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Increasing Share of Agriculture in Employment in the Time of Crisis: Puzzle or Not?*

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Abstract

In the first quarter of 2008, along with the beginning of the crisis, the employment share of agriculture in Turkey deviated from its long-run trend and started to rise. Both the timing and the direction of the change caused a public debate for an explanation of this phenomenon. Less to the attention of the debate, labor productivity in agriculture has been declining since that quarter. How much of the increase in agricultural employment can be explained by the secular changes in its productivity? We use a multi-sector general equilibrium model, in which employment share in agriculture is determined solely by the subsistence constraint and labor productivity in agriculture, where sectoral productivity growth rates are treated as exogenous to answer this question. The model accounts for more than 90 percent of the decline in the agricultural employment share between 2000:Q2 and 2010:Q3. The model is also able to generate the increase in agricultural employment since 2008:Q1, although it slightly overpredicts the agricultural employment share. The model also predicts the sectoral allocations of labor in non-agricultural activities during the sample period. A detailed analysis of the driving forces of the agricultural productivity growth is needed as it is at the heart of the secular changes in employment shares in Turkey.

JEL Classification: O11, O41, O57.
Key Words: Sectoral productivity differences, reallocation of labor, Turkey.

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1 Introduction

Turkey had started to reduce its employment share in agriculture quite late compared to other countries, in 1960s', and reached a share of 23.5 percent by the end of 2007 (see Figure 1). However, the trend of this decline seems to reverse in 2008. As of the third quarter of 2010, 24.9 percent of all employed is working in agriculture. This paper aims mainly to understand the unexpected rise of agricultural employment in Turkey in recent years.

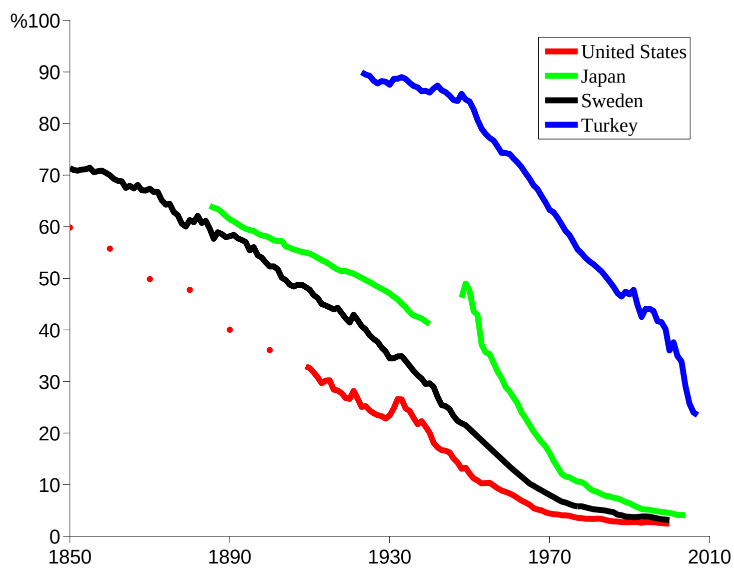

Figure 1: Employment Share in Agriculture

Understanding the movement of agricultural employment is important as the movement of labor out of agriculture is one of the typical features of economic development, both historically in developed countries and currently in developing ones. Figure 1 shows the historical pattern for the employment share in agriculture in Turkey and compares it with that of it in Japan, Sweden, and the United States.[1] The pattern over time shows a dramatic fall in the employment share of agriculture from 89.9 percent in 1923 to 23.5 percent in 2007 in Turkey. However, while share of employment in agriculture is proportionally decreasing and reaching to very low levels in today's richest countries, the agricultural employment share is still comparatively very high in Turkey.[2] For example, Turkey in 2007 had a higher

[1]Data are from Dennis and İşcan 2009 (for the United States), Hayashi and Prescott 2008 (for Japan), Krantz and Schön 2007 (for Sweden), and the Turkish Statistical Institute (for Turkey).

[2]Altuğ, Filiztekin, and Pamuk (2008) note that the inclusion of women working in the family farm in the labor force but the exclusion of urban women working at home from the labor force tends to overstate the

share of the total employment in agriculture (23.5 percent) than the United States in 1927 (23.3 percent), Sweden in 1946 (23.3 percent), and Japan in 1964 (22.8 percent).

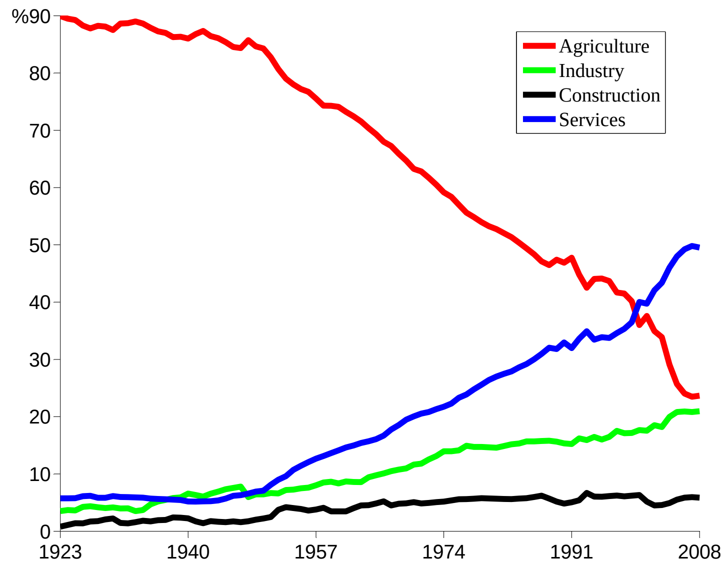

Figure 2: Sectoral Employment Shares in Turkey, 1923-2008

While the employment share in agriculture declines, industry and services increase their share in total employment from 1923 to 2008 (see Figure 2).[3] The industrial sector increases its share of the total employment from 3.5 percent to 21.0 percent between 1923 and 2008. Since 1948 decreasing employment in agriculture results in a larger expansion of employment in services than in industry.[4] However, it is only after 2000 that service sector employs more

share of agriculture in Turkish employment statistics.

[3]Turkish Statistical Institute, Statistical Indicators, 1923-2009, Table 8.4. This source provides data for nine sectors: agriculture, forestry, hunting and fishing; mining and quarrying; manufacturing; electricity, gas and water; construction; wholesale and retail trade, restaurants and hotels; transportation, communication and storage; finance, insurance, real estate and business services; community, social and personal services. These data are aggregated into agriculture, industry, construction, and services using ISIC Rev. 3 definitions. Industry includes mining and quarrying; manufacturing; electricity, gas and water. Services include wholesale and retail trade, restaurants and hotels; transportation, communication and storage; finance, insurance, real estate and business services; community, social and personal services.

[4]The industrial sector shows the inability to absorb the larger outflow of labor from the agricultural sector; and the employment opportunities in industrial sector are surpassed by the rapid growth rate of the service sector employment. OECD (2008) argues that the large size of the low-skilled working age population remains a serious challenge for the absorption capacity of the industry. The employment of the lowest-skilled was traditionally secured in Turkey through informal work. Sectors employing this workforce are primarily agriculture, construction, retail trade, and small-scale manufacturing. One reason for the increase in service sector employment for recent years is the increases in the number of the foreign-controlled firms, which were very few in Turkey until 2001. These firms are mainly concentrated in domestic market-oriented service sector activities such as banking, telecommunications and retail trade. Their role in export-oriented manufacturing is minor, except in the car industry (OECD 2008).

persons than does agriculture. The Turkish economy experiences 4.32 percent annual growth of the service sector employment between 1923 and 2008. Average annual growth rates in employment series are 0.12 percent, 3.85 percent, and 4.12 percent in agriculture, industry, and construction, respectively.

Contemplating the evolution of agricultural employment in Turkey is proven to be an important challenge to a comprehensive understanding of the overall economic development in the country. Altuğ, Filiztekin, and Pamuk (2008) study the sources of long-term economic growth for Turkey between 1880 and 2005 and argue that "the relatively low rate of transition from agriculture to non-agricultural activities" is one of the puzzles of the Turkish economic development noting that the share of the agricultural employment in Turkey is one of the highest ones in Europe today. Adamopoulos and Akyol (2009) state that Turkey has been relatively slow in moving labor out of agriculture. They argue that the key question is why relative agricultural productivity growth has been so slow in Turkey. Using a two-sector model, İmrohoroğlu, İmrohoroğlu, and Üngör (2010) show that low agricultural productivity in Turkey accounts for the increased income gap between Turkey and Spain in the 60s and 70s. If Turkey could have experienced the Spanish productivity growth in agriculture, the share of employment in agriculture would have declined much more rapidly and the overall per capita GDP would have increased more dramatically. They conclude that policies that discriminated against agriculture deserve special attention for understanding the lack of convergence in the Turkish economy.

In light of these historical patterns, the seemingly new turn the agricultural employment took deserves attention. Some discussion on this phenomenon has already started. For instance, Gürsel, İmamoğlu, and Zeydanlı (2010a,b) analyzed the data of the Household Labour Force Survey from the perspective of Harris and Todaro (1970). Looking at changes in earnings in agriculture and changes in the population of young in different regions of Turkey, they argue that observed increase in agricultural goods prices increased the incomes of those in agriculture. This implied labor to move towards the agricultural activities. In addition, the current crisis reduced the opportunity cost of working in agriculture, as employment in other sectors became harder to find, which pushed the young population (new entrants to the labor force) to agriculture. Our contribution is to look at the question from a different angle. We think that what drives the changes in agricultural employment is not income per se, but productivity in agriculture. We organize our thoughts around a multi-sector general equilibrium model and assess the relevance employing a quantitative analysis.

A primary driving source for sectoral allocation of employment is sectoral productivity (see Ngai and Pissarides 2007). Therefore, it is informative to look at the agricultural productivity and employment in Turkey. Figure 3 reveals a distinct relationship between productivity and employment in agriculture between 2008:Q1 and 2010:Q3. We observe an increase in agricultural employment in that period, while the labor productivity is declining. The average quarterly growth in employment level and in labor productivity in agriculture are 1.50 percent and -1.28 percent, respectively.[5] The simple correlation between these two series is -0.93, and this suggests a significantly negative relationship between agricultural productivity growth and agricultural employment.

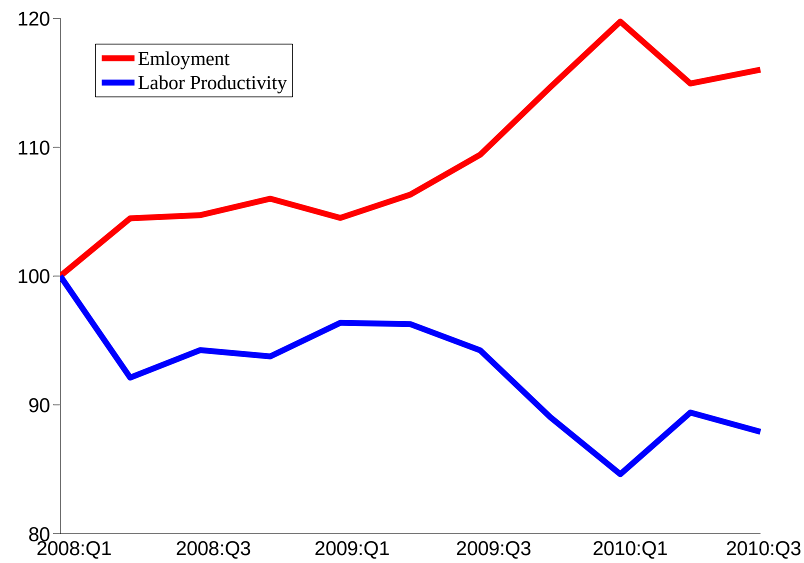

Figure 3: Employment and Productivity in Agriculture, 2008:Q1-2010:Q3

A Discussion on Measuring Agricultural Productivity. At this point, we want to pause and focus more on measuring the agricultural productivity as the path of the labor productivity in agriculture is in the heart of our quantitative analysis. We look at some other measures of productivity in agriculture to make sure that the series we use captures the dynamics of productivity in agriculture. First, we use the annual data used in Altuğ, Filiztekin, and Pamuk (2008) for output per worker and total factor productivity (TFP) in agriculture (where we calculate TFP as a standard Solow Residual with capital's share equal to 0.5) to investigate whether there is a close relationship between labor productivity and TFP in agriculture.[6] We observe a strongly positive relationship between output per worker in agriculture and agricultural TFP between 1923 and 2005. For example, a simple correlation is 0.76, 0.84, and 0.99 between 1923 and 2005, between 1980 and 2005, and between

[5]The index for employment increases from 100.00 in 2008:Q1 to 116.01 in 2010:Q3 while the index for productivity decreases from 100.00 in 2008:Q1 to 87.91 in 2010:Q3.

[6]The data used in Altuğ, Filiztekin, and Pamuk (2008) are available at:
http://myweb.sabanciuniv.edu/alpayf/files/2010/04/erehdata.xls

2000 and 2005, respectively. We also look at the number of tractors used in agriculture since 2000 to see whether there is a significant capital accumulation in (or mechanization of) agriculture. We observe that the total number of tractors used in agriculture grew from 941,835 in 2000 to 1,070,746 in 2008 with an average growth rate of 1.6 percent.[7] Moreover, the annual growth rate seems to be declining over time. Based on comparisons with these two different measures of productivity, we conclude that output per worker is indeed a good measure of agricultural productivity.

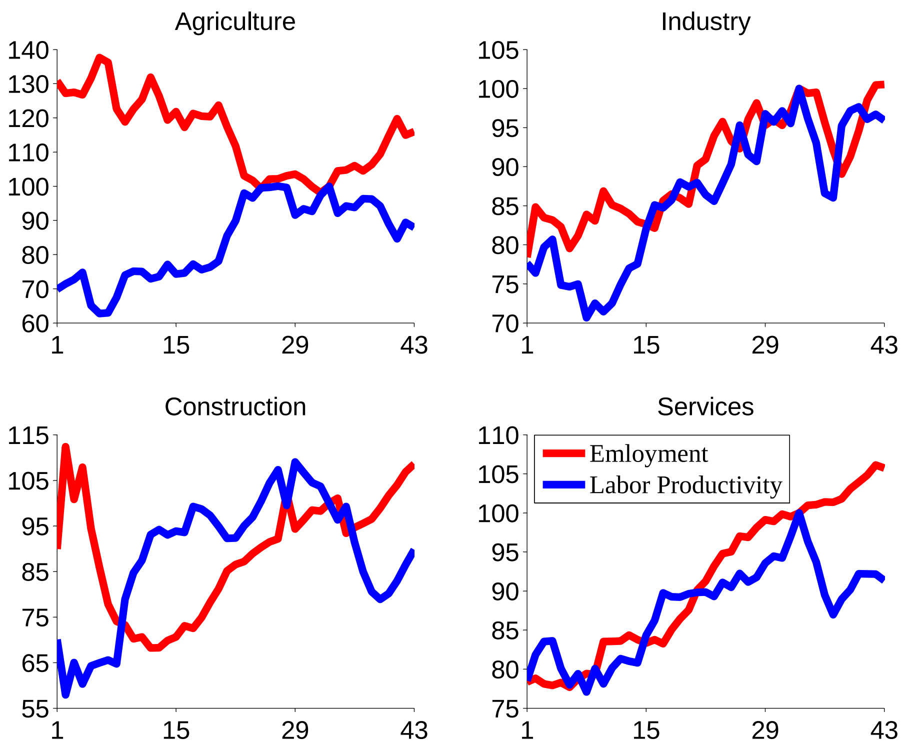

Figure 4: Employment and Productivity by Sector (2008:Q1=1)

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

To distinguish this strong relationship between employment and productivity in agriculture from that of the other sectors, we plot the paths of employment level and labor productivity in agriculture, industry, construction, and services between 2000:Q1 and 2010:Q3 in Figure 4. The relationship between employment and labor productivity is quite different in non-agricultural sectors. The correlation between employment and productivity is -0.95 in agriculture, -0.14 in construction, and 0.83 in both services and industry. Figure 3 and Figure 4 motivate us to ask the following question: To what extent can labor produc-

[7]Turkish Statistical Institute, Statistical Indicators, 1923-2009, Table 9.19.

tivity growth in agriculture explain the secular changes in agricultural employment share? Although not the main focus of the paper, we also ask: How much of the sectoral allocation in non-agricultural activities can be explained by the differences in relative sectoral productivities?

To answer these questions, we develop a four-sector general equilibrium model, where the sectors are given by agriculture, industry, construction, and services. We have a representative agent who needs to consume a specific amount of agricultural good (subsistence level) and has demand for goods of other sectors. What determines the employment allocation in agriculture is the subsistence level and the labor productivity in this sector. While the subsistence level mainly contributes to the level of employment in agriculture, the path of the labor productivity is the only determinant of the change in labor over time. In other sectors, however, the labor productivity in all sectors affect the allocation of labor within non-agricultural sectors.

There is a literature arguing that while relative productivities in non-agricultural sectors matter to understand sectoral allocations within these sectors, productivity in agriculture matters most for employment in agriculture. Therefore, technological progress in agriculture, combined with the subsistence level of consumption in agriculture, would cause structural change, with the economy shifting from a preponderance of agricultural production to marginalization of the same sector (see Laitner 2000; Stokey 2001; and Gollin, Parente, and Rogerson 2002, 2004, 2007). Unlike other goods, agricultural products are consumed at the subsistence level: one needs to (and wants to) consume some specific amount of these goods, not more, not less. This feature forces a specific relationship between labor productivity in agriculture and employment in this sector. As productivity increases, a lower amount of people will be employed to produce the same level. Any labor not needed to produce the subsistence units of agricultural output will flow into the non-agricultural sector, regardless of productivity levels in that sector. This view is also consistent with the literature arguing that the agricultural revolution preceded the industrial revolution. For example, Nurkse (1970, p. 52) argues that the introduction of the turnip and other improvements in agriculture led the rise in agricultural productivity and then caused the expansion of the industrial sector.[8]

We calibrate the model to match the employment shares in the beginning of our sample period, 2000:Q1. Then, we take the path of the actual sectoral labor productivity growth rates from the data to get the model-predicted allocation of employment across sectors between 2000:Q2 and 2010:Q3. The model delivers an allocation of labor across sectors over time that is close to the data. Our model accounts for more than 90 percent of the decline

[8] See Johnston and Mellor (1961) and Johnston (1970) and the references therein.

in the agricultural employment share over the sample period. The model is also able to generate the increase in agricultural employment since 2008:Q1, although it overpredicts the agricultural employment share. Given the fact that we dismiss many possible transmission mechanisms of the crisis, other than the sectoral productivity changes, it is not surprising that the model overpredicts this share as it does in the 2001 crisis of the Turkish economy as well.

The rest of the paper is organized as follows: The following section develops a multi-sector general equilibrium model, characterizes the competitive equilibrium, and derives equilibrium conditions for sectoral employment shares. Section 3 presents the quantitative analysis of the model for the Turkish economy between 2000 and 2010. Section 4 discusses alternative explanations for increasing share of agricultural employment. Section 5 concludes the paper with a brief policy discussion.

2 A Four-Sector Model

We develop a four-sector general equilibrium model, where the sectors are given by agriculture, industry, construction, and services.[9] In the model economy, the structural transformation of employment results both from sectoral differences in productivity and from non-homothetic preferences. Specifically, in each sector, productivity is exogenous and we impose a non-homotheticity in preferences by introducing a subsistence level of consumption in agriculture.

Households and preferences. The economy is populated by an infinitely-lived representative household of constant size. The population is normalized to one, without loss of generality. We assume that the household is endowed with one unit of productive time, which it is supplied inelastically to the market, and consumption is the only determinant of the instantaneous utility function, which is given by:

$$U(\bar{A}, C) = \bar{A} + \log(C). \tag{1}$$

The instantaneous utility is defined over the agricultural good ($\bar{A}$) and the composite consumption good (C), which is derived from the goods (industry and construction), and services:

$$C = (\gamma_1^{1/\eta} C_1^{(\eta-1)/\eta} + \gamma_2^{1/\eta} C_2^{(\eta-1)/\eta} + \gamma_3^{1/\eta} C_3^{(\eta-1)/\eta})^{\eta/(\eta-1)}, \tag{2}$$

where C_1, C_2, C_3 are the consumption of the non-agricultural goods. The weights $\gamma_1, \gamma_2, \gamma_3$ influence how non-agricultural consumption expenditure is allocated among these three sec-

[9]The model we develop in this section follows Üngör (2011).

tors. The parameter η is the (constant) elasticity of substitution among the non-agricultural goods and it underlies the magnitudes of price responses to quantity adjustments. Lower substitution elasticity implies that sharper price changes are needed to accommodate a given change in quantities consumed.[10]

Before proceeding further, we would like to elaborate on the assumption of the subsistence level in agriculture. This is a widely accepted assumption used in development literature. For example, Gollin, Parente, and Rogerson (2007) document that, in most poor countries, large amounts of labor are devoted to the production of basic foods for domestic consumption to meet the subsistence needs. In addition, a look at the Turkish data suggests the validity of this assumption for Turkey as well. For instance, agricultural value added per working age person, although changes over time, does not increase much.[11] We also look at the food expenditure (in constant prices) per working age population as well as the share of food expenditure in GDP (see Figure B.2). As expected, as the GDP increases over time, we observe the share of food expenditure in total income to decrease. Although food expenditure per person increases in pre-2005 era, after 2005 all series follow a more steady path. Nonetheless, we check the assumption of time-invariant subsistence level in agriculture in the subsequent section.

At each date, and given prices, the household chooses consumption of each good to maximize his lifetime utility subject to the budget constraint,

$$p_A\bar{A} + p_1C_1 + p_2C_2 + p_3C_3 = 1, \tag{3}$$

where p_j is the price of good-j output and ω is the wage-rate in the economy (normalized to 1).

Firms and technologies. At each date there are four goods produced. The production function for sector j is given by

$$Y_j = \theta_j N_j, \tag{4}$$

where Y_j is output of sector j, N_j is labor allocated to production, and θ_j is sector j's labor

[10]The utility function belongs to the following general type of utility function:

$$U(A, C) = \begin{cases} \bar{A}, & \text{if } A < \bar{A}, \\ \log(C) + \bar{A}, & \text{if } A \geq \bar{A}. \end{cases}$$

This specification of preferences implies that the economy specializes in agriculture until the subsistence level $\bar{A}$ is reached. Moreover, the economy will never produce more agricultural good than $\bar{A}$. Once $\bar{A}$ is reached, the representative household will supply labor to the other sectors. The idea is that consumers care mainly about food up to a satiation point; beyond that point their attention focuses exclusively on non-agricultural goods.

[11]Average quarterly growth rate is less than 0.2 percent.

productivity.[12]. Firm j problem is given by

$$max \quad p_j Y_j - \omega N_j \qquad s.t. \qquad Y_j = \theta_j N_j, \qquad N_j > 0. \tag{5}$$

Competitive Equilibrium. Given $\bar{A}$, a competitive equilibrium consists of a set of prices, $\{p_A, p_1, p_2, p_3\}$, consumption decisions of the households, $\{\bar{A}, C_1, C_2, C_3\}$, and factor allocations for the firms, $\{N_A, N_1, N_2, N_3\}$, such that, given prices, the household's allocations solve the household's utility maximization problem and the firm's allocations solve its profit maximization problem, and all product and factor markets clear:

1. The demand of labor from firms must equal exogenous supply at every date:

$$N_A + N_1 + N_2 + N_3 = 1. \tag{6}$$

2. Since there is no international trade or capital accumulation the following conditions hold at each date implying that the market must clear for each goods and services produced:

$$\bar{A} = Y_A, \quad C_1 = Y_1, \quad C_2 = Y_2, \quad C_3 = Y_3. \tag{7}$$

The following two propositions characterize the sectoral employment shares at a certain date.

Proposition 1 *Employment share in agriculture is determined solely by the subsistence constraint and labor productivity in agriculture:*

$$N_A = \bar{A}/\theta_A. \tag{8}$$

Note that the agricultural employment is negatively correlated with the productivity in this sector (and it is independent of the productivity in other sectors).[13] Hence, increases in the

[12] Since we abstract from capital and fixed factors in production, differences in labor productivity implicitly incorporates differences due to capital as well as due to the institutional differences across sectors.

[13] In the data we observe a strong negative correlation between employment and labor productivity in agriculture. The way we model agriculture implies that the causality is from productivity towards employment: A (an) decrease (increase) in agricultural productivity causes agricultural employment to increase (decrease). The other direction of the correlation, which we do not model, is that an increase in agricultural employment may reduce the labor productivity in agriculture. The direction of causality we consider is also supported by studies that use cross-country data (see Alvarez-Cuadrado and Poschke (*forthcoming*)). Nonetheless, we perform a Granger causality test to provide statistical evidence. We cannot reject the null hypothesis that the number of people employed in agriculture does not Granger cause the labor productivity in agriculture. However, we reject the null hypothesis that labor productivity does not Granger cause the employment in agriculture, at 95 percent confidence interval. These results suggest that the causality seems to work from the labor productivity to the employment in agriculture, as we formulate in the model.

level of agricultural productivity push labor out of the agricultural sector since the same amount of agricultural goods can be produced with lower levels of employment. Also note that high agricultural productivity is a necessary condition for industrialization and economic development since poor countries (lower productivity) have a much larger fraction of their employment in the agricultural sector than rich countries to be able to produce enough food to satisfy their subsistence requirements (see Lagakos and Waugh 2010).

Proposition 2 *Employment share in a non-agricultural sector j is given by:*

$$N_j = \frac{\gamma_j \theta_j^{\eta-1}(1-\bar{A}/\theta_A)}{\gamma_1\theta_1^{\eta-1}+\gamma_2\theta_2^{\eta-1}+\gamma_3\theta_3^{\eta-1}}, \qquad j=1,2,3. \tag{9}$$

First observe that the allocation of labor to a sector depends not only on that sector's labor productivity, but also productivity in other sectors. Furthermore, a productivity increase in sector j leads to flows of labor out of this sector, i.e., $\partial N_j/\partial\theta_j < 0$ as long as $\eta < 1$. Productivity in agriculture affects all non-agricultural sectors as it determines the amount of labor remained to allocate among the non-agricultural sectors.

3 Quantitative Analysis

Having laid down the model, we turn to its quantitative assessment. Our sample period covers 43 quarters from 2000:Q1 to 2010:Q3. We calibrate the model to the first quarter of our sample (2000:Q1). Moreover, we normalize the productivity levels across sectors to one for the first quarter in the sample period. Then, we use the observed labor productivity growth rates from 2000:Q2 to 2010:Q3 to construct the path of productivity series. Using these series, we calculate the shares of employment in each sector during that period and compare the model results to their counterparts in the data. All time series are seasonally adjusted before any ratios are computed. Data is described in more detail in Appendix A.

Table 1: Calibration

Parameter	**Value**	**Target**
$\bar{A}$	0.3304	Employment share in agriculture in 2000:Q1
γ_1	0.2753	Employment share in industry in 2000:Q1
γ_2	0.0893	Employment share in construction in 2000:Q1
γ_3	0.6355	Employment share in services in 2000:Q1

There are 5 parameters in the model to assign values to: $\bar{A}$, γ_1, γ_2, γ_3, and η. We calibrate the subsistence term in agriculture so that the equilibrium of the model matches the share of employment in agriculture for the initial quarter. Next, we calibrate γ_j to match the share of employment in sector j for the initial quarter. The calibration of γ_j is independent of the value of the elasticity of the substitution parameter since we normalize the labor productivity in each sector to 1 for the initial period, i.e., $\theta_j = 1$, $\forall j$. Moreover, $\bar{A}$ is calibrated independent of the value of the elasticity of the substitution by construction. Calibrated parameters are reported in Table 1. The elasticity of substitution is a free parameter and we set $\eta = 0.5$ for our benchmark computation. We do sensitivity analysis for this parameter and observe that the main findings are robust.

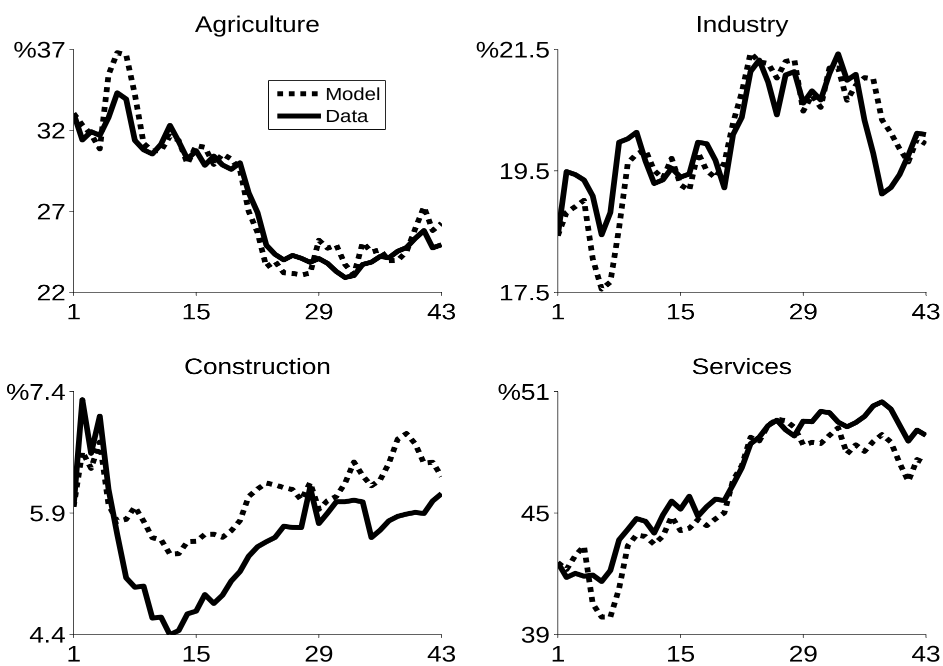

Figure 5: Sectoral Employment Shares in Turkey, Model versus Data

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

Benchmark Results. Figure 5 shows the model predicted sectoral employment shares for all sectors and compares it with the data between 2000:Q1 and 2010:Q3. The model captures the sectoral trends in each sector's employment share throughout the sample period. Table 2 reports the average quarterly growth rates of employment shares for each sector for two periods: 2000:Q2-2010:Q3 and 2008:Q1-2010:Q3. The figures reported on the table are calculated as follows: We find the growth rate of each variable from the first to the last period of the sample period in the question. Then, we find the average quarterly growth rate during the sample period that would have given this change. For example, the model predicts that agricultural employment share decreases (on average) by 0.51 percent per quarter (from 32.32 percent in 2000:Q2 to 26.25 percent in 2010:Q3, a 100*ln(32.32/26.25)/41=0.51 percent quarterly decrease) while in the data the decrease is 0.56 percent (from 31.40 percent to 24.93 percent, a 100*ln(31.40/24.93)/41=0.56 percent quarterly decrease). Thus, the model accounts for 90.12 percent of the decline in agricultural employment share between 2000:Q2 and 2010:Q3.[14]

Table 2: Average Quarterly Growth Rates (%)

	2000:Q2-2010:Q3		*2008:Q1-2010:Q3*	
	Data	Model	Data	Model
Agriculture	-0.56	-0.51	0.79	1.29
Industry	0.08	0.14	-0.64	-0.61
Construction	-0.42	-0.11	0.13	-0.28
Services	0.38	0.29	-0.13	-0.36

We can also look at the performance of the model for pre- and post-crisis periods. The model accounts for 98.24 percent of the decline in agricultural employment share if we exclude the period starting with the recent crisis, i.e., looking at the period between 2000:Q2 and 2007:Q4.[15] The model predicts the trend but not the magnitudes of the changes in agricultural employment share in post-crisis era, overpredicting the share of employment in agriculture for many quarters (except the first three quarters of 2009) of the post-2008:Q1 period. For instance, the model predicts a 5.31 percent higher increase in employment share in agriculture in 2010:Q3 than the actual data. Overall, there is an increase in agricultural employment share of 3.17 percentage points between 2008:Q1 and 2010:Q3 in the model, and the actual increase is 1.90 percentage points. Our intuition for the observed discrepancy is that, although agricultural productivity growth explains almost all of secular changes in agricultural employment share by itself in the pre-crisis period, it cannot match the post-2008 agricultural employment share as the productivity in this sector may not be the only

[14]The subsistence level of consumption in agriculture is crucial for the success of the model to fit the data. Appendix B evaluates the performance of a similar model economy without the subsistence term in the utility.

[15]Since we are more interested in explaining the trends, i.e., the turn the agricultural employment took in recent years, rather than the quarter by quarter analysis, we calculate the average quarterly growth rates as described above. One alternative approach is to take the average of quarter by growth rates of the data and the model and to compare these two. If we do that, the model accounts for 93.50 percent of the decline in agricultural employment share between 2000:Q2 and 2007:Q4.

transmission channel of the 2008 crisis for the actual changes in agricultural employment observed in the data.

The model does a good job in capturing the average growth rate of the employment shares in other sectors as well, except for the construction sector in terms of magnitudes. For example, the model accounts for 75.48 percent of the rise in the service sector employment share between 2000:Q2 and 2010:Q3. During the same period, it accounts for only 27.25 percent of the decline in construction's employment share. The model predicts most of the secular changes in industrial employment share accounting for 94.73 percent of the decline in industrial employment share between 2008:Q1 and 2010:Q3.

More on the Driving Forces of the Results. We would like to point out that, although the model implies a negative correlation between labor productivity and employment in agriculture, that doesn't necessarily guarantee that it explains the data. We observe that the model behaves differently in 1923-1960 period and 1960 onwards. The model performs poorly in the earlier stages of the de-agriculturalization in Turkey compared to the post-1960 era (see Figure 6).[16]

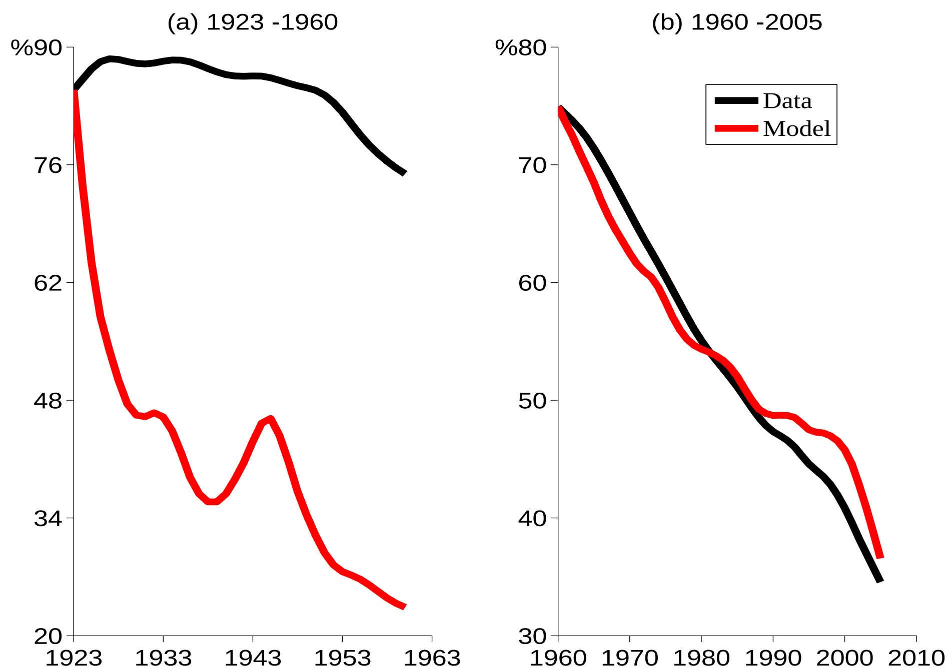

Figure 6: Agricultural Employment Share in Turkey, 1923-2005

We would like to explain why our model performs better in later, but not the former, peri-

[16]We need to emphasize that in both cases the calibration strategy is the same as we explain earlier. Data are from Altuğ, Filiztekin, and Pamuk (2008). The details are available upon request.

ods of the de-agriculturization. The literature agrees that there are two general mechanisms of the structural transformation: pull and push channels. In our model labor allocation to agriculture is mainly driven by agricultural productivity, i.e., "labor push channel". We exclude the labor pull mechanism (improvements in non-agricultural technology attract labor out of agriculture) stressed by Lewis 1954, Harris and Todaro 1970, and Hansen and Prescott 2002. A recent study by Alvarez-Cuadrado and Poschke (*forthcoming*) argue that productivity improvements in the non-agricultural sector were the main driver of structural change (movements of resources out of the agricultural sector) before 1960.[17] After that, the evidence indicates productivity changes in agriculture as the driver of change. In other words, their results suggest that the "pull" channel dominates the earlier stages of the de-agriculturalization, while the "push" channel dominates the later periods. Having labor push mechanism as the only driving force of the secular declines in agricultural employment, our model better fits the data for time periods during which countries are in later stages of structural transformation.

Model Implications for Relative Prices. It is possible to test the model's explanatory power by looking at the implications for relative prices.[18] Observe that in the model the labor is perfectly mobile across sectors. Hence there is one wage across sectors in the model. Since the wage is marginal productivity of a worker in a sector, relative prices are a function of relative labor productivities.

Proposition 3 *The model implies that the producer price of good i relative to good j is given by the ratio of labor productivity in these sectors:*

$$\frac{p_i}{p_j} = \frac{\theta_j}{\theta_i}, \qquad i \neq j. \tag{10}$$

We can easily compare the relative prices implied by the model to their counterparts in the data. We calculate the price of a sector in the data by dividing its value added in current prices by its value added in constant prices. The relative prices are deduced form there. Figure 7 shows the model implied relative producer prices and compares it with the relative implicit price deflators between 2000:Q1 and 2010:Q3.

The model predicts the rise of the relative price in agriculture during the crisis period. For example, the model implies that the producer price of agriculture relative to industry

[17] They study the de-agriculturalization in 12 industrialized countries since the 19th century. The countries are Belgium, Canada, Finland, France, Germany, Japan, the Netherlands, South Korea, Spain, Sweden, the United Kingdom, and the United States.

[18] In the model, sectoral output is given by labor productivity times the labor input. Because the model matches the time path of sectoral labor allocation closely, the output implications of the model over time are also quite close to the data. Therefore, we focus on the implications for relative prices.

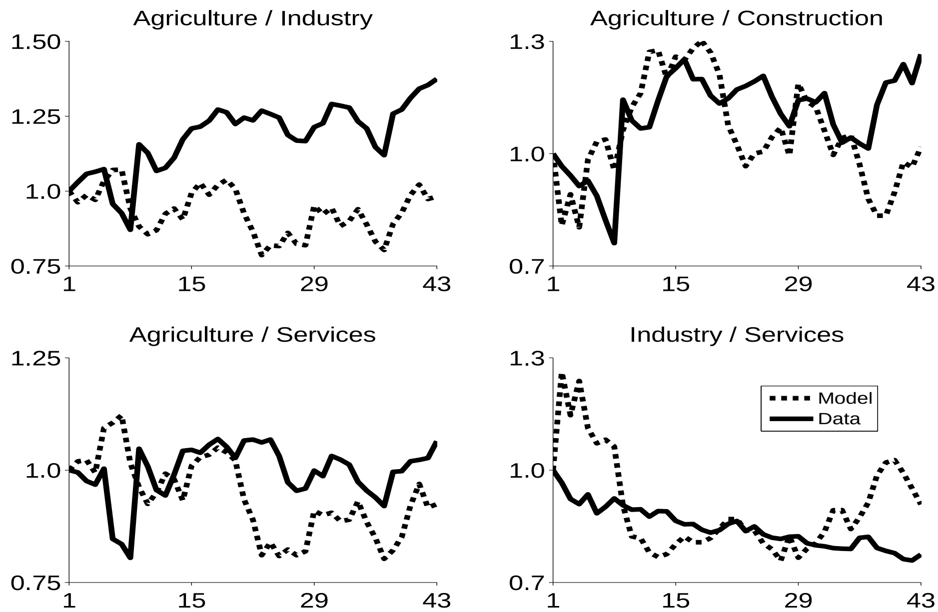

Figure 7: Sectoral Relative Prices, Model versus Data

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

increases by 0.88 percent per quarter between 2008:Q1 and 2010:Q3. This increase in the relative price of agriculture is consistent with the data, although the relative price of agriculture increases somewhat less in the data (0.73 percent per quarter) than in the model.[19] The increase in the data for the relative price of agriculture to services from the implicit price deflators is 0.50 percent per quarter. The price of agriculture relative to services increases in the model at a rate of 0.38 percent per quarter from 2008:Q1 to 2010:Q3. Although the model cannot match relative prices as well as it does the employment shares, the pattern of prices in the model is close to the data and given the simplicity of the model and the focus of the paper, the model is relatively successful in that aspect as well.

Sensitivity. We start our sensitivity analysis with parameter values. Recall that η is the free parameter we have decided to set to 0.5. Figure 8 compares the results of model with $\eta = 0.1$ and the benchmark case ($\eta = 0.5$). Notice that the model predicted agricultural employment share is independent of η. The qualitative nature of our results do not change although the quantitative results change slightly. The recent literature provides a range of

[19] In addition to the implicit price deflators, we also use the sectoral producer price indices (for agriculture and industry) from TurkStat (databases, Inflation and Price, Producer Price Index, by main economic activity, 2003 prices) covering the period from 2005 to 2010. These monthly series are seasonally adjusted and converted into quarterly series. These series imply that the producer price of agriculture relative to industry increases by 0.99 percent per quarter between 2008:Q1 and 2010:Q3.

estimates for η. Rogerson (2008), Bah (2009), and Duarte and Restuccia (2010) study three-sector closed economy models and calibrate an elasticity of 0.44, 0.45, and 0.40, respectively, studying the U.S. data for the post-1950 period. Ngai and Pissarides (2008) cite the empirical literature and argue that the elasticity of substitution lies between 0.1 and 0.3.

In our quantitative analysis, we have calibrated the model for the beginning of our sample period and calculated the employment shares for the rest. Alternatively, we can calibrate the model to any period in the sample period. Calibrating to a different period changes the value of $\bar{A}$, hence it affects the employment shares the model delivers. However, the changes are not big enough to have a significant effect on model's explanatory power (see the panel in the left in Figure B.3). We also check our time-invariant subsistence level assumption. We let this level to change with the growth rates of (i) the agricultural production per working age population, and (ii) the share of food expenditure in GDP. We find that the model implied agricultural employment share is above the benchmark model's predictions for the second half of the sample period using (i) (see the line "Alternative 1" in Figure B.3). On the other hand, the predicted agricultural employment share is below the benchmark model's predictions for the second half of the sample period using (ii) (see the line "Alternative 2" in Figure B.3).

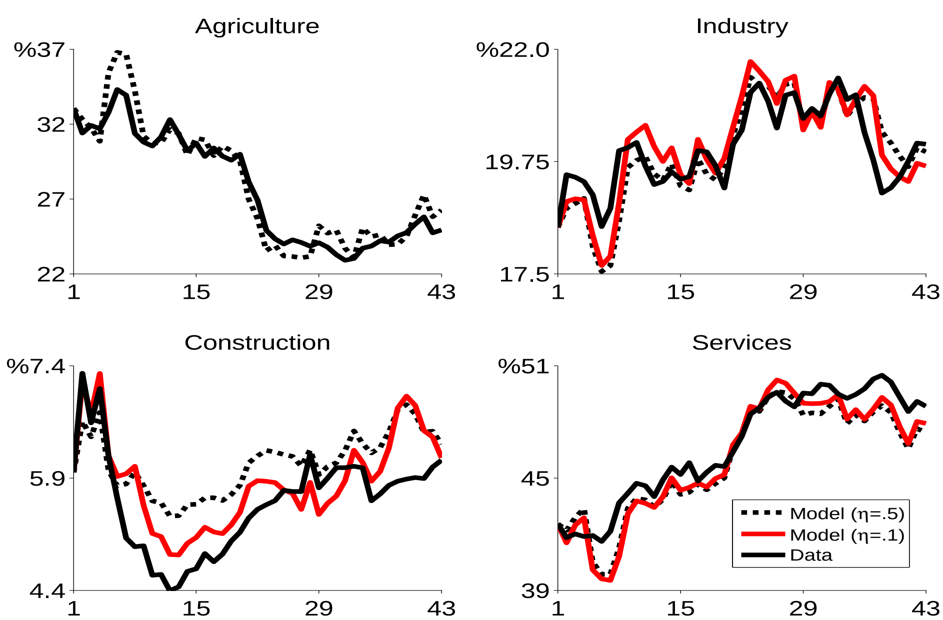

Figure 8: Sensitivity

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

4 A Discussion on Alternative Explanations

The discussion above shows that the labor productivity in agriculture is the main driving force for the allocation of employment to agriculture. As described above, agricultural employment allocation solely depends on the productivity in that sector. We call this explanation as the own-productivity-driven allocation. An alternative explanation, which incorporates the observation that the upward deviations from the main trend in agricultural employment coincides with the recession times supporting the view that agricultural employment increases during crisis and declines in other times, is that workers may go to agricultural sector when the prospects of finding a job in non-agricultural sectors deteriorate. We call this explanation as the own-productivity-independent allocation.

Both of these explanations are (qualitatively) observationally equivalent. To understand their quantitative relevance, we first develop a simple two-sector model for each to present the intuition. Then, we calibrate these two models and compare the model implied labor allocations, given that both of these models take the same productivity series as given, to the data. As discussed below, the own-productivity-driven allocation theory, which predicts that agricultural employment allocation is mostly determined by the productivity in this sector, has a better fit to the data. The path labor productivity follows not only explains the mid-term trend better, it also is better at explaining deviations from the trend.

In both of these models, there are two sectors in the economy: agriculture and industry (non-agriculture). Goods in these sectors are produced by competitive firms using only labor as input. The production function for sector j, where $j \in \{A, I\}$, is given by equation 4. Similarly, firm j problem is given by equation 5. The economy is populated by a unit measure of infinitely-lived representative household, which is endowed with one unit of productive time and supplies it inelastically to the market. The consumer's instantaneous utility is a function of both agricultural (A) and non-agricultural (I) goods:

$$U(C_A, C_I) = u(C_A) + v(C_I). \tag{11}$$

The household's budget constraint is: $p_A C_A + C_I = \omega$, where p_A is the price of the agricultural good and ω is the wage in the economy, and the non-agricultural good is the numeraire.[20]

[20] Given a set of prices, $\{p_A, \omega\}$, a competitive equilibrium consists of consumption decisions that are the household's allocations, $\{C_A, C_I\}$, and factor allocations for the firms, $\{N_A, N_I\}$, such that the firm's allocations solve its profit maximization problem, the household's allocations solve the household's utility maximization problem, and all product and factor markets clear:

$$N_A + N_I = 1, \quad C_A = Y_A, \quad C_I = Y_I.$$

How we choose utility functions $u(\cdot)$ and $v(\cdot)$ determines whether we are in the world of the first or the second hypothesis.

Own-Productivity-Independent Allocation. Let us assume that $u(C_A) = \gamma log(C_A)$ and $v(C_I) = C_I$, where γ is the relative weight of the agricultural consumption in overall utility. Household chooses both C_A and C_I subject to its budget constraint to maximize the utility. The solution for the demand for agricultural good is $C_A = \gamma\theta_A/\theta_I$. Hence, in equilibrium:

$$N_A = \gamma/\theta_I. \tag{12}$$

Observe that the employment in agriculture only depends on the productivity in the non-agricultural sector.[21] To illustrate the mechanism, assume that the productivity in agriculture increases. Then, the relative price of the agricultural good decreases, which makes consumers demand more of the agricultural good. However, this will not require more (or less) workers to produce the higher amount demanded as productivity would be up by the same fraction. Suppose now that the productivity in non-agricultural sector decreases. Therefore, the price of agricultural goods decreases and employment share in agriculture will increase.

Own-Productivity-Driven Allocation. Let us now assume that $u(C_A) = \bar{A}$ and $v(C_I) = log(C_I)$, where $\bar{A}$ is the exogenously given subsistence level for agriculture. The household only chooses C_I. The economy needs to produce the subsistence amount first, then allocates remaining labor to the non-agricultural sector. Hence, in this model, employment share in agriculture is determined solely by the subsistence constraint and labor productivity in agriculture:[22]

$$N_A = \bar{A}/\theta_A. \tag{13}$$

Note that the agricultural employment is negatively correlated with the productivity in this sector (and it is independent of the productivity in the other sector).

Own-Productivity-Driven vs. Own-Productivity-Independent Allocations. Now we have two different hypothesis about the allocation of labor to agriculture. If we assume that the agricultural production is by allocating labor that is not needed in other sectors, then we have $N_A = \gamma/\theta_I$. On the other hand, if we assume that the agricultural production is to supply a specific amount of subsistence level, then we have $N_A = \bar{A}/\theta_A$.

To compare these two models quantitatively, we calibrate them to the first quarter of 2000, as described in the four-sector model. Observe that the only parameters we need to calibrate are $\bar{A}$ (in the own-productivity-driven allocation model) and γ (in the own-

[21] If we assume a concave production function in labor, instead of a linear one, then the agricultural employment will still be independent of the productivity in agriculture.

[22] Note that this is the simplified version of the four-sector model.

productivity-independent allocation model) and we calibrate them to match the share of agricultural labor initially. We normalize the productivity levels for the initial period to 1 and generate productivity series for the models as described in Section 3.[23]

Figure 9 shows that the model of own-productivity-driven allocation (Model 1), where the employment in agriculture only depends on the productivity in this sector, matches the trend in the agricultural employment share better than the theory of own-productivity-independent allocation (Model 2). Although both of the models can generate the path of the agricultural employment close to the data until 2005, Model 1 is better at capturing the trend and the magnitudes afterwards. The model of own-productivity-independent allocation (Model 2) not only substantially overpredicts the crisis era employment allocation, but also the era between 2005 and 2008.

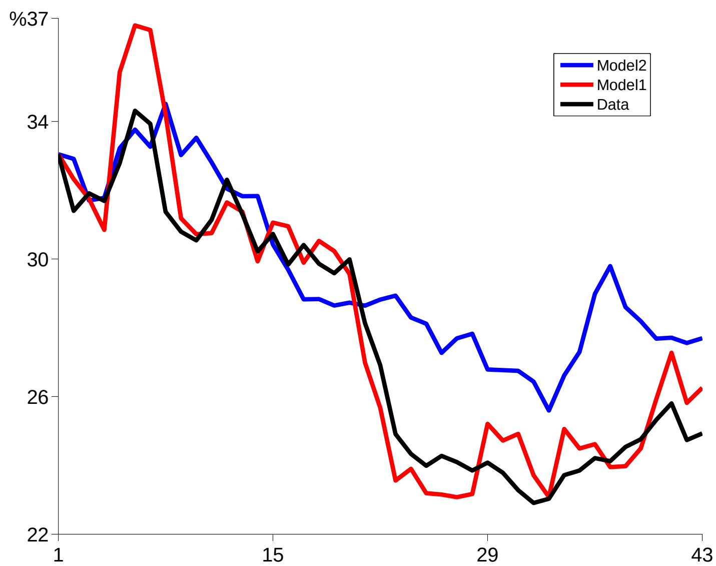

Figure 9: Employment Share in Agriculture: Comparing Models

Model1: $N_A = \bar{A}/\theta_A$, Model2: $N_A = \gamma/\theta_I$

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

Since the labor productivity for both agriculture and non-agriculture have a common trend, one can argue that it may cloud the judgement of the explanatory powers of these models. Therefore, we compare the models' predictions using de-trended productivity series as well.[24] Figure 10 compares the de-trended employment series of the models and the data.

[23]We refer to the sectors as agriculture and industry for clarity. The industrial sector, in this section, is more properly thought of as the non-agricultural sector. It includes all economic activity that is not specifically attributed to agriculture. To find values for non-agriculture sector, we add output and employment values of construction, industry, and services before seasonal adjustment.

[24]We de-trend the both the productivity and employment series (both in the model and in the data) using

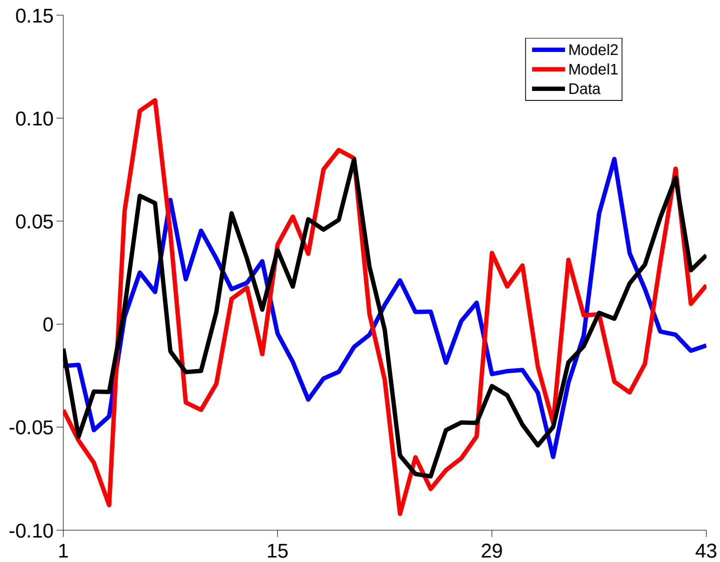

Figure 10: Employment Share in Agriculture with De-trended Series: Comparing Models
Model1: $N_A = \bar{A}/\theta_A$, Model2: $N_A = \gamma/\theta_I$
(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

As the figure suggests, the model of own-productivity-driven allocation matches the data better. The correlation between the deviations in employment share in agriculture is 0.77 for the own-productivity-driven allocation model while it is 0.14 for own-productivity-independent allocation model (Table 3). We see that the model with subsistence level performs better if we compare the standard deviations of de-trended agricultural employment series.

Table 3: Data and Models: Cyclical Behaviors

	Standard Deviation (%)	Correlation with Data
Data	4.30	1.00
Benchmark Model	5.38	0.77
Alternative Model	3.01	0.14

HP-filter with a smoothing parameter of 1600.

5 Concluding Remarks

The importance of agriculture in development is widely acknowledged. One of the stylized facts of economic development is that agricultural employment share decreases as countries prosper. Turkey has been experiencing a continuous decline until the year 2008. This paper aims to explain the increasing share of agriculture in employment starting with the first quarter of 2008.

We find that the observation of the decreasing labor productivity in agriculture since 2008:Q1 can explain the increase in agricultural employment share. We utilize a multi-sector general equilibrium model, in which employment share in agriculture is determined solely by the subsistence constraint and labor productivity in agriculture. This model accounts for the most of the secular changes in employment shares in Turkey between 2000:Q1 and 2010:Q3. The model also predicts the increase in agricultural employment since 2008:Q1. In addition, we look at the performance of the model by examining the implications for relative prices. Considering the simplicity of the model and all other factors we omit in this analysis (such as factor market distortions, inter-industry trade, international trade, etc.), the model also successfully delivers the path of relative prices in these sectors.

To relate this work to the recent discussion, we find that an increase in agricultural employment since 2008 is mainly due to the declining productivity growth in agriculture. We do take a different stand on the determinants of agricultural employment than many participants of the recent public discussion in Turkey (see Gürsel, İmamoğlu, and Zeydanlı 2010a,b). We argue that agricultural employment has the unique property of producing to meet some subsistence level of agricultural goods, resulting in a strongly negative correlation between employment and productivity in agriculture as supported by both the theory and the data. The rise in agricultural employment in recent quarters is mostly the response to the low agricultural productivity. This argument explains not only the majority of the increase in share of agriculture in employment, but also the rise in the relative price of agriculture.

This paper shows that agricultural productivity is central to the allocation of labor. Hence, to fasten the de-agriculturalization, policies shall be tailored to increasing agricultural productivity, as well established in the literature. For example, recent economic success of China started with economic reforms in agriculture.[25] Although this paper is silent about

[25] China began moving away from the command system in 1978 with the introduction of the Household Responsibility System (HRS) in agriculture. In the early reform period (1978-1984), the HRS, which replaced the production team system as the unit of production and income distribution, significantly increased agricultural productivity transferring the collective agricultural production system to individual farms by contracting land-use rights to individual rural households, price and marketing reforms improving the peasants' work incentives. Thus, agriculture had the highest labor productivity (and total factor productivity) among all other sectors between 1978 and 1984 in China (see Lin 1988, 1994).

a specific policy recommendation, we should note that policies that focus on several institutional structures such as technology adoption, barriers to the market entry, regulations, distortions to competition, high costs to starting a new business, stifling labor market regulations at the sector level, constraints for higher modern input use would be directly related to the mechanism of the paper as they may increase agricultural productivity.

We think that our work can stimulate further research in different directions. An important question is why the labor productivity in agriculture started to decline in 2008. It is important to understand the driving forces of the trend changes in agricultural productivity as this could help the policy makers to design efficient institutions and policies. We think that a starting point of an inquiry could be to look at the changes in agricultural support. Agricultural support creates distortions, keeping resources in low-productivity activities and maintaining prices received by farmers above world market levels as it is the case in Turkey: "The productivity and competitiveness of Turkish agriculture have been constrained by socio-economic weaknesses in rural areas and a protective trade and subsidy regime, which has created a status quo of highly fragmented, low-skilled, low-technology and domestic-market-driven farming." (OECD 2006, p. 169).

Studying agricultural policies, OECD (2010) shows that "in all OECD countries, except Turkey, the burden of total agricultural support on the overall economy declined.". It is also documented that Producer Support Estimate (PSE) was 30 percent in 2007, and it increased to 36 (and 37) percent in 2008 (and in 2009) in Turkey.[26] Although increases in PSE for some other OECD countries are also documented during that period, given Turkey's slow de-agriculturalization compared to other OECD countries, increases in these values may be more important for the dynamics of the Turkish agriculture.[27] One needs to study the evolution of the agricultural support policies carefully and more systematically to conclude that these were the reasons of the fall in agricultural productivity in recent years.

Another possible direction for further research is to look at the cross-country data to see whether the phenomenon we observe for Turkey is common across the other countries in times of crisis. Although not conclusive, a preliminary look at the data for some of the OECD countries motivates a need for cross-country studies. Agricultural employment share has been declining in Austria, Belgium, France, and Germany, while Greece, Italy, and Spain

[26]The monetary value of policy transfers expressed as a percentage of gross farm receipts is the percentage Producer Support Estimate (%PSE) and is a key measure of the level of support provided to the agricultural sector. Two complementary measures of the %PSE are the Nominal Assistance Coefficient (NAC) and Nominal Protection Coefficient (NPC). NPC was 1.23, 1.51, and 1.40 percent in 2007, 2008, and 2009, respectively, while NAC was 1.42, 1.56, and 1.58 percent.

[27]There are other features of Turkish agriculture that might interfere with these support policies. For instance, prices received by farmers in 2007-09 were about 38 percent higher than those received on the world market (OECD 2010).

had some increases in mid-to-late 2008, highest of which was in Greece from 11.12 percent in 2009:Q1 to 12.08 percent in 2010:Q3 (see Appendix Table A.1).

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Appendix A Data

Sectoral employment data for Turkey from 2000:Q1 to 2010:Q3 come from the Central Bank of the Republic of Turkey and the Turkish Statistical Institute (TurkStat) Household Labor Survey. To reach the data, select “databases” on TurkStat’s homepage, then go to “Employment, Unemployment, and Wages” and click on ”Household Labor Survey”. Select employment, then 15+ for age, Turkey for settlements, total for gender, and variable “Branch of the Economy”. First, note that “Branch of the Economy” variable is available for 4 groups (agriculture, industry, construction, and services). For earlier periods than 2009, there are 9 economic activities which are agriculture, 3 sub-sectors of industry, construction, and sub-sectors of services, with this order. Second, Turkstat delivers data on economic activity according to NACE.Rev2, starting from 2009, instead of revision 1. This leads to a slight change in regrouping the economic activities. This part of the data is converted to revision 1 by the Central Bank of the Republic of Turkey.

Sectoral real and nominal GDP data for 2000:Q1-2010:Q3 period come from the Central Bank of the Republic of Turkey and are available online (from the main page, go to data, statistical data, general statistics). The data are called “GDP by Kind of Economic Activity in Basic Prices”. Our sectors are composed of the detailed series in that in the following fashion:

- Agriculture is the sum of “TP.UR.BP01.C.1: Agriculture hunting and forestry” and “TP.UR.BP02.C.1: Fishing”
- Industry is the sum of “TP.UR.BP03.C.1: Mining and quarrying”, “TP.UR.BP04.C.1: Manufacturing”, and “TP.UR.BP05.C.1: Electricity, gas and water supply”.
- Construction is the series “TP.UR.BP06.C.1: Construction”
- Services is the sum of the series listed below minus “TP.UR.BP19.C.1: Financial intermediation services indirectly measured” (this is a correction needed to prevent double counting). We do not include the series “TP.UR.BP11.C.1: Ownership and dwelling” since this imputed production does not have an employment equivalent and should preferably not be included in output for the purposes of labor productivity calculations.
  - TP.UR.BP07.C.1: Wholesale and retail trade
  - TP.UR.BP08.C.1: Hotels and Restaurants
  - TP.UR.BP09.C.1: Transport storage and communication

– TP.UR.BP10.C.1: Financial intermediation

– TP.UR.BP12.C.1: Real estate, renting and business activities

– TP.UR.BP13.C.1: Public administration and defense; compulsory social security

– TP.UR.BP14.C.1: Education

– TP.UR.BP15.S.1: Health and social work

– TP.UR.BP16.C.1: Other community, social and personnel service activities

– TP.UR.BP17.S.1: Private household with employed persons

All the series are seasonally adjusted using Tramo method.

Population data is from TurkStat and it is non-institutionalized population over 15 years of age. Data on food expenditure is from the Central Bank of Republic of Turkey.

Employment share data for some of the EU countries are from the SourceOECD, National Accounts Data, Quarterly National Accounts, Employment By Industry. The share of agriculture in total employment for these countries is reported in the Table A.1, starting from 2008:Q1.

Table A.1: Employment Shares in Agriculture

	Austria	**Belgium**	**France**	**Italy**	**Spain**	**Germany**	**Greece**	**Turkey**
Q1-2008	0.052	0.018	0.032	0.040	0.043	0.021	0.114	0.230
Q2-2008	0.053	0.018	0.032	0.038	0.043	0.021	0.114	0.237
Q3-2008	0.052	0.018	0.032	0.039	0.043	0.021	0.113	0.239
Q4-2008	0.052	0.018	0.032	0.039	0.043	0.021	0.112	0.242
Q1-2009	0.052	0.018	0.032	0.040	0.044	0.021	0.111	0.241
Q2-2009	0.052	0.018	0.032	0.039	0.044	0.021	0.113	0.245
Q3-2009	0.052	0.018	0.032	0.039	0.044	0.021	0.117	0.248
Q4-2009	0.051	0.018	0.031	0.039	0.045	0.021	0.120	0.253
Q1-2010	0.051	0.018	0.031	0.039	0.046	0.021	0.121	0.258
Q2-2010	0.051	0.017	0.031	0.040	0.045	0.021	0.120	0.247
Q3-2010	0.051	0.017	0.031	0.040	0.045	0.021	0.121	0.249

Appendix B Importance of the Subsistence Term

Here we show the quantitative importance of the subsistence level of consumption in agriculture. To do this, we subtract $\bar{A}$ from the utiliy function and treat agriculture as one of the other goods in the period utility function defined below:

$$C = (\gamma_A^{1/\eta} C_A^{(\eta-1)/\eta} + \gamma_1^{1/\eta} C_1^{(\eta-1)/\eta} + \gamma_2^{1/\eta} C_2^{(\eta-1)/\eta} + \gamma_3^{1/\eta} C_3^{(\eta-1)/\eta})^{\eta/(\eta-1)},$$

where C_A denotes the consumption of the agricultural good; and C_1, C_2, C_3 are the consumption of the non-agricultural goods. In this case, non-agricultural sectoral productivity growth rates and the elasticity of substitution also matter for the predicted agricultural employment share. Figure B.1 presents the sectoral employment shares in this case. We observe that there is a significant gap between the model and the data in the absence of the subsistence level of consumption in agriculture. For example, the model predicts a decline in agricultural employment share of 0.39 percentage points between 2000:Q2 and 2010:Q3. The actual fall is 6.47 percentage points. The model accounts for only 5.19 percent of the decline in agricultural employment share between 2000:Q2 and 2010:Q3. Recall that our benchmark model accounts for 90.12 percent of the decline in agricultural employment share. These results suggest that the subsistence level of consumption in agriculture is a very important element of the structural transformation (see Gollin, Parente, and Rogerson 2002, 2004, 2007).

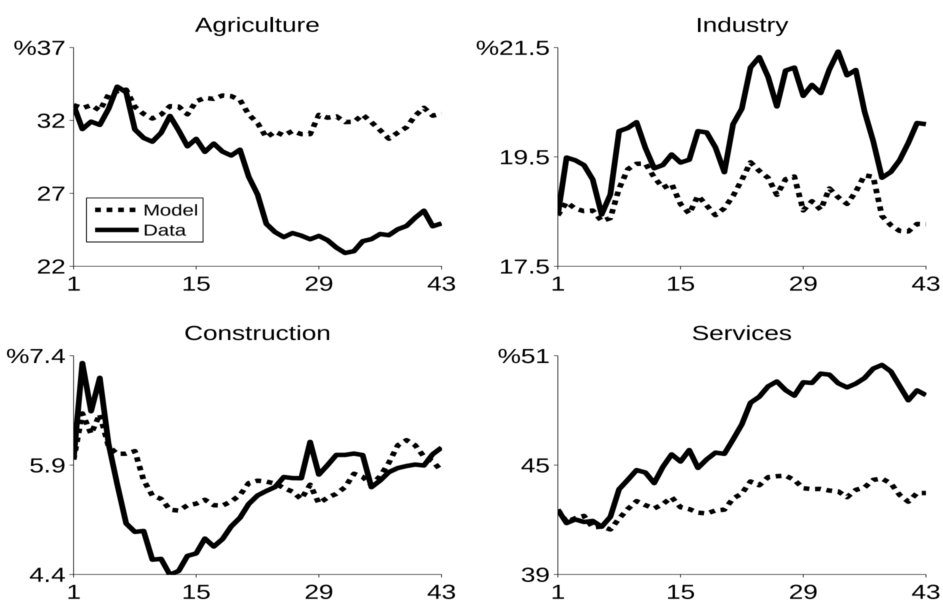

Figure B.1: Sectoral Employment Shares: No Subsistence Consumption

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

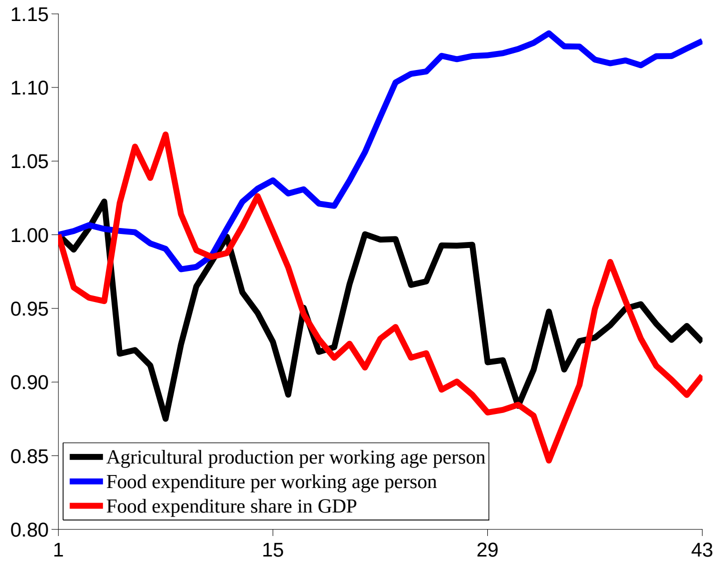

Figure B.2: Agricultural Production and Food Expenditure Shares

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

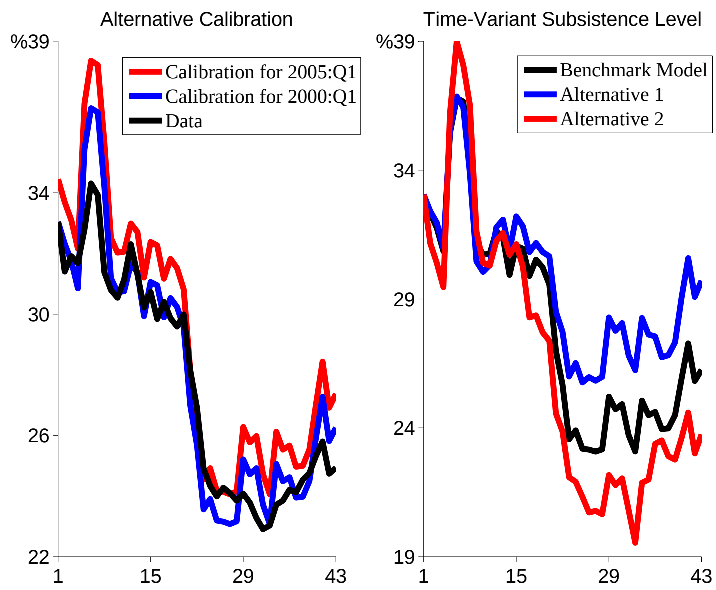

Figure B.3: Employment Share in Agriculture: Different Assumptions

(1= 2000:Q1; 15=2003:Q3; 29=2007:Q1; 43=2010:Q3)

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