

Agricultural Productivity and Growth*

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Abstract

This paper investigates the growth experience of one country in detail in order to enhance our understanding of important factors that affect economic growth. Using a two sector model we identify the low productivity growth in the agricultural sector as the main reason for the divergence of income per capita between Turkey and its peer countries. An extended model that incorporates distortions in the use of intermediate goods in producing the agricultural output indicates that policies that have different effects across sectors and across time may be important in explaining the growth experience of countries.

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1 Introduction

Many authors have focused on the role of institutions, low human capital, and lack of sound macroeconomic policies in hindering growth in developing countries. For example, Hall and Jones (1999) attribute most of the differences in output per worker to differences in institutions and government policies across countries. Acemoglu, Johnson and Robinson (2001) estimate large effects of institutions on income per capita.¹ Recently, models of sectoral transformation have been emphasized in providing further insight into these differences. For example, Gollin, Parente, and Rogerson (2002) and Restuccia, Yang, and Zhu (2008) discuss the importance of the agricultural sector in accounting for the differences in income per capita while Duarte and Restuccia (2010) conclude that low productivity in services explains the lack of convergence across a large set of countries.

This paper investigates the growth experience of one country, Turkey, in detail in order to enhance our understanding of important factors that affect economic growth. The growth rate of GDP per capita in Turkey between 1923 and 2008 was 3.0%, while fluctuating considerably over time. For example, from 1960 to 1977, GDP per capita grew at 3.8% while during 1977-2001 it grew by 1.6%.² Despite the fact that the 1977-2001 period could almost be classified as a ‘great depression’ based on the Kehoe and Prescott (2007) definition, it is the earlier period when the gap between Turkey and some of its peers widened. Indeed, in the 1960s and 1970s Turkish per capita GDP significantly fell behind its peers, who we define for the purposes of this paper as Greece, Portugal, and Spain.³ In 1960 Turkish GDP per capita was 73% of its peers. By 1977 this ratio had declined to 50% and continued to be around 47% in the 1980s and 1990s.

The divergence of income per capita between Turkey and its peers took place in a period when neither one of the peer countries was a member of the European Union, and some of the fiscal and monetary policy indicators such as the share of government consumption in GDP and the inflation rate were not significantly different across countries. A striking difference, however, was present in their sectoral employment shares and sectoral productivities. In 1960 the share of employment in agriculture was 76% in Turkey, 57% in Greece, 44% in Portugal, and 42% in Spain. All countries experienced a decline in the share of agriculture over time. However, the decline was much slower in Turkey compared to its peers. By 2008, the share of employment in agriculture had fallen to 24% in Turkey, 11% in Greece, 12% in

¹For the role of human capital see Glaeser, La Porta, Lopez-de-Silanes, and Schleifer (2004), and Barro (1999).

²The data after the 1950 period are from the Conference Board, Total Economy Database. Before 1950 we use Maddison (2003).

³We use these three countries as a comparison group that were similar to Turkey in terms of their income gap with the U.S. after WWII, in addition to geographical proximity and similar institutional setups such as the civil and penal codes.

Portugal, and 4% in Spain.⁴ This indicates a dramatically slow de-agriculturalization of the Turkish economy relative to its peers. In addition, Turkish labor productivity, especially in the agricultural sector was lower than that of its peers significantly. For example, average productivity growth in Turkish agriculture between 1968 and 1978 was 1.76%, while it was 6.80% in Spain. Turkey provides an interesting case to study as these differences help us isolate some of the key factors in generating differences in income per capita.

In this paper we use a two-sector model to examine the reasons behind the low sectoral productivities, slow de-agriculturalization, and increased divergence of income per capita in Turkey relative to its peers.⁵ In our framework labor allocation between sectors is driven by the differences in sectoral productivities as well as the income effect of non-homothetic preferences. We calibrate the model to the structural transformation of Spain between 1968-2005 and use it to understand the sectoral allocations in Turkey. We investigate if it is low productivity in agriculture or industry (or both) that is responsible for the slow de-agriculturalization and the low overall productivity in Turkey.⁶ We conduct a counterfactual experiment in which we equip Turkey with either the agricultural or the industrial productivity growth from Spain starting in 1968.

Our results indicate that if Turkey had inherited Spanish agricultural productivity growth from 1968 to 2005, de-agriculturalization would have been much faster and the growth rate of aggregate GDP per capita would have been much higher in Turkey. Inheriting Spanish industrial productivities, on the other hand, would not have contributed to the growth experience. Moreover, our results reveal that Turkey would not have fallen behind its peers had Turkey inherited the Spanish productivity growth in agriculture during the 60s and 70s. Similar results are obtained where sectoral productivity data from several other European countries are used in the counterfactual experiment. This result is due to the fact that many of Turkey's peer countries enjoyed much higher productivity growth in agriculture as opposed to the industry in this period. While Turkish productivity growth was lagging behind its

⁴The data are from the OECD Employment and Labor Market Statistics.

⁵Our framework is similar to Adamopoulos and Akyol (2009) and our results fit well with the recent literature on models of sectoral transformation that highlights the importance of agriculture, such as Gollin, Parente, and Rogerson (2002, 2004, 2007), Restuccia, Yang, and Zhu (2008), and Lagakos and Waugh (2009).

⁶Gollin (2009) provides a detailed survey of theories related to the role of agriculture in economic growth. He summarizes some of the debate in economic history such as whether or not agricultural productivity improvements preceded the industrial revolution, and whether government assistance should prioritize agricultural development or industrial development. There is still a debate on whether the structural transformation is achieved by increases in productivity in the industrial sector, which pulls employment out of the agricultural sector, or increases in productivity in the agricultural sector which pushes employment out of agriculture to the industry (see Alvarez-Cuadrado and Poschke (2009) and the references therein).

peers in both sectors, it was particularly worse in agriculture.

Many authors, including Altuğ, Filiztekin, and Pamuk (2008), have focused on the role of institutions, low human capital, and flawed macroeconomic policies in hampering growth in Turkey. While all of those factors are surely important, our findings indicate that we need to look deeper into policies that have different effects across sectors and across time. We show some preliminary evidence that indirect policies such as import substitution and overvalued exchange rates that discriminated against agriculture in Turkey may have hampered the efficient use of intermediate inputs resulting in lower agricultural productivity. A more systematic study of how agricultural policies, like those discussed in Krueger (1974), Olgun (1991) or Olgun and Kasnakoglu (1989), among others, affect economic growth is left for future research.

The rest of the paper is organized as follows. In Section 2, we examine the growth experience of the Turkish economy. Section 3 introduces the two sector model and Section 4 provides the results. Section 5 concludes.

2 The Growth Experience of Turkey

Figure 1 shows the GDP per capita in Turkey and in a set of European countries, relative to the GDP per capita in the U.S. between 1923 and 2008. We divide the European countries into two sub groups: ‘Europe 1’ (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, and the United Kingdom) and ‘Europe 2’ (Greece, Portugal, and Spain).

Relative income in ‘Europe 1’ starts at about 60% of the U.S. level in 1923, increases to above 80% by 1933, declines to 40% after WWII, and then gradually increases back to 60% in 2008. Relative income in ‘Europe 2’ is at 27% of the U.S. level in 1960 and ends at 54% in 2008. Turkish GDP per capita starts at 20% of the U.S. level in 1960 and ends at only 28% in 2008. Note that per capita GDP relative to the U.S. in the second set of European countries is quite similar to that in Turkey in late 1930s. Consequently, we define these countries as a relevant peer group for Turkey. This set of European countries catch up significantly with the U.S. after WWII compared to Turkey. In fact, the gap in GDP per capita between these countries and Turkey widens between 1960 and 1977 and then stays relatively flat. In particular, Turkish GDP per capita starts at 73% of the GDP per capita of the set of Europe 2 countries in 1960. However, it gradually declines to 50% by 1976. In 2008 the relative GDP per capita is at 52%.

To understand the growth patterns in more detail we examine if there are any episodes in Turkey as well as in its peers that can be classified as a great depression. Kehoe and Prescott (2007) propose three criteria for classifying a cyclical episode as a great depression: a) the downturn must be sufficiently severe, b) the decline must be rapid, and c) the reversal must be slow. Kehoe and Prescott (2007) adopt a working definition of severity as a decline

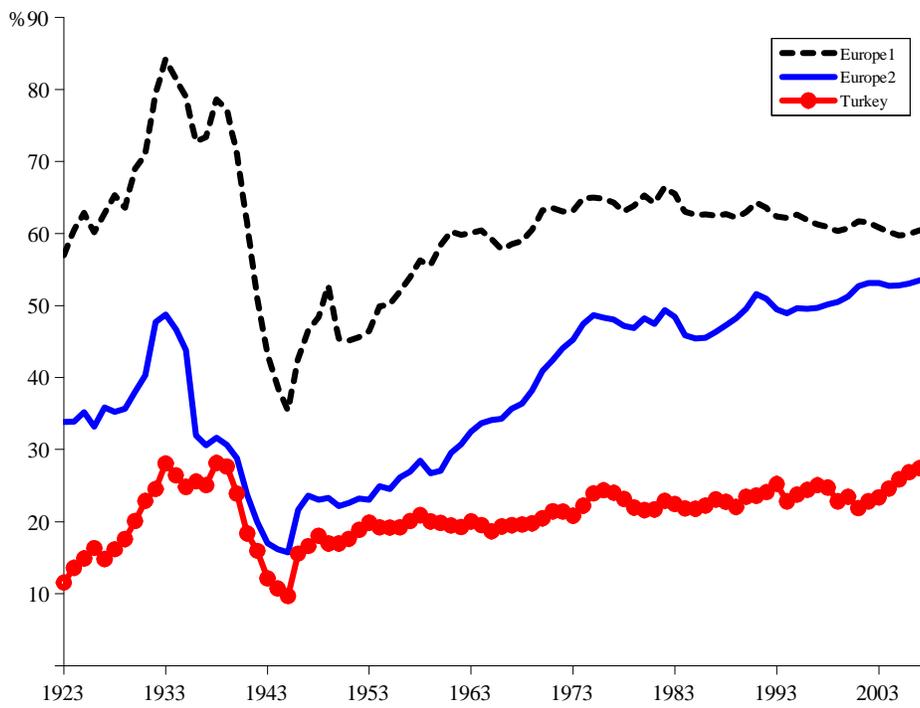


Figure 1: GDP per Capita Relative to the U.S.

of at least 20% below trend and of rapidity as a decline of at least 15% below trend within the first decade of the episode. They argue that the 2% trend growth in the U.S. should be used in judging the relative performance of other countries.⁷

We define the detrended output per working age as $y_t^d = y_t * (1.02)^{t_0-t}$ where y_t is output per working age person at time t , t_0 is the base year, and the trend is 2%.⁸ Figure 2 shows y_t^d in Greece, Portugal, Spain, and Turkey between 1960 and 2007, where the value in 1960 is normalized to 100. Several observations stand out. First, there is a significant change in trend in Turkey as well as in Greece, Portugal, and Spain in mid 1970s. Second, GDP per working age person declines by 26% between 1976 and 2001 in Turkey which classifies this period as a great depression.⁹ Greece loses 22% of output from the peak in 1979 to the trough in 1996. Both countries experience large declines in output in the first decade of the episode. Turkey loses 14% of its output between 1976 and 1985; Greece loses 16% of its output between 1979 and 1992. Spain and Portugal also experience significant declines in their growth rates. However, they recover much faster compared to Greece and Turkey. Third, until 1970s growth in Greece, Portugal, and Spain is much stronger than that in Turkey.

We point to two observations based on these comparisons. First, examining growth in Turkish GDP per working age person in isolation reveals the 1976-2001 period as a period of significant stagnation. While this observation is correct, significant decline in growth rates are experienced by its peers as well. Second, if one is interested in examining the lack of catch up in the Turkish economy, the 1960-1976 period deserves special attention. This is a period when Turkish growth rates fall behind the growth rates enjoyed by its peers significantly. In order to understand the factors that are responsible for these observations, we conduct a growth accounting exercise in the next section.

⁷Others have argued that it may not be appropriate to use the growth rate of the U.S. as a reference point. For example, Ahearne, Kydland and Wyne (2006) argue that the use of a 2% trend growth rate is probably reasonable for countries that were relatively rich at the beginning of their great depressions but not for all countries. During the period under investigation, the average growth rate of GDP per working age population in all four countries was above 2%. Consequently, we use the 2% growth as the benchmark to judge their growth experiences.

⁸Working age population data come from the OECD Employment and Labor Market Statistics.

⁹While this episode is not consistent with the third criteria used by Kehoe and Prescott (2007) it clearly presents a severe slowdown of the Turkish economy. See also Çiçek and Elgin (2009). Turkey underwent different major economic and political crises starting with the late 1970s. They are the economic crises of April 1994, November 2000, and February 2001, and the military takeovers of 1960, 1971, and 1980.

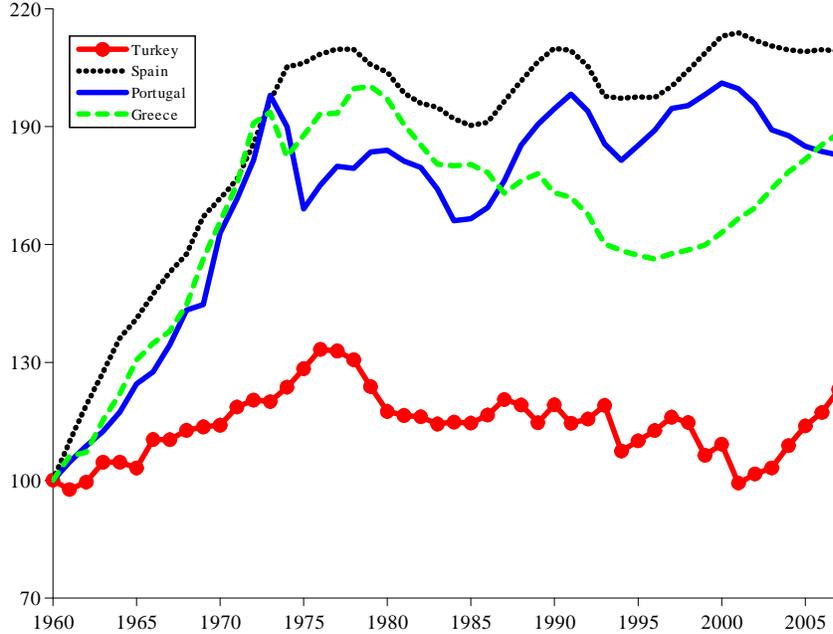


Figure 2: GDP per working age person relative to 2% trend

2.1 Growth Accounting

Consider a Cobb-Douglas aggregate production function

$$Y_t = A_t K_t^\alpha (h_t E_t)^{1-\alpha}, \quad (1)$$

where Y_t is GDP in year t , K_t is the capital stock, h_t is hours worked per employee, E_t is total employment, A_t is total factor productivity (TFP), and α is capital's share of income.¹⁰ In this context TFP is calculated as a residual given by

$$A_t = Y_t K_t^{-\alpha} (h_t E_t)^{\alpha-1}. \quad (2)$$

Output per working age population, Y_t/N_t , can be decomposed into four factors that contribute to its growth in the following way:

$$Y_t/N_t = A_t^{1/1-\alpha} (K_t/Y_t)^{\alpha/1-\alpha} (E_t/N_t) h_t. \quad (3)$$

¹⁰In order to conduct the growth accounting exercise, we need to choose a value for the capital share of income in Greece, Portugal, Spain, and Turkey. Gollin (2002) reports this parameter as 0.51 for 1992 in Turkey; Altuğ, Filiztekin, and Pamuk (2008), Saygılı, Cihan, and Yurtoğlu (2005), and İsmihan and Metin-Özcan (2008) use 0.5. Given the difficulty of calibrating this parameter we use three values for the capital share: 0.35, 0.50, and 0.65 in our growth accounting exercise. In addition, we assume that there are no differences between Turkey and its peers regarding the capital share. This assumption is justified with Gollin's (2002) findings about the similarities in the labor and capital shares across many countries. Reported results are for a capital share of 0.5.

In Table 1, we compare the growth accounting facts in Turkey with those in Greece, Portugal and Spain.¹¹ Several observations are worth mentioning. First, for the 1960-2004 period, what sets the Turkish experience apart from these three countries is a combination of two factors: large decline in the employment rate and a low TFP growth rate. Capital intensity factor in Turkey is not very different from that in the other countries. This observation is also true for the sub periods 1960-1977 and 1977-2001. In other words, capital intensity is not responsible for the relatively low performance of the Turkish economy. The culprits are the decrease in the employment rate and low TFP growth rates.

Second, when examined in isolation, the 1960-1977 period in Turkey stands out as a high growth period. However, the relative performance of Turkey in this period is much weaker compared to Greece, Portugal, and Spain. The average per worker growth rate of output for these countries during 1960-1977 is 5.79% which is 2.5 percentage points higher than the growth experienced in Turkey during this period. The 1977-2001 period, when the Turkish economy barely grows at 0.51%, the three economies on average also display very slow growth rates, with an average of 1.71%. Again, in both of these episodes, the capital intensity in Turkey is not very different from these countries. Both the TFP factor and employment rate, on the other hand, seem much weaker. Adamopoulos and Akyol (2009) demonstrate convincingly that differences in tax rates between Turkey and its peers plays a pivotal role in accounting for the dramatic decline in relative Turkish hours. Thus, we focus on factors that determine the differences in productivity growth rates and the sectoral change in employment shares in the next section. Lastly, during 2001-2004 the TFP factor in Turkey is dramatically higher than that in these three countries.

¹¹We use two different data sets for Turkey to conduct the growth accounting exercise. The main difference between these two data sets is the measurement of capital and GDP. In the first one, capital and output are measured in constant dollars following the Penn World Tables for the years between 1960 and 2004. In the second one we use data from Saygılı, Cihan, and Yurtoğlu (2005), which span the period 1972-2003. The working-age population data for both are from the OECD Employment and Labor Market Statistics. The data for hours worked per employee are from the Conference Board, Total Economy Database. The reported results in Table 1 are based on the data from Penn World Tables to keep consistency across countries. The qualitative nature of the results is independent of the data sets used. Capital stock data for all countries are calculated using the perpetual inventory method as shown in the Appendix.

Table 1. Growth Accounting					
Country/Period	<i>Due to</i>				
	Y_t/N_t	TFP	Capital	Emp	Hours
Greece					
1960-1977	6.10	3.40	3.84	-0.69	-0.50
1977-2001	0.90	0.84	0.17	0.01	-0.11
2001-2004	4.31	3.43	-0.43	1.71	-0.42
1960-2004	3.11	2.00	1.53	-0.15	-0.28
Portugal					
1960-1977	5.68	3.78	2.01	0.45	-0.62
1977-2001	2.43	0.69	1.51	0.58	-0.37
2001-2004	-0.32	-3.26	3.78	-0.59	-0.12
1960-2004	3.48	1.60	1.86	0.45	-0.45
Spain					
1960-1977	5.59	1.34	4.42	-0.43	0.22
1977-2001	1.81	1.30	0.93	0.08	-0.50
2001-2004	1.09	-0.05	1.74	1.83	-2.38
1960-2004	3.20	1.22	2.32	0.00	-0.35
Turkey					
1960-1977	3.32	1.64	3.20	-1.01	-0.50
1977-2001	0.51	-0.52	2.39	-1.21	-0.11
2001-2004	4.17	8.72	-2.59	-1.23	-0.42
1960-2004	1.83	0.92	2.35	-1.14	-0.28

2.2 Sectoral Productivities

Examining sectoral productivities displayed in Table 2, where A stands for productivity in the Agricultural sector and I for the productivity in the non-agricultural sector, reveals that Turkey lags behind in agricultural productivity in almost all the periods compared not only to its peers but also to others such as France and Italy.¹² Industrial productivity, on the other hand, catches up with its peers after late 1970s. In addition, the share of

¹²Data for France, Italy, and Spain are from the Groningen Growth and Development Centre (GGDC) 10-sector database. See Timmer and de Vries (2007). Sectoral value added data for Greece and Portugal are from the World Development Indicators, whereas we use the Turkish Statistical Institute data for Turkey. All sectoral value added data are measured in constant local currencies. Sectoral employment data for Greece, Portugal, and Turkey are from the OECD Employment and Labor Market Statistics.

employment in agriculture in Turkey in 1960, given in Table A1 in the Appendix, is higher than that of Greece by a factor of 1.3, Portugal by a factor of 1.7 and Spain by a factor of 1.8. All countries experience a decline in the share of employment in agriculture over time. However, the decline is much slower in Turkey compared to its peers. By 2008, the share of employment in agriculture is 24% in Turkey while it is 4% in Spain, 12% in Portugal and 11% in Greece. This indicates a dramatically slow de-agriculturalization of the Turkish economy relative to its peers. Recently, however, agricultural productivity in Turkey has surpassed the productivity in its peers. Between 1998 and 2005 average productivity in Turkey was 5.46% while it was -0.71% in Spain, 0.62% in Portugal, 2.38% in Italy, 1.83% in France and 2.17% in Greece. While we do not investigate this period in detail, changes made to agricultural policies and how they led to increased productivity in the post 2001 period can be found in Adaman, Karapınar, and Özertan (forthcoming).

Table 2: Average Annual Productivity Growth by Sector (%)

Period	Greece		France		Italy	
	A	I	A	I	A	I
1968 – 1978	6.56	4.07	4.92	2.82	4.39	2.33
1978 – 1988	1.67	-1.17	5.74	1.88	7.36	1.49
1988 – 1998	2.74	-0.02	5.63	1.33	6.98	1.13
1998 – 2005	2.17	2.00	1.83	0.93	2.38	-0.25

Period	Portugal		Spain		Turkey	
	A	I	A	I	A	I
1968 – 1978	-1.64	4.80	6.80	1.96	1.76	0.83
1978 – 1988	5.42	0.34	7.90	1.03	1.56	1.37
1988 – 1998	2.66	1.06	6.00	0.78	0.46	1.82
1998 – 2005	0.62	0.78	-0.71	-0.26	5.46	0.90

All productivity figures are calculated based on constant national currencies.

Data for Portugal starts from 1970.

In order to understand the forces behind this slow de-agriculturalization in Turkey we use a two-sector model to compare the growth experience of Turkey relative to Spain.

3 A Two-Sector Model

There has been a recent growing interest in multi sector general equilibrium models to understand the sources of the structural transformation of production and to quantify the impact of the shift in resources across the sectors on aggregate growth and productivity. These

studies utilize two (agriculture and non-agriculture) or three (agriculture, industry, and services) sector models and rely on two types of forces to generate the structural transformation observed in the data. The first type of models, such as Baumol (1967) and Ngai and Pissarides (2007) views the structural transformation as a supply-side phenomenon based on the sectoral differences in productivity growth. The second type of models views the structural transformation as a demand-side phenomenon based on the sectoral differences in income elasticities of demand (see, for example, Kongsamut, Rebelo, and Xie 2001). There are also models combining two types of channels, which are known as hybrid models (see, for example, Duarte and Restuccia 2010 and Rogerson 2008).¹³

We study a two-sector closed economy model to understand the role of domestic sectoral productivity changes on the structural transformation of Turkey combined with the Engel's law of demand.

3.1 Technology

At each date t there are two sectors, agriculture (A) and industry (I). The industrial sector, in this section, is more properly thought of as the non-agricultural sector. It incorporates both services and manufacturing.¹⁴ The production function for sector $j=A,I$ is given by

$$Y_{j,t} = \theta_{j,t}N_{j,t}, \quad (4)$$

where $Y_{j,t}$ is output of sector j , $N_{j,t}$ is labor allocated to production, and $\theta_{j,t}$ is sector j 's labor productivity at date t . We assume that labor is fully mobile across sectors and the wage rate in the economy is given by

$$\omega_t = \theta_{j,t}p_{j,t}, \quad (5)$$

where $p_{j,t}$ is the price of good- j and ω_t is the wage-rate in the economy at date t . Given the absence of any distortions, relative prices reflect relative productivities in this economy, i.e., $p_{I,t}/p_{A,t} = \theta_{A,t}/\theta_{I,t}$. Since we abstract from capital and fixed factors in production, differences in labor productivity implicitly incorporate differences due to capital as well as due to technology adoption, regulation, etc. across sectors.

3.2 Household's Problem

The economy is populated by an infinitely-lived representative household. Population is constant and normalized to one. Preferences are described by a period utility function given

¹³See also Acemoğlu and Guerrieri (2008), Alvarez-Cuadrado and Poschke (2009), Buera and Kaboski (2009), Echevarria (1995, 1997), Gollin, Parente, and Rogerson (2002, 2004, 2007) and the references therein for recent studies of structural transformation.

¹⁴Our findings extend to a three sector model for Turkey that separately examines agriculture, manufacturing and services.

by:

$$U(C_t) = \log(C_t). \quad (6)$$

C_t is a composite consumption good derived from the agricultural, A_t , and non-agricultural consumption, I_t via a CES aggregator.

$$C_t = (\gamma_A^{1/\eta}(A_t - \bar{A})^{(\eta-1)/\eta} + \gamma_I^{1/\eta}I_t^{(\eta-1)/\eta})^{\eta/(\eta-1)}.$$

The parameter \bar{A} represents the subsistence level of agricultural good consumption and satisfies at each date t

$$\theta_{A,t} > \bar{A} > 0. \quad (7)$$

The first inequality states that the economy's agricultural sector is productive enough to provide the subsistence level of food to all households (see Matsuyama 1992). The second inequality implies that preferences are non-homothetic and the income elasticity of demand for the agricultural good is less than unity. It is also assumed that the representative household has enough income to purchase more than \bar{A} units of agricultural good. The weight γ_j influences how consumption expenditure is allocated between the two sectors, with $\gamma_A, \gamma_I > 0$, and $\gamma_A + \gamma_I = 1$.

The parameter $\eta > 0$ is the (constant) elasticity of substitution between agricultural and industrial goods and it underlies the magnitudes of price responses to quantity adjustments. A lower substitution elasticity implies that sharper price changes are needed to accommodate a given change in quantities consumed. If η approaches 1, preferences over the two goods approach a Cobb-Douglas so that the substitution effect vanishes regardless of the magnitude of the differences between sectoral productivities.

We assume that the household is endowed with one unit of productive time in each period which it supplies inelastically to the market. At each date, the household chooses consumption of each good to maximize its lifetime utility subject to the budget constraint,

$$p_{A,t}A_t + p_{I,t}I_t = 1, \quad (8)$$

taking prices as given. The demand for labor must equal the exogenous labor supply at every date:

$$N_{A,t} + N_{I,t} = 1. \quad (9)$$

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

$$A_t = Y_{A,t}, \quad I_t = Y_{I,t}. \quad (10)$$

3.3 Equilibrium

A competitive equilibrium consists of consumption decisions $\{A_t, I_t\}$ of the households, factor allocations $\{N_{A,t}, N_{I,t}\}$ and sectoral output decisions $\{Y_{A,t}, Y_{I,t}\}$ of the firm, and prices $\{p_{A,t}, p_{I,t}\}$ such that given prices, 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.

The equilibrium employment share in agriculture is given by:

$$N_{A,t} = \left(\frac{\gamma_A \theta_{A,t}^{\eta-1}}{\gamma_A \theta_{A,t}^{\eta-1} + \gamma_I \theta_{I,t}^{\eta-1}} \right) + \left(\frac{\gamma_I \theta_{I,t}^{\eta-1}}{\gamma_A \theta_{A,t}^{\eta-1} + \gamma_I \theta_{I,t}^{\eta-1}} \right) \frac{\bar{A}}{\theta_{A,t}}. \quad (11)$$

The equilibrium employment share in industrial sector is given by:

$$N_{I,t} = 1 - N_{A,t}. \quad (12)$$

3.4 Calibration

We calibrate the model economy to Spain between 1968 and 2005. We use sectoral value added (measured in constant prices in Euros) and employment data for Spain for agriculture and non-agriculture. All time series are de-trended using the Hodrick-Prescott filter with a smoothing parameter of 6.25 for annual data before any ratios are computed.¹⁵ We normalize productivity levels across sectors to one for the initial year. We use data on sectoral labor productivity growth rates to obtain the time paths of sectoral productivities for the sample period.

The subsistence level in agriculture \bar{A} is calibrated so that the equilibrium of the model matches the share of employment in agriculture for the initial year in Spain:

$$\bar{A} = (N_{A,1968} - \gamma_A)/(1 - \gamma_A) = 0.28. \quad (13)$$

Next, we set γ_A and η to match the long run share of employment in agriculture in Spain and examine two cases: $\gamma_A = 0.04$ and $\eta = 0.5$ so that the goods are complements, and $\gamma_A = 0.01$ and $\eta = 1.5$ so that the goods are substitutes. Since η determines the amount of substitution among different goods this parameter determines how much labor will be reallocated to the non-agricultural sectors in response to uneven changes in productivity growth.

After calibrating the model economy for Spain we produce sectoral labor productivity series for Turkey between 1968 and 2005. We follow the Duarte and Restuccia (2010) method and calibrate the initial year productivity series for both sectors in Turkey using the calibrated model economy for Spain as follows. We choose the two labor productivity levels

¹⁵We follow Ravn and Uhlig (2002) for choosing 6.25 as a smoothing parameter.

$\theta_{A,1968}$, and $\theta_{I,1968}$ to match two targets in the first year in Turkey: (1) the share of employment in agriculture (the model also matches the share of non-agriculture by the labor market clearing condition), (2) aggregate labor productivity relative to that of Spain.¹⁶

As argued in Duarte and Restuccia (2010), the lack of PPP-adjusted sectoral output data across countries is one of the reasons for this approach. This strategy results in productivities in agriculture and non-agriculture in Turkey to be around 45 and 65 percent, respectively, of Spanish productivities in 1968. The levels of sectoral labor productivity implied by the model for the first year together with data on growth rates of sectoral value added per worker in local currency (Turkish lira) units imply time paths for sectoral labor productivity in Turkey between 1968 and 2005.¹⁷

4 Results

We start this section by discussing our key findings. Next, we examine the properties of our model economy in more detail and conduct several sensitivity analyses.

4.1 Key Findings

In Figure 3 we display the agricultural and non-agricultural employment shares that are generated by the model economy against their data counterparts in Turkey. Two observations stand out. First, the model captures the secular decline in the share of employment in agriculture reasonably well. Second, η plays a quantitatively insignificant role on the share of employment in each sector. The results with $\eta = 0.5$ and $\eta = 1.5$ are very similar. This finding indicates that labor allocation is mainly determined by increases in productivity in the agricultural sector during this time period in Turkey.

We use this framework to investigate the role of productivity growth in agriculture versus non-agriculture in impacting the speed of de-agriculturalization in Turkey. We ask what would have happened to the share of employment in the two sectors and the overall GDP per capita if Turkey had inherited Spanish productivities starting in 1968. More importantly we are interested in finding out if inheriting sectoral productivities in both sectors or in one of them in particular would have put the Turkish economy in a significantly different growth

¹⁶We use the Conference Board, Total Economy Database to get the aggregate labor productivity relative of Turkey and Spain in 1968. We use the series of *labor productivity per person engaged in 1990 US\$ (converted at Geary Khamis PPPs)*. The implied aggregate productivity ratio between Turkey and Spain in 1968 was 0.5261.

¹⁷We use GDP by kind of economic activity in 1987 prices and employment by kind of economic activity to derive labor productivity (value added per worker) series for the Turkish economy between 1968 and 2005. Turkish data are from the Turkish Statistical Institute, <http://www.tuik.gov.tr> and the OECD Employment and Labor Market Statistics.

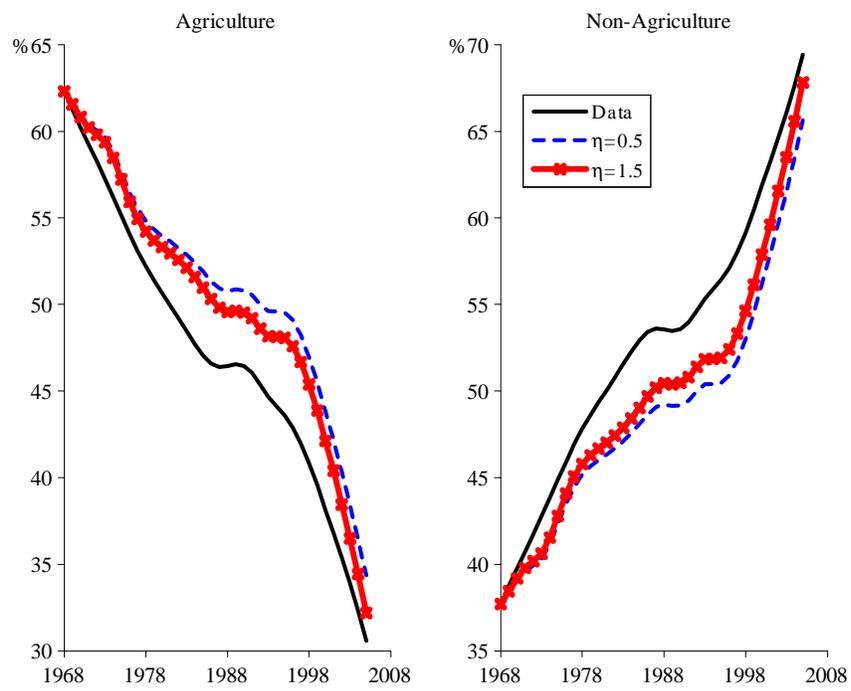


Figure 3: Benchmark

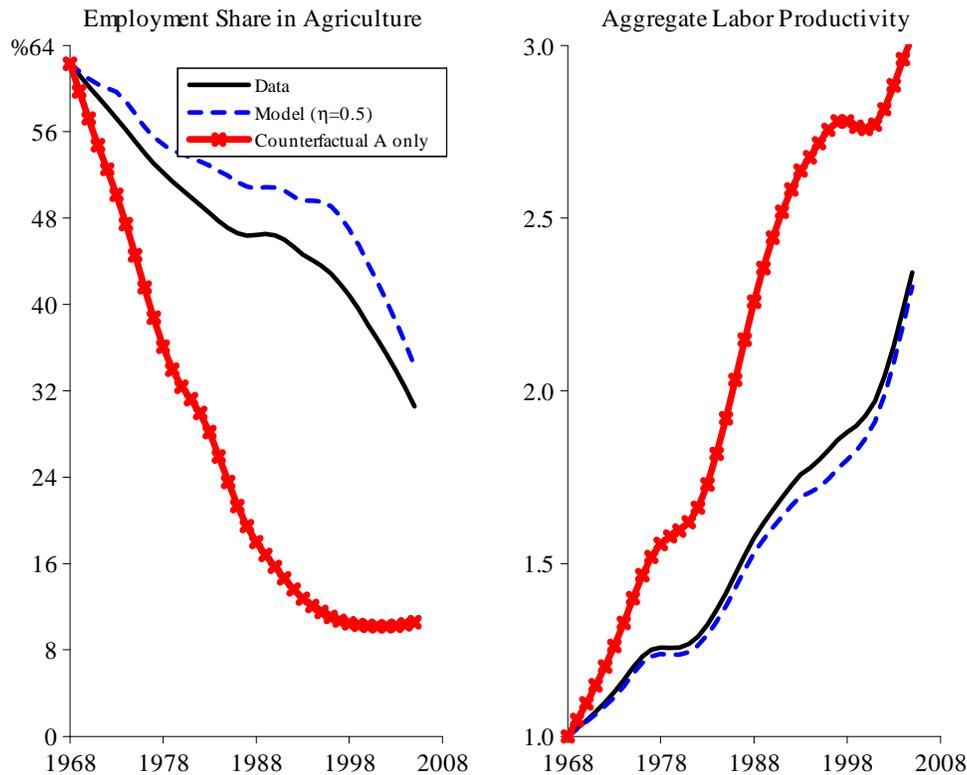


Figure 4: Role of Agriculture

path. In the following counterfactual experiment we allow Turkey to inherit productivity levels from Spain starting in 1968 in each sector one at a time.

Figure 4 shows the share of employment in agriculture and the GDP per worker that is obtained under the first counterfactual experiment where we only use the agricultural productivity growth from Spain and keep the non-agricultural productivity growth as it is in the benchmark. Compared to the benchmark results, this counterfactual experiment generates a much faster de-agriculturalization and a higher growth in overall productivity. By 2005 the share of employment in agriculture falls to around 10% and aggregate labor productivity is about three times its 1968s level.

A more interesting point emerges, however, when we compare the results from this counterfactual experiment with those from using sectoral productivities for both sectors from Spain. Comparing the series labeled ‘counterfactual A only’ to the series ‘counterfactual A&I’ where both productivities are taken from the Spanish data in Figure 5 reveals the importance of the agricultural sector in driving the results. In particular, the fast decline in the share of employment in agriculture and the high growth in aggregate labor productivity are

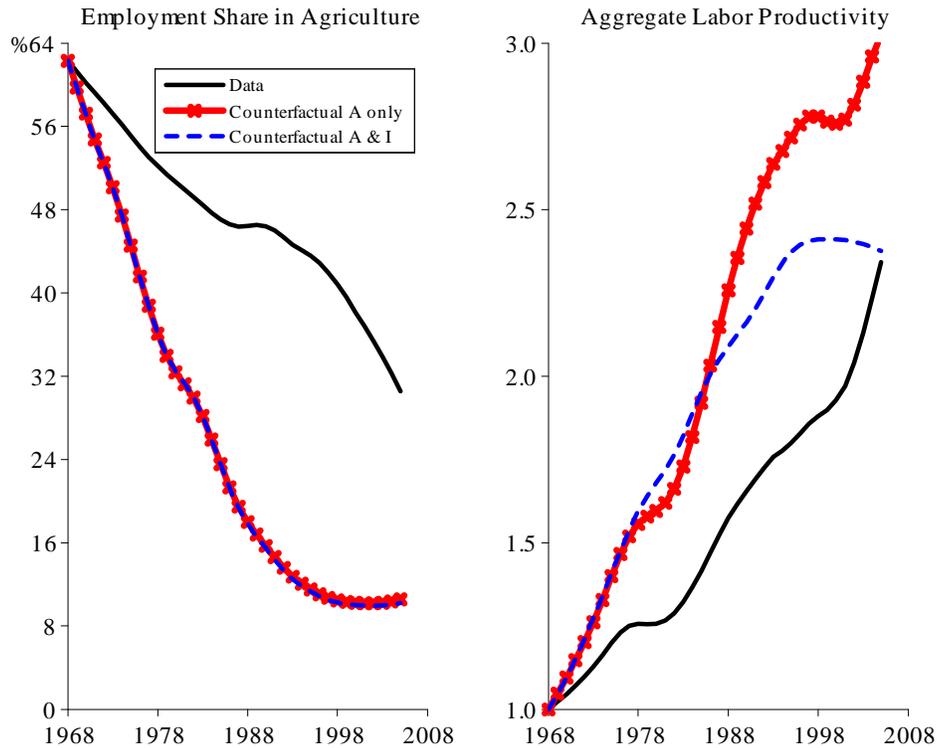


Figure 5: Role of Agriculture versus Non-agriculture

accomplished by feeding in the agricultural productivities alone. In the first panel of Figure 5, the employment share in agriculture implied by both counterfactual experiments coincide. This is due to the fact that, first, differences in growth rates in the industrial sector between Turkey and Spain are not very large, and second, their impact in equation (11) is small. The period from 1968 to late 1970s, when Turkey was falling behind its peers, displays significantly higher growth in labor productivity that comes entirely from productivity growth in the agricultural sector. These results are nearly identical for the $\eta = 1.5$ case.

4.2 An Extension

In this extension we investigate one channel through which productivity in general and agricultural productivity in particular might have been adversely affected in Turkey. Krueger (1974) studies the growth effects of the trade regime in Turkey in the 1960s where Turkey was pursuing an import substitution strategy. Focusing on the income gap between Turkey and its European neighbors, Krueger (1974) conducts several counterfactual experiments to investigate the growth rate that could have been achieved under alternative policies instead of the quantitative-restriction and the import-substitution regime that was present in

Turkey. Her econometric analysis suggests that “alternative strategies could have resulted in significant increases in the rate of growth of manufacturing output and value-added at both Turkish and international prices, reduced import requirements for both new investment and for intermediate goods, a reduced incremental capital-output ratio, and greatly increased employment opportunities for the same level of investment.” (Krueger 1974, Chapter 9).

Krueger, Schiff, and Valdes (1988) utilize a measure called the relative rate of assistance (*RRA*) to quantify the impact of sector-specific and economy wide policies on agricultural incentives. Anderson and Valenzuela (2008) provide data on estimates of (*RRA*) for 75 countries from 1955 to 2008. These estimates attempt to capture the entire array of governmental policies that affect agricultural incomes relative to what they would be in the presence of a free market system. Policies considered include direct interventions to agricultural prices (price setting by the government, subsidies to inputs, policies affecting the costs of transportation and marketing). Indirect interventions are the ones that affect the prices of agricultural tradables relative to non-tradables through their impact on the real exchange rate or to other tradables as a result of industrial protection or import substitution policies. These policies affect production incentives by making agriculture more or less attractive than other sectors of the economy. Using this data set Dennis and İşcan (2010) find that the rate of structural change and productivity growth in agriculture have been very slow in countries that discriminated against their agriculture.

Krueger, Schiff, and Valdes (1988) show that government policies regarding agriculture have adversely affected agricultural incentives in developing countries where the bulk of the discrimination was due to indirect price interventions. Among the eighteen developing countries examined, indirect taxation and tax due to industrial protection were highest in Turkey. The average reduction in farm prices relative to nonfarm prices because of the indirect interventions was 37% in Turkey while direct policies were subsidizing agriculture at a rate of 5.3% between 1961 to 1983.¹⁸

Figure 6 provides data on the relative rate of assistance to agriculture for Spain, Portugal, U.S., France and Turkey obtained from Anderson and Valenzuela (2008).¹⁹ Turkey exhibits high but declining levels of discrimination against agriculture until 1990s while the rest of the countries exhibit varying degrees of protection to agriculture.

One way to incorporate the measure of *RRA* into the two sector growth model of the previous section is to assume that low output prices discourage the application of intermediate inputs that are needed for the production of the agricultural good. This is a simplification of the impact of *RRA* where inefficiencies created by subsidizing one good versus the other

¹⁸Krueger (1992) argues that in Turkey agricultural producers associations were influential in affecting direct interventions but were virtually voiceless in affecting trade and exchange rate policies.

¹⁹*RRA* is defined as $\frac{1+NR_{ag}}{1+NR_{non-ag}} - 1$ where NR_{ag} is the nominal rate of assistance to agriculture and NR_{non-ag} is the nominal rate of assistance to non-agriculture.

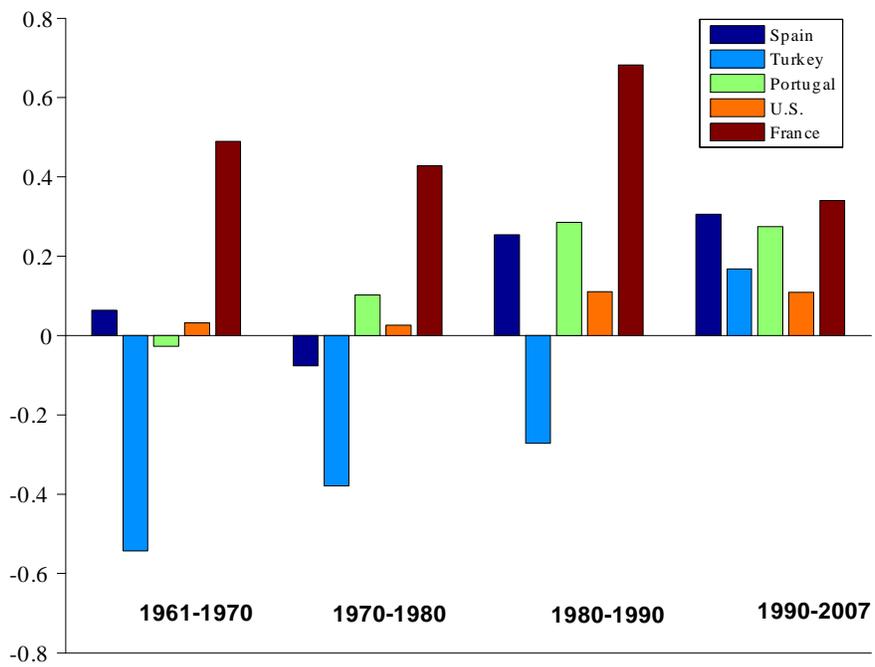


Figure 6: Relative Distortion

are much more complicated. Nevertheless, we proceed with this interpretation to see the potential quantitative impact of this measure on agricultural productivity in Turkey. We use a version of the model in Restuccia, Yang, and Zhu (2008) that incorporates the impact of distortions to intermediate goods on agricultural productivity.

In particular, we make one change in the previous model and assume a different production function in the agricultural sector given by

$$Y_{A,t} = X_t^\alpha (\theta_{A,t} N_{A,t})^{1-\alpha} \quad (14)$$

where X_t is the intermediate input used in the production of the agricultural good $Y_{A,t}$ and α is the intermediate-input elasticity of output in agriculture. This intermediate input may consist of chemical fertilizers, pesticides, hybrid seeds, fuel, energy, and other purchased factors. Restuccia, Yang, and Zhu (2008) introduce a distortion that requires one unit of non-agricultural output to produce $1/\pi_t$ units of X_t . Therefore a low value of π_t implies high efficiency of producing the input. With this formulation in competitive factor and output markets, π_t is the price of intermediate inputs relative to non-agricultural goods.

In this setup, the representative farmer maximizes profits by choosing labor inputs and the use of the intermediate input

$$\max \quad p_{A,t} X_t^\alpha (\theta_{A,t} N_{A,t})^{1-\alpha} - \pi_t X_t - \omega_t N_{A,t}, \quad (15)$$

where $p_{A,t}$ is the price of agricultural good relative to non-agricultural good; thus, the price of non-agricultural good is treated as the numeraire. The solution to this problem yields the following first-order conditions:

$$\frac{X_t}{Y_{A,t}} = \frac{\alpha p_{A,t}}{\pi_t}. \quad (16)$$

$$p_{A,t}(1 - \alpha) \frac{Y_{A,t}}{N_{A,t}} = \omega_t = \theta_{I,t}. \quad (17)$$

The intensity of using intermediate inputs is determined by the elasticity of output to intermediate inputs, α , and by the price of the agricultural good relative to the cost of intermediate inputs. We only consider direct barriers in the market for intermediate inputs X_t that increase π_t , the resource cost of converting non-agricultural output into X_t . A high value of π_t represents a high level of direct barriers confronting farmers in using the technical input.²⁰ The production function in the non-agricultural sector and the utility function are the same as in the previous section.

²⁰Restuccia, Yang, and Zhu (2008) also consider labor market distortions that increase the cost of reallocating labor from agriculture to non-agriculture.

To examine changes in productivity over time in Turkey, we focus on four key variables of the competitive equilibrium: the intermediate input ratio $X_t/Y_{A,t}$, the share of employment in agriculture $N_{A,t}$, labor productivity in agriculture $Y_{A,t}/N_{A,t}$, and aggregate labor productivity Y_t . The agricultural production function yields the following decomposition of agricultural final output per worker:

$$\frac{Y_{A,t}}{N_{A,t}} = \theta_{A,t} \left(\frac{X_t}{Y_{A,t}} \right)^{\alpha/(1-\alpha)}. \quad (18)$$

Labor productivity in agriculture depends positively on the intensity of technical input use $X_t/Y_{A,t}$. We can get the following expressions performing simple algebraic manipulations:

$$\frac{X_t}{Y_{A,t}} = \left[\frac{\alpha}{\pi_t(1-\alpha)} \frac{\theta_{I,t}}{\theta_{A,t}} \right]^{1-\alpha}, \quad (19)$$

$$\frac{Y_{A,t}}{N_{A,t}} = \theta_{I,t}^\alpha \theta_{A,t}^{1-\alpha} \left[\frac{\alpha}{\pi_t(1-\alpha)} \right]^\alpha. \quad (20)$$

The consumption allocation equations of the representative household imply

$$A_t = \bar{A} + \frac{\gamma_A}{\gamma_I} p_{A,t}^{-\eta} I_t. \quad (21)$$

Substituting the market-clearing conditions for A_t and I_t into the above equation, we obtain

$$Y_{A,t} = \bar{A} + \frac{\gamma_A}{\gamma_I} p_{A,t}^{-\eta} (Y_{I,t} - \pi_t X_t). \quad (22)$$

Notice that $\pi_t X_t = (\alpha/(1-\alpha))\theta_{I,t}N_{A,t}$. Now, we can derive the following equation for the share of employment in agriculture.

$$N_{A,t} = \frac{\bar{A} + \frac{\gamma_A}{\gamma_I} \left(\frac{Y_{A,t}}{N_{A,t}} \right)^\eta \left(\frac{1-\alpha}{\theta_{I,t}} \right)^\eta \theta_{I,t}}{\left(\frac{\alpha\theta_{I,t}}{\pi_t(1-\alpha)} \right)^\alpha (\theta_{A,t})^{1-\alpha} + \frac{\gamma_A}{\gamma_I} \left(\frac{Y_{A,t}}{N_{A,t}} \right)^\eta \left(\frac{1-\alpha}{\theta_{I,t}} \right)^\eta}. \quad (23)$$

If the benchmark economy for Turkey incorporates distortions, then it must be the case that the observed labor productivity, $Y_{A,t}/N_{A,t}$, is a result of an unobserved $\theta_{A,t}$ and exogenously taken π_t . We solve equation (20) for $\theta_{A,t}$ that together with π_t results in the observed $Y_{A,t}/N_{A,t}$. Other than this modification we follow the procedure outlined in the previous calibration exercise to conduct this counterfactual experiment where $\eta = 0.5$, $\gamma_A = 0.04$, and $\alpha = 0.5$. We solve equation (23) for the employment share in agriculture.

4.2.1 Results

In this section we assume that Spain has no distortions in the use of intermediate inputs ($\pi_t = 1$), while π_t in Turkey is set to 1.36 between 1968 and 1980, 1.25 until 1990 and 1.0 afterwards. While the *RRA* discussed in the previous section may not directly correspond to the π_t used to capture the distortions, the purpose of this section is to examine the quantitative implication of a distortion on the economy that mainly affects the use of intermediate inputs. We interpret the size of *RRA* to reflect the potential distortions faced in the agricultural sector.

In this experiment we are interested in measuring the quantitative impact of the distortions in the use of intermediate inputs on the share of labor in agriculture and productivity in agriculture in Turkey. The first panel in Figure 7 presents the share of employment in agriculture with and without distortions. The economy is calibrated to start from an employment share of 62% with the distortions since now the benchmark economy has distortions. Setting $\pi = 1$ as a counterfactual experiment where distortions are eliminated results in a starting employment share of 54% instead. In other words the existence of a 36% distortion on the use of intermediate inputs results in a 16% higher share of employment and 14% lower productivity in agriculture.²¹

This is a stylized experiment and it does not model all the complicated features of the agricultural policies that were followed in Turkey. However, it demonstrates that policies that discriminated against agriculture indirectly can have important quantitative effects. A more detailed study of these policies is left for future research.

5 Conclusions

This paper examines the growth experience of Turkey through the lens of a multisectoral model. We devote special attention to comparing the Turkish experience to that in countries we identify as its peers, Greece, Portugal, and Spain. We abstract from many historical, institutional, and economic differences between these countries. For example, there are at least three military coups in Turkey (1960, 1971, and 1980), several financial crises (1973-1974, 1994, 1999, 2001), and periods of very high inflation rates (1978-2003). Meanwhile, Greece has a military junta between 1967 and 1974, Portugal a military coup in 1974 and its first free elections in 1975, while Spain ends the Franco regime in 1975. Greece joins the European Union in 1981, while Spain and Portugal in 1986. While these facts as well as many others may have a bearing on the growth experience of countries, we rely on growth accounting to guide us in a certain direction.

²¹This framework generates the same results for the counterfactual experiment conducted earlier where the lack of productivity in the agricultural sector is shown to be the major determinant of the divergence in income per capita between Turkey and its peers.

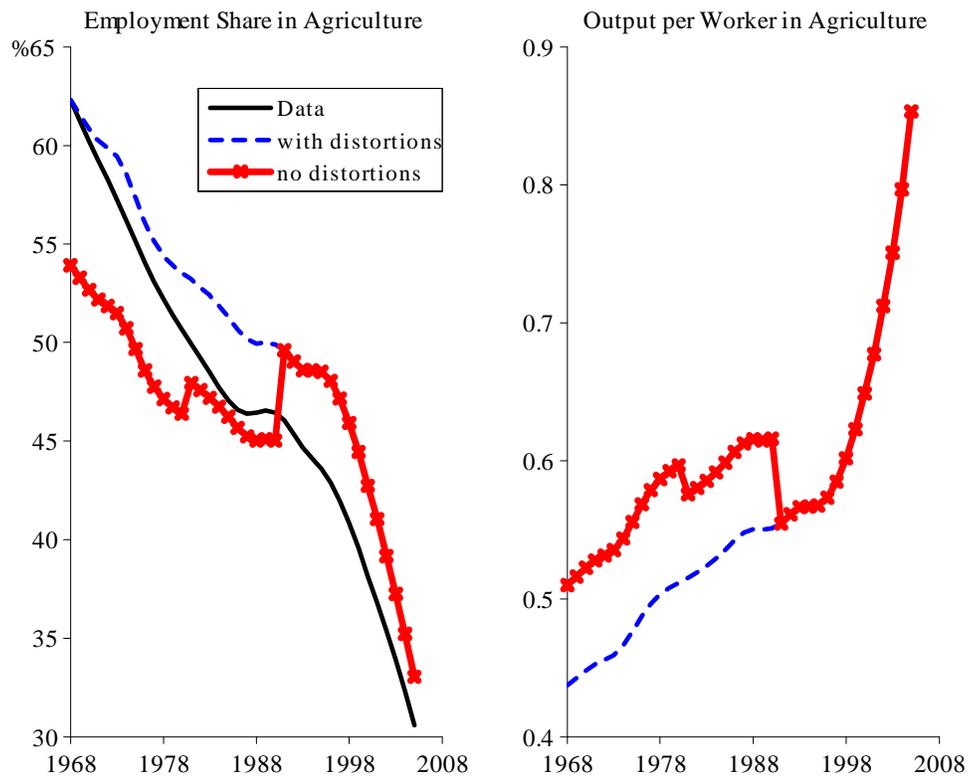


Figure 7: Role of Distortions

We conclude that the 1960s and early 1970s where Turkey falls behind its peers deserves special attention if we are interested in understanding the lack of convergence of the Turkish economy. This is a period where Turkish GDP per working age person grows in excess of 3%. However, the growth rate of its peers is significantly higher, 5% to 6%. Using a two-sector model we show that low agricultural productivity in Turkey accounts for the increased income gap between Turkey and Spain in the 60s and 70s. Our results indicate that 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. We argue that policies that discriminated against agriculture deserve special attention for understanding the lack of convergence in the Turkish economy.

6 Appendix

6.1 Employment Shares

Data for sectoral employment shares are based on civilian employment figures and are obtained from the OECD Employment and Labor Market Statistics.

Table A1: Sectoral Employment Shares (%)

	1960				1965			
	Greece	Portugal	Spain	Turkey	Greece	Portugal	Spain	Turkey
Agriculture	57.1	43.6	42.0	75.9	49.3	37.5	33.3	71.2
Non-agriculture	42.9	56.4	58.0	24.1	50.7	62.5	66.7	28.8
	1970				1975			
	Greece	Portugal	Spain	Turkey	Greece	Portugal	Spain	Turkey
Agriculture	40.8	29.9	29.5	63.2	35.2	33.9	22.1	58.4
Non-agriculture	59.2	70.1	70.5	36.8	64.8	66.1	77.9	41.6
	1980				1985			
	Greece	Portugal	Spain	Turkey	Greece	Portugal	Spain	Turkey
Agriculture	30.3	27.3	18.9	53.2	28.9	23.9	17.9	49.4
Non-agriculture	69.7	72.7	81.1	46.8	71.1	76.1	82.1	50.6
	1990				1995			
	Greece	Portugal	Spain	Turkey	Greece	Portugal	Spain	Turkey
Agriculture	23.9	17.9	11.5	46.9	20.4	11.6	8.9	44.1
Non-agriculture	76.1	82.1	88.5	53.1	79.6	88.4	91.1	55.9
	2000				2008			
	Greece	Portugal	Spain	Turkey	Greece	Portugal	Spain	Turkey
Agriculture	17.4	12.8	6.7	36.0	11.3	11.5	4.4	23.7
Non-agriculture	82.6	87.2	93.3	64.0	88.7	88.5	95.6	76.3

6.2 Construction of the Physical Capital Stock Series

The capital-output ratio series is derived as follows. We use population, investment, and per capita GDP data from Penn World Tables (Version 6.2). The data are from 1960 to 2004. Our methodology is similar to Bernanke and Gürkaynak (2001), Caselli (2005), Hall and

Jones (1999), Hulten and Isaksson (2007), and Klenow and Rodriguez-Clare (1997, 2005). We use the following formula to estimate the capital stock in 1960:

$$K_{1960} = I_{1960}/(g + \delta), \quad (24)$$

where K_{1960} is the capital stock in 1960, I_{1960} is the investment in 1960, $g = (I_{1970}/I_{1960})^{1/10} - 1$ is the average geometric growth rate from 1960 to 1970 of the investment series, and δ is the depreciation rate, which is set to 0.05. The calculated capital stocks include both residential and nonresidential capital. Given this initial stock we can calculate the capital series for the period 1960-2004 with the accumulation equation:

$$K_{t+1} = (1 - \delta)K_t + I_t, \quad t = 1960, 1961, \dots, 2003. \quad (25)$$

Investment series is calculated as $I_t = RGDP L_t * (POP_t * 1000) * (KI_t/100)$. $RGDP L$ is real per GDP per capita in constant price in Laspeyres in method, POP is population in 1000 people, and KI is investment share of $RGDP L$. Finally, we derive the capital-output ratio by dividing the capital stock in year t by GDP of that year where $GDP_t = RGDPCH_t * POP_t * 1000$, where $RGDPCH$ is real GDP per capita computed with chain method.

In Figure 8 we compare the capital output ratios obtained from two different data sources. The one labeled ‘‘Penn World Tables’’ uses capital stock data that are obtained from the investment series given in the Penn World Tables as explained above. The second one uses the data for capital and GDP from Saygılı, Cihan, and Yurtođlu (2005) who have applied the methodology used in OECD (2001). Notice that data from Saygılı, Cihan, and Yurtođlu (2005) are in Turkish liras whereas Penn World Tables report PPP-adjusted data which might explain some of the differences between the two sets.

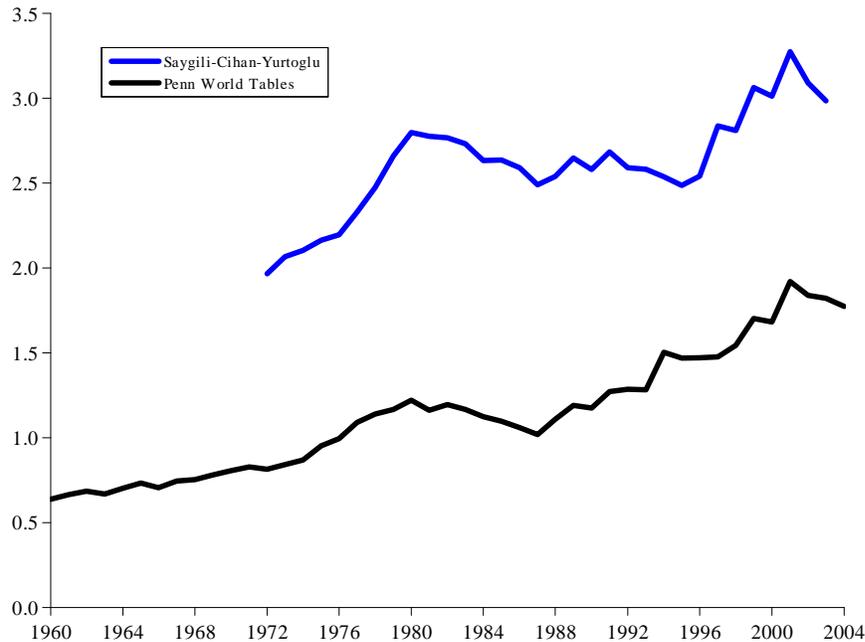


Figure 8: Data Comparisions

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