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Structural change and economic growth: a calibration exercise for Turkey

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Abstract

Using data for the years 1972-2006, we calibrate the dynamic general equilibrium model of structural change by Kongsamut et al. (2001) to Turkey. We then predict the shares of output and employment for the agricultural, manufacturing, and services sectors along the balanced growth path for Turkey until 2050. Similar to the past experience of the developed economies, we observe a declining share of agriculture in both employment and output. However, the rate of decline is much slower and based on the model, we predict the agricultural sector will still have a 10% share of output and employment by 2050 in Turkey.

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1. Introduction

Modern economic growth models are consistent with well known Kaldor facts which assert that the capital output ratio, share of capital income in total income, real interest rate and long term-growth rate are constant over time (Kaldor, 1963). While models with balanced growth paths can easily reproduce Kaldor facts in numerical simulations, their predictive power in the presence of changes in the sectoral composition of output and employment, are limited. Nonetheless, labeled as Kuznets facts, the significant shift of labor from agriculture to manufacturing and then to services sectors, coupled with an increasing share of the services sector in total output, a stable manufacturing share and a decreasing share of agricultural output are the prominent features of the structural change modern economies have gone through (Kuznets, 1957).

In OECD countries, the share of labor in agriculture has been on the decline while the share of labor in services has been on the rise since the 19^{th} century. The share of labor in manufacturing has increased until the first half of the 20^{th} century and began to decline since. Consumption shares have followed a similar path (Acemoglu, 2009). Low-income countries tend to have a higher share of agricultural output, but as income rises, reproducible capital replaces agricultural capital and the share of agriculture in output declines (Laitner, 2000). As productivity differences across sectors and the sectoral composition of labor and output have important consequences for the overall economy, understanding and modeling the structural change along the balanced growth path seems to be very crucial.

One of the basic properties of models that feature a balanced growth path is that shares of capital and labor allocated to different sectors are constant. Therefore, these models seem inconsistent with structural changes that occur at the sectoral level. Kongsamut *et al.* (1997, 2001) introduce a simple structural change model that is consistent with both the Kaldor and the Kuznets facts. In other words, their model retains some of the important features of balanced growth but is still consistent with the dynamics of structural change. Echevarria (1997), Laitner (2000), Caselli and Coleman (2001), Gollin *et al.* (2002), and Ngai and Pissarides (2007) are other examples in this line of research.

All these studies focus on structural change and economic growth in the context of economies that have already completed the transformation from agriculture to manufacturing and services. We are interested in considering the structural transformation process within the context of a developing economy, Turkey.

Turkey has undergone a structural change process which is in most ways similar to those experienced by the developed economies. However, while the Turkish structural composition follows a similar path as in OECD economies, Turkey also exhibits a somewhat different trajectory and is late to exhibit structural change. The share of agriculture in total employment was about 80 percent in 1880 and was still close to that level in the 1950s. The shift to the urban sector was not rapid even after WWII. Until the 1960s, the main driver of Turkish agricultural growth was the cultivation of new lands, not the increase in productivity. Labor productivity in the agriculture increased at 2.75 percent per annum on average from 1950 to 2000 (Pamuk, 2008).

Altug *et al.* (2007), using growth accounting approach, find that output growth in Turkey is mostly due to capital accumulation rather than TFP growth, contrary to the experiences of other developed economies. They also report that the rate of capital growth in Turkey has not been uninterrupted with declines during the instability periods of the 1980s and the 1990s, which contrasts with the experiences of East Asian economies for which the engine of growth is also identified as (sustained) capital accumulation (see Young, 1995). According to Ventura (1997), the increase in the capital stock in these economies, and hence economic growth, leads to a structural transformation where labor-intensive sectors contract and capital-intensive sectors expand. However, as Altug *et al.* report, the Turkish structural transformation, in this regard, seems incomplete as 34% of the labor force is still employed by the agricultural sector while the share of agriculture in GDP is around 10% in 2005.

The Turkish structural change and economic growth experience, therefore, seems to depart from that in developed and East Asian economies. Hence, the aim of this paper is to model and understand the structural transformation along with economic growth in Turkey. For this end, we adopt the structural change model of Kongsamut *et al.* (2001) and calibrate it for the Turkish economy, keeping the main features of their model but also allowing for different sectoral production functions. To our knowledge, this paper is the first to calibrate a structural change model for Turkey.

We are able to reproduce the change in sectoral output composition of Turkey fairly accurately for the years between 1972 and 2008. We also obtain estimates of sectoral output composition and labor share until year 2050. The predictions of the model indicate that unlike the developed and East Asian economies, in Turkey, the share of agriculture in employment and output will still be significant by 2050.

The paper is organized as follows. The model is briefly described in the next section. The third section presents the simulation results. Section four concludes.

2. A Simple Model

The main features of the model are as follows. The infinitely-lived representative household consumes a composite of agricultural, manufacturing and service goods. The household owns one unit of labor which is supplied inelastically, and k_0 units of initial capital stock. Population grows at rate n so that at any time the labor supply is given by $L_t = (1+n)L_t$. The household gets utility from consumption.

There are three sectors in the economy: manufacturing (M), agriculture (A), and services (S). There is labor-augmenting technological progress specific to each of the three sectors. These evolve according to $A_{it+1} = (1 + g_i)\, A_{it}$ where g_i is the growth rate of A_{it}, $i = M, A, S$. For simplicity, all three sectors are assumed to have production functions with capital and efficient labor as inputs which exhibit constant returns to scale, diminishing returns to each input and satisfy the Inada conditions. Capital stock of the economy is produced only in the manufacturing sector. Hence, services and agricultural output are consumed and not used for capital accumulation purposes.

Household's Problem

Let c_t be the per -capita consumption of a Stone-Geary aggregate of agricultural, manufacturing,and services consumptions. which we denote by c_{At}, c_{Mt},and c_{St} respectively.

$$c_t = (c_{At} - \gamma^A)^{\eta A} c_{Mt}^{\eta^M} (c_{St} + \gamma^S)^{\eta^S} \tag{1}$$

where $c_{At} \in \left(\gamma^A, \infty\right]$ denotes per capita agricultural consumption, $c_{Mt} \in \mathbb{R}^+$ is manufacturing consumption and $c_{St} \in \mathbb{R}^+$ is services consumption, $\gamma^A, \gamma^S, \eta^A, \eta^M$ and $\eta^S$are positive constants with $\eta^A + \eta^M + \eta^S = 1$.

Households are infinitely-lived with the following utility function

$$\sum_{t=0}^{\infty} u(c_t) = \sum_{t=0}^{\infty} \beta^t (1+n)^t \left[\frac{c_t^{1-\varepsilon} - 1}{1-\varepsilon}\right] \tag{2}$$

where $\varepsilon > 0$ and $\varepsilon \neq 1$, .

Household's problem can thus be written as

$$\max_{\{c_{At}, c_{Mt}, c_{St}, \hat{k}_{t+1}\}} \sum_{t=0}^{\infty} \beta^t (1+n)^t \left\{ \frac{\left[(c_{At} - \gamma^A)^{\eta^A} c_{Mt}^{\eta^M} (c_{St} + \gamma^S)^{\eta^S}\right]^{1-\varepsilon} - 1}{1-\varepsilon} \right\} \tag{3}$$

s.t.

$$\frac{1}{A_t}\left(c_{Mt} + P_t^A c_{At} + P_t^S c_{St}\right) = \frac{w_t}{A_t} + r_t \hat{k}_t - (1+n)(1+g)\hat{k}_{t+1} + (1-\delta)\hat{k}_t \tag{4}$$

where $\hat{k}_t$ is the capital per effective worker.

Firm's Problem:

The production takes place using a labor-augmenting technology. The output in manufacturing sector, agriculture sector and the services sector are respectively given by

$$Y_{Mt} = \bar{M} F_M(K_{Mt}, L_{Mt} A_{Mt}) \tag{5}$$

$$Y_{At} = \bar{A} F_A(K_{At}, L_{At} A_{At}) \tag{6}$$

$$Y_{St} = \bar{S} F_S(K_{St}, L_{St} A_{St}) \tag{7}$$

where K_{it} and L_{it} are capital and labor used in sector i where $i = M, A, S$. $\bar{M}$, $\bar{A}$, and $\bar{S}$ are sectoral productivity factors. $F_i(.,.)$ are assumed to be Cobb-Douglas with share of K as α_i for sector i.

Equilibrium

A competitive equilibrium in this economy is defined as

1. A sequence of sectoral factor demands $[K_{Mt}, K_{At}, K_{St}, L_{At}, L_{Mt}, L_{St}]_{t=0}^{\infty}$ that maximize profits given the sequence of total capital and labor $[K_t, L_t]_{t=0}^{\infty}$ and prices $\left[P_t^A, P_t^S, w_t, r_t\right]_{t=0}^{\infty}$.

2. A sequence of sectoral per-capita consumption levels and capital stock $\left[c_{At}, c_{Mt}, c_{St}, \hat{k}_{t+1}\right]_{t=0}^{\infty}$ which maximize utility given prices $\left[P_t^A, P_t^S, w_t, r_t\right]_{t=0}^{\infty}$.

3. The following resource constraints hold

$$K_t = K_{A_t} + K_{M_t} + K_{S_t} \tag{8}$$

$$L_t = L_{A_t} + L_{M_t} + L_{S_t} \tag{9}$$

$$c_{At} L_t = Y_{A_t} \tag{10}$$

$$c_{St} L_t = Y_{S_t} \tag{11}$$

$$K_{t+1} - (1-\delta)K_t + c_{Mt} L_t = Y_{M_t} \tag{12}$$

and the per capita capital stock chosen by the household equals the aggregate per capita capital stock:

$$\hat{k}_t = \frac{K_t}{A_t L_t} \tag{13}$$

4. We also assume that

$$\bar{A} F(K_A(0), L_A(0)A(0)) > \gamma^A L(0) \tag{14}$$

so that the economy has sufficient initial resources to support subsistence level of agricultural goods production. To see characterization of a solution of the model see Kongsamut *et al.* (1997, 2001), Tol (2007) and Acemoglu (2009).[1]

3. Calibration and Simulation Results

We calibrate the model using data from Turkey as follows.

- η^A, η^M and η^s values are from Kongsamut *et al.* (2001) for the U.S. economy. We assume those elasticities are the same in Turkey as well.

- β and δ are calculated using data from Turkey and the equations of the model.

- Aghion and Montiel (1999) report the value for ε is around 1.5 for developing economies. We adopt that value here.

- n and g are annual average growth rate of population and GDP for Turkey.

[1] All transitional dynamics, resource constraint and equilibrium equations are available from authors.

- $\bar{A}$, $\bar{M}$, and $\bar{S}$ are from Kongsamut *et al.* (2001).

- Sector-specific capital intensities are chosen in the following manner. α_M and α_A are estimated from the Turkish data between 1972-2003 (see Saygili *et al.*, 2005, for the data set). α_S is calculated based on the share of services in the economy as well as the ratio of the capital stock to GDP.

- g_M, g_S, and g_A are calculated using the productivity series constructed by the State Planning Organization (SPO).

- There is no restriction as to the values γ^A and γ^S can take, and we know of no econometric study that estimated these using Turkish data. Hence, we picked the values of γ^A and γ^S so that the simulated sectoral output and employment shares fit the actual data.

Table 1 summarizes the parameter values used to calibrate the model. After calibration, we simulate the model using these parameter values, feeding in the 1972 data as initial conditions. Comparing the model output with actual data for the 1972-2008 period indicates that the in-sample fit is fairly accurate for sectoral employment and output shares (see Figures 1-4).[2] The last step is to extend these simulations out-of-sample to predict the sectoral composition of output and employment for the 2009-2050 period. It can be observed from Figures 5 and 6 that although the share of agriculture is on the decline, the rate of decline will still be much slower than that in developed and East Asian economies, and that the agricultural sector will constitute a significant portion of the economy by 2050.

4. Conclusion

Developed and East Asian economies have experienced similar structural transformation processes where a shift of labor from agriculture to manufacturing and services is coupled with a declining share of the agriculture sector in output, an increasing share of the services sector and a stable share of manufacturing. For some of these economies, the driving force of this transformation was TFP growth, for some others it is sustained capital growth.

As put forth by Altug *et al.* (2008), the structural transformation process in Turkey is somewhat different. Although a shift in the same direction has occurred, the share of agriculture in employment is still very high. In addition, while capital growth is seen to be the driving source of growth, it was not uninterrupted in the case of Turkey. Hence, the aim of this paper is to model structural change and economic growth for Turkey.

For this purpose, we adopt the model by Kongsamut *et al.* (2001) with different production functions and biased technological progress. We calibrate the model for Turkey and run simulations. Our in-sample simulations suggest a good fit while out-of-sample predictions indicate that although the share of agriculture in Turkey will decline in the future, the rate

[2] Capital per effective worker reaches the steady state in 34 periods.

of decline will be slower than that in developed and East Asian economies, and that the agricultural sector will constitute a significant portion of the economy by 2050.

To our knowledge, this is the first attempt to calibrate and simulate a structural change model for Turkey. Potential extensions of this research includes extending the model for different policy purposes and discuss policy implications.

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Tables

Parameter	Value	Parameter	Value
γ^A	35	$\bar{M}$	1
γ^S	21.875	$\bar{A}$	4
η^A	0.12	$\bar{S}$	2.5
η^M	0.18	α_M	0.6
η^S	0.70	α_A	0.72
β	0.9258	α_S	0.55
ε	1.5	g_M	0.02
n	0.0136	g_S	0.018
g	0.0288	g_A	0.08
δ	0.047		

Table 1: Parameter values used to calibrate the model.

Figures

Figure 1: Sectoral Employment Shares in Turkey: 1972 - 2005

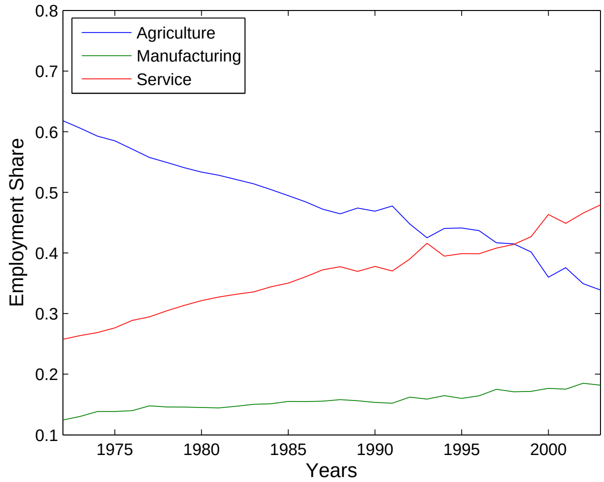

Figure 2: Sectoral Output Shares in Turkey: 1972 - 2008

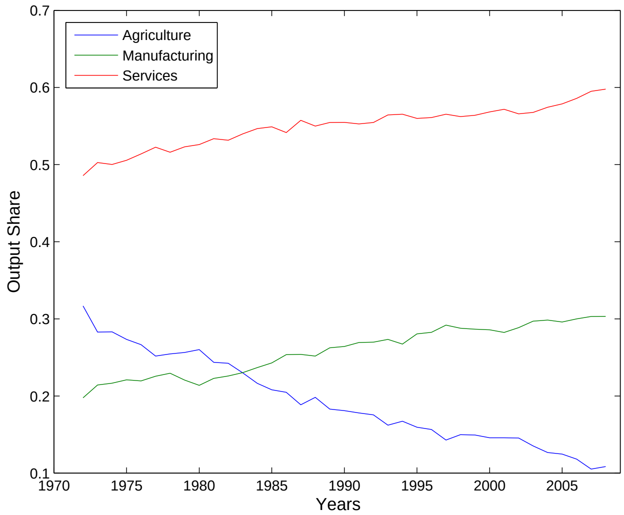

Figure 3: Sectoral Employment Shares: In-Sample Simulations

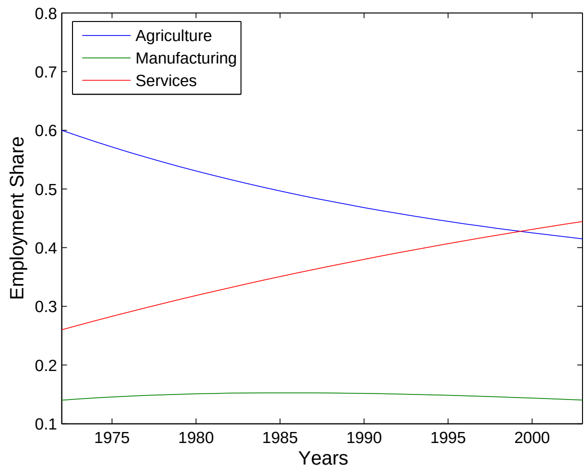

Figure 4: Sectoral Output Shares: In-Sample Simulations

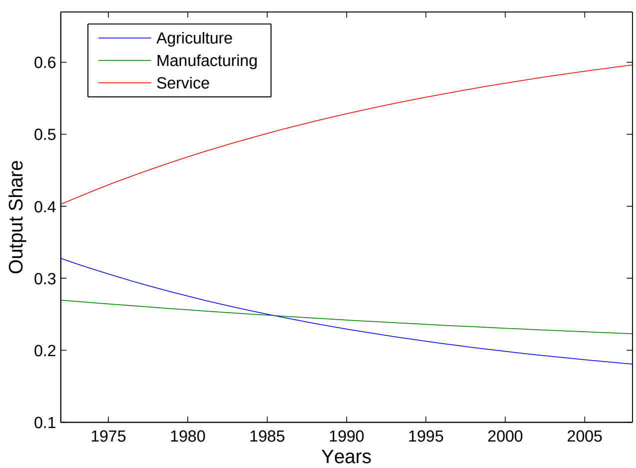

Figure 5: Sectoral Employment Shares: Out-of-Sample Simulations

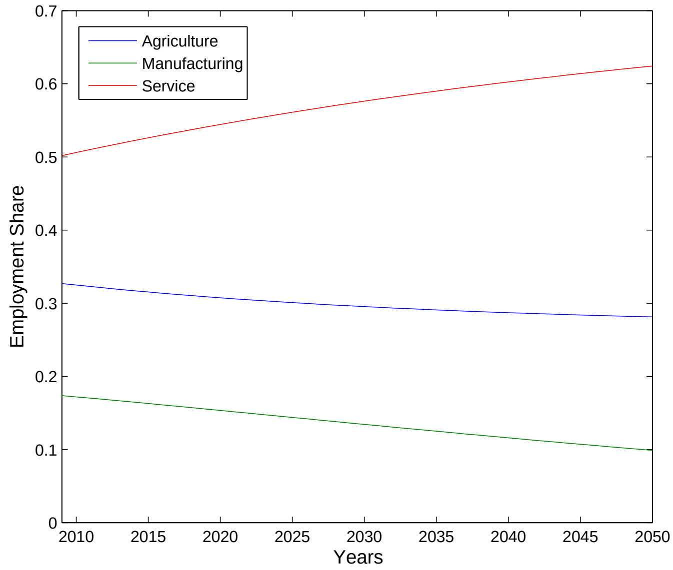

Figure 6: Sectoral Output Shares: Out-of-Sample Simulations