productivity fluctuations. Instead of it, labor hoarding, which means the quasi-fixity of the labor input, is seen as the primary source of cyclical changes in productivity. This approach states that productivity falls in recessions because the firms retain their workers. This is consistent with the observation in the data that, as the economy enters a recession, the percentage fall in output exceeds the percentage fall in labor input; thus, the productivity is procyclical. In particular, Rotemberg and Summers (1990) find that productivity is more procyclical in industries and in nations where labor hoarding appears more important. In this context, both the procyclicality of the public sector productivity during the real shocks (i.e., 1989 and 1999 crises) and the procyclicality of the private sector during financial shocks (i.e., 1994 financial crisis, 1998 Russian financial crisis and 2001 financial crisis) may be related to the relevant labor hoardings in such sectors. This may also give more insight about the business cycle specificities of these sectors.

5. Conclusions

We have analyzed the productivity cycles of public and private manufacturing sectors in Turkey by using a regime shifting model applied through the multimove Gibbs-sampling approach. By considering timing of the business cycles, we find that the public sector has higher productivity
growth rates compared to the growth rates of private sector and total productivities, in both low and high productivity growth regimes; the productivity in public sector is procyclical in periods of real shocks, such as stagnation or earthquakes (i.e., 1989 and 1999 crises); the productivity in private sector is procyclical in periods of financial shocks (i.e., 1994 currency crisis, 1998 Russian crisis and 2001 financial crisis); and finally, the productivity in the public sector has a smoothing effect in terms of reducing the effects of private sector cycles.

A possible explanation for our results is the capital and finance structures of the two sectors. In particular, while the private sector mainly finances its capital from financial institutions, which are directly affected through financial crisis, the public sector is mainly financed by the government, which is directly affected through real shocks. Another complementary possible explanation may be the export oriented private sector. More specifically, while the public sector mostly serves to the domestic market, the private sector serves to the foreign markets in addition. This fact may give rise to productivity drops in private sector due to the terms of trade effects of the financial crises. In particular, a private company that cannot sell its product in financial crisis periods adds its production to its inventory instead of selling it, which, in turn, leads to underproduction of the firm with the very same capacity. Similarly, the public sector is mostly affected through the demand shocks in the domestic economy. By the same token, the public sector may also end up with underproduction due to the underused capacity.

Analyzing and testing empirically the reasons for the difference in productivity growth rates between public and private sectors are also very important in terms of privatization process and competition policies. Considering capital and finance formation of the two sectors together with their market structure would also be interesting empirically. Another interesting study would include the type of owners into the analysis that determine how these sectors are managed. All of these empirical issues are beyond the scope of this paper, but they may be subject of future research.

Endnotes

* Department of Economics, Temple University, Philadelphia, PA 19122, USA. E-mail: hakan.yilmazkuday@temple.edu.

1. For the comparison of the efficiency levels in public and private manufacturing sectors, see also the overviews in Megginson and Netter (2001); Willner and Parker (2007).

2. For other analyses on the productivity of the Turkish manufacturing sector, see Krueger and Tuncer (1982); Yildirim (1989); Uygur (1990); Aydogus (1993); Gokcekus (1997); Onder and Lenger (2003); Taymaz and Saatci (1997). See Denizer et al. (2007) for the comparison of the banking efficiency in Turkey before and after the financial liberalization. Also see Willner (2001) for studies comparing the efficiency of public and private sectors in US, UK, Sweden, Brazil, Canada, Australia, Finland, Germany and Switzerland.

3. http://www.tcmb.gov.tr/ is the web page of CBRT.
4. http://www.oecd.org/document/29/0,2340,en_2649_34349_35725597_1_1_1_1,00.html is the webpage of the OECD that publishes the OECD Composite Leading Indicators: Reference Turning Points and Component Series.

5. See Akay and Yilmazkuday (2008) for a complete business cycle analysis of Turkey.

6. See http://www.oib.gov.tr/program/uygulamalar/completelyPrivatized.htm for the list of all companies that have been privatized in Turkey.

7. See Yilmazkuday (2009) about the relation between seasonality and growth measures.

8. For the estimation, we modify the GAUSS codes written by Kim and Nelson (1999).

References


Table 1 - Priors for the Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_{00}$</td>
<td>0.8</td>
<td>0.16</td>
</tr>
<tr>
<td>$p_{11}$</td>
<td>0.8</td>
<td>0.16</td>
</tr>
<tr>
<td>$\mu_0$</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>$\mu_1$</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>$\sigma^2$</td>
<td>_</td>
<td>_</td>
</tr>
</tbody>
</table>

Note: The prior distribution of $\sigma^2$ is improper.
Table 2 - Gibbs-Sampling Results

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
<th></th>
<th></th>
<th>Private</th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M₁</td>
<td>SD₁</td>
<td>MD₁</td>
<td>M₂</td>
<td>SD₂</td>
<td>MD₂</td>
<td>M₃</td>
</tr>
<tr>
<td>μₚ</td>
<td>0.77</td>
<td>0.10</td>
<td>0.79</td>
<td>0.77</td>
<td>0.11</td>
<td>0.79</td>
<td>0.76</td>
</tr>
<tr>
<td>μₙ</td>
<td>0.96</td>
<td>0.03</td>
<td>0.96</td>
<td>0.94</td>
<td>0.05</td>
<td>0.95</td>
<td>0.94</td>
</tr>
<tr>
<td>μ₁</td>
<td>2.40</td>
<td>0.77</td>
<td>2.39</td>
<td>2.05</td>
<td>0.82</td>
<td>2.07</td>
<td>2.33</td>
</tr>
<tr>
<td>σ²</td>
<td>42.34</td>
<td>9.78</td>
<td>41.00</td>
<td>68.47</td>
<td>12.62</td>
<td>67.10</td>
<td>33.53</td>
</tr>
</tbody>
</table>

Notes: Mᵢ, SDᵢ, and MDᵢ stand for the mean, the standard deviation and the median, respectively. Results are obtained by Gibbs-sampling. The first 2,000 draws are discarded and the next 10,000 are recorded. The productivity growth rates have been multiplied by 100 in order to have the results in percentage terms. The sample size is 72 in all equations.
Table 3 - Expected Durations

<table>
<thead>
<tr>
<th>Sector</th>
<th>$p_{00}$</th>
<th>$p_{11}$</th>
<th>$E(D_0)$</th>
<th>$E(D_1)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>0.77824</td>
<td>0.96201</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>Private</td>
<td>0.77690</td>
<td>0.94034</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>0.76540</td>
<td>0.94529</td>
<td>3</td>
<td>18</td>
</tr>
</tbody>
</table>

Notes: $p_{00}$ and $p_{11}$ are the same as in Table 2. $E(D_0)$ and $E(D_1)$ stand for the durations of state 0 and state 1 of the productivities, respectively.
Figure 1 – Productivity Series

Notes: All series are seasonally adjusted. The base year is 1997 (=100) for all series. The correlation coefficient between public and private is 0.95; it is 0.97 between public and total; and it is 0.99 between private and total.
Figure 2 – Annual Growth of Productivity

Notes: The annual growth rates are calculated by the fourth log difference of the quarterly productivity series. The shaded areas show the recessionary periods determined by the OECD. The correlation coefficient between public and private is -0.16; it is 0.10 between public and total; and it is 0.96 between private and total.
Figure 3 – Privatization in Turkey

Source: Privatization Administration of Turkey (http://www.oib.gov.tr/index_eng.htm).
Figure 4 – Probabilities of Low-Productivity

Notes: The shaded areas show the recessionary periods determined by the OECD.