GROWTH AND DEVELOPMENT IN THE IBERIAN PENINSULA: THREE ESSAYS

by

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Licenciatura, Universidade de Coimbra, 1999
M.B.A., Kansas State University, 2001

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Economics
College of Arts and Sciences

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Manhattan, Kansas

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Abstract

Although geographic proximity is not enough to imply similar social, political and economic outcomes, the Portuguese and Spanish development experiences have been quite alike since the 15th century and in particular during the post-WWII period. Since 1950, both countries went through significant market transformations, ranging from democratization to market liberalization and adhesion to the European Union. However, even today, these economies, and in particular Portugal, do not rival those of the more developed European countries. This dissertation contributes to the growing body of literature on the Iberian economies by presenting three essays that employ modern macroeconomics tools to further our understanding about the growth and development experiences of these countries. The first essay provides a detailed growth accounting exercise and reconciles the results with the political and socioeconomic context of the 1950-2004 period. Since Total Factor Productivity is identified as the main engine of growth, the second essay explores a quantitative measure for the level of barriers that each country faced in the process of adopting new technologies. The numerical experiments suggest that Spain had consistently lower barriers than Portugal and that the gap has been increasing since the establishment of the European Single Market. The last essay investigates the role of fiscal policy and, specifically, if distortionary taxes on capital and labor income may have been a key factor behind the observed volatility for factor inputs. The simulation results derived from several potential scenarios support this conjuncture. Additionally, the last essay contributes by offering a time series for the levels of effective tax rates on labor and capital income in the Iberian economies over the 1975-2004 period.

JEL classification: E20, E62, O11, 033, O47.

Keywords: Economic development, Growth accounting, Technology barriers, Effective tax rates, Portugal, Spain.

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Although geographic proximity is not enough to imply similar social, political and economic outcomes, the Portuguese and Spanish development experiences have been quite alike since the 15th century and in particular during the post-WWII period. Since 1950, both countries went through significant market transformations, ranging from democratization to market liberalization and adhesion to the European Union. However, even today, these economies, and in particular Portugal, do not rival those of the more developed European countries. This dissertation contributes to the growing body of literature on the Iberian economies by presenting three essays that employ modern macroeconomics tools to further our understanding about the growth and development experiences of these countries. The first essay provides a detailed growth accounting exercise and reconciles the results with the political and socioeconomic context of the 1950-2004 period. Since Total Factor Productivity is identified as the main engine of growth, the second essay explores a quantitative measure for the level of barriers that each country faced in the process of adopting new technologies. The numerical experiments suggest that Spain had consistently lower barriers than Portugal and that the gap has been increasing since the establishment of the European Single Market. The last essay investigates the role of fiscal policy and, specifically, if distortionary taxes on capital and labor income may have been a key factor behind the observed volatility for factor inputs. The simulation results derived from several potential scenarios support this conjuncture. Additionally, the last essay contributes by offering a time series for the levels of effective tax rates on labor and capital income in the Iberian economies over the 1975-2004 period.

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Dedication

To my family, Dominika, friends and Portugal.

ESSAY 1 - Growth Accounting in the Iberian Political and Socioeconomic Context after World War II

1.1. Introduction

During the 15^{th} and 16^{th} centuries, Spain and Portugal were the major economic, political and cultural powers of Europe, sharing the world according to the 1492 Treaty of Tordesillas. Alas, leadership proved difficult to maintain and between the 17th and 19th centuries. The balance of power moved toward northern European states and the Iberian nations became relatively backward. The early 20th century saw further stagnation and lengthy periods of dictatorship rule. However, after WWII and in particular during the 1960s, the reconstruction of Europe led to an extraordinary period of growth in the old continent. Portugal and Spain were no exception, experiencing their golden years during the 1960-1973 period.

The worldwide effects of the 1973 oil shock along with a long and costly colonial war fostered the Portuguese discontent with the dictatorial regime. The increasing social and economic unrest culminated in the Carnation Revolution of April 25^{th}, 1974, and initiated the so-called third wave of democratization in the world (Huntington, 1997). Coincidentally, Francisco Franco died in November 1975 and Spain initiated a similar democratization process, despite restoring to King Juan Carlos, who in the meantime had been exiled in Portugal, the role of Chief of State.

Not surprisingly, the young democracies had a checkered start. The striving for power by newly established political parties along with weakened institutions resulted in a period of political and economic instability. In the first two years after the revolution there were six provisional governments in Portugal, followed by eight constitutional governments during the 1976-1983 period.

Spain, on the other hand, was able to manage the transition in a relatively less turbulent manner. More specifically, in their attempt to end hostilities between the new and the old politics, Spain followed a negotiated model of transition to democracy where, according to Colomer (1991), negotiations and pacts among political elites and consensus among citizenry avoided acts of revenge, violent confrontations, and civil war. Despite relative stability during the early years, Tejero's failed *coup d'état* in 1981 uncovered the political and social fragilities of a young democracy.

Currency crises in the early 1980s shattered both economies and shortly after a sluggish and mild recovery came the joint adhesion to the European Community in 1986. The favorable oil shock and the massive inflow of European structural funds prompted economic performance until the 1992 widespread recession. At this time, in addition to the already challenging economic conditions, the Maastricht treaty imposed severe fiscal and monetary policy constraints to meet the criteria for adopting the euro currency a decade later.

The dynamic of economic transformations did not stop. In 1994, the establishment of the European Single Market and resulting free mobility of goods, services, capital and labor, marked the beginning of an era characterized by increasing exposure to international competition.

Most recently, between 2000 and 2004, a series of international developments impacted the Iberian Economies. These events included, for example, the international stock market crash in March of 2000, and a gradual increase in oil prices along with worsening terms of trade.

Based on the above, each Iberian country seems to routinely experience what the other does. However, even today, these economies, and in particular Portugal, do not rival those of the more developed members of the European Union.

The purpose of this essay is to present a detailed examination of the post-WWII Iberian development experiences and to identify the main drivers and deterrents of growth. With this goal in mind, a standard growth accounting framework will be employed and the quantitative results consolidated with the political and socioeconomic context.

To our knowledge, this essay contributes to the literature by offering a comprehensive growth accounting exercise for the Iberian countries that contemplates two potential capital accumulation processes (linear and exponential) along with two different capital depreciation regimes. Consequently, we examine four different capital construction scenarios and assess the sensitivity of the growth accounting results for the entire 1950-2004 period.

The text is structured as follows. Section 1.2. derives the growth accounting methodology. Section 1.3. describes the data and the calibration procedure. Section 1.4. provides a detailed assessment of the Iberian political and socioeconomic context, and macroeconomic indicators. Section 1.5. discusses the growth accounting results and Section 1.6 concludes.

1.2. Growth Accounting Methodology

The usefulness of growth accounting is to identify the main sources and deterrents of growth for a given economy during a specific time interval. Like most of the economic techniques, it oversimplifies the number of variables that could impact a country's performance, mainly due to constraints in data collection and availability. The accounting exercise presented in this study focuses on assessing whether differences in growth performance between Portugal and Spain arise mostly due to differences in paths for factor inputs or total factor productivity.

Notwithstanding, it provides valuable quantitative insights about potential growth related issues and a coherent methodology to perform cross-country comparisons.

This essay adopts the framework used by Bergoeing *et al.* (2002) and Hayashi and Prescott (2002) to perform similar growth accounting exercises for other countries. Real Gross Domestic Product (GDP) is assumed to follow a relationship quantified by the standard Cobb-Douglas production function, $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$, where at any time *t*, the quantity of output available (Y_t) depends on employed levels of labor (L_t) and capital (K_t), the marginal contribution of each factor input (α for capital), as well as on total factor productivity (A_t). In this set up, the latter component, also known as the Solow residual, captures technological progress and other elements that contribute toward output which are not accounted for as capital or labor. Another noteworthy aspect of this output formulation is that it exhibits constant returns to scale because the marginal contributions of the factor inputs add up to one, meaning that if each input changes by a scalar, z, then output changes by an equal proportion, and vice-versa.

As commonly agreed, when performing country comparisons it is appropriate to use per capita measures. Here, the number of hours available for work by working age persons (N_t) is used as a proxy for the population and L_t is redefined as the number of hours actually worked. To express output in per capita terms, the Cobb-Douglas production has been rearranged as follows.

$$Y_t = A_t\left(\frac{K_t Y_t}{Y_t}\right)^{\alpha} L_t^{1-\alpha} \Leftrightarrow Y_t^{1-\alpha} = A_t\left(\frac{K_t}{Y_t}\right)^{\alpha} L_t^{1-\alpha} \Leftrightarrow Y_t = A_t^{\frac{1}{1-\alpha}}\left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} L_t \Leftrightarrow$$

$$\frac{Y_t}{N_t} = A_t^{\frac{1}{1-\alpha}}\left(\frac{K_t}{Y_t}\right)^{\frac{\alpha}{1-\alpha}} \frac{L_t}{N_t}. \qquad (1.1)$$

In addition, to decompose the growth rate of output per capita in terms of changes in the capital-output ratio and the employment rate it is convenient to express the above relationship in logarithmic form (Hayashi and Prescott, 2002).

$$\ln\left(\frac{Y_t}{N_t}\right) = \frac{1}{1-\alpha}\ln A_t + \frac{\alpha}{1-\alpha}\ln\left(\frac{K_t}{Y_t}\right) + \ln\left(\frac{L_t}{N_t}\right) \tag{1.2}$$

Equation (1.2) is the key formula for growth accounting exercises since it allows one to estimate the contributions of each factor input and Total Factor Productivity (TFP) on the growth rate of output per capita.

1.3. Data and Calibration

Aggregate levels for real GDP, Y_t, investment, I_t, during the 1950-2004 period were computed based on data from Penn World Table version 6.2 (Heston *et al.*, 2006) for real GDP per capita, population and the percentage of real GDP per capita allocated toward investment.[1] Values for aggregate consumption, C_t, were calibrated using $C_t = Y_t - I_t$. Data on N_t and L_t and α are from the Groningen Growth and Development Centre's Total Economy Database (2008). Hence, α is set at 0.3 based on historical averages for both countries.[2] The depreciation rate, δ, is set initially at a 5 percent rate, similar to Bergoing *et al.* (2002), and later at 10 percent in order to assess the results' sensitivity to the depreciation rate assumptions.

The next step involved generating a series for the capital stock following the standard capital motion equation (Bergoing *et al.*, 2002), $K_{t+1} = (1_t - \delta)K_t - I_t$, where K_{1950} was set at

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[1] Using Penn World Table version 6.2 data, aggregate output per year was computed by multiplying the annual values of GDP per capita with total population. Similarly, aggregate investment was set equal to the product of GDP per capita times the percentage allocated toward investment and total population.

[2] Standard marginal contribution of capital in macroeconomic analysis.

the value mentioned in Nehru and Dhareshwar (1993) for Spain and Portugal, respectively. The robustness of the accounting exercise is also tested under an exponential capital accumulation function, $K_{t+1} = A_k K_t^{1-\delta} I_t^{\delta}$ (Lucas and Prescott, 1971), where A_k was set at 1.305 based on the procedure outlined in Parente and Prescott (2000) and discussed in detailed in Essay 2. Succinctly, the value is calibrated assuming the principle of common technology in factor inputs across countries, otherwise there would be no discipline in the analysis.[3] Consequently, the accounting results will be tested under four possible time series for capital stock, derived from the set of assumptions for its capital accumulation process and depreciation rates. Given α, K_t, L_t, and Y_t, four different series for TFP were computed, using $A_t = \dfrac{Y_t}{K_t^{\alpha} L_t^{1-\alpha}}$ and the assumptions mentioned above regarding the depreciation rate and the motion of capital formulation.

1.4. Iberian Experiences in the Post-WWII Period

Before engaging the growth accounting exercises, it is useful to understand the main social, political and economic events that may also had an impact on the growth and development experiences of Portugal and Spain during the post-WWII period. This assessment begins with the characterization of the political and socioeconomic context and then proceeds by reconciling this history with the observed path of output per capita, the unemployment rate, consumption, investment, capital-output ratios, and TFP.

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[3] See pages 49-50.

1.4.1. The Political and Socioeconomic Context

In 1950, both Portugal and Spain were under consolidated dictatorship regimes. António de Oliveira Salazar had been the prime minister of Portugal since 1932 and had complete control over governmental policies. Similarly, Francisco Franco, another right-wing dictator, had been the Spanish head of state since October 1936.

The roots of these dictatorships followed similar routes. Salazar started his political career as finance minister of the "Ditadura Nacional", instituted after the 1926 coup d'etat that ousted the First Portuguese Republic. This regime change was followed by Spain a decade later, though in a more turbulent manner. In July 1936, Franco participated in a failed coup d' etat that ousted the Second Spanish Republic and led the country back into civil war. In the midst of this conflict, Franco emerged as the leader of the Nationalists and achieved victory by April 1939 with the support of Hitler, Mussolini, and Salazar.[4]

Until the 1950s both dictatorships pursued similar economic policies, primarily driven by import substitution and transformation of the industrial sector. Alas, the turmoil of the 1930s along with WWII inhibited the potential success of these policies and economic performance.

In the 1960s, the Iberian countries decided to engage in significantly different trade policies. Portugal joined the European Free Trade Agreement (EFTA) and progressively opened its economy to the world while Spain remained focused on autarky policies. Notwithstanding different views about international trade, both countries continued to pursue industrial policies

[4] The Iberian Pact, signed in March 1939, is another example of the long lived complicity between Portugal and Spain. This pact conveyed a treaty of friendship and nonaggression between Franco and Salazar and insurance that both countries would remain neutral during WWII and protect the Iberian Peninsula from any attack.

and experienced an unprecedented period of growth from early 1960s until the international energy crisis of 1973.[5] This period became known as the Iberian golden years (Lopes, 2004a).

A cursory look at Appendix A reveals that Spanish growth was mainly driven by the massive and profound transformation of the industrial sector and dramatic increases in productivity. Industrial productivity increased by 100 percent between 1964 and 1973. Particularly impressive was automobile production which increased at an extraordinary pace of 22 percent per year (Tortella, 2000). In fact, Tortella (2000) characterizes this period as the Spanish industrial revolution, and the automobile sector its leading source because it fostered the development of at least three additional industries: rubber production, iron and steel, and petroleum refining.

On the other hand, Portugal focused more on the progressive opening of its economy to the world; the merchandise export growth rate between 1959 and 1973 was 11 percent per year whereas in industrialized countries it averaged 8.9 percent (Baklanoff, 1992). Interestingly, an analysis of the direction of trade from 1960 to 1972 shows two major trends: the relative decline in importance of overseas territories and the growing importance of EFTA in the composition of exports and imports (Baklanoff, 1992). Regardless of the different approaches to international trade both Iberian countries experienced significant growth during the 1960-1973 period.

Despite spending most of the 1960s protecting its domestic industry from international competition, in 1968 Spain began to tentatively open its borders.[6] Yet, these early steps where

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[5] Lopes (2004a) indicates that output per capita during the 1960-1973 period grew at an annual average of 6.9 percent in Portugal and 6.1 percent in Spain, and that these growth rates were significantly higher than those experienced by Portugal and Spain during the 1950-1960 period (3.6 and 3.8 percent, respectively) and the 1973-1994 period (1.9 and 1.7 percent, respectively).

[6] A landmark of such efforts was the 1970 Preferential Trade Agreement with the European Common Market which by 1979 turned into full adhesion to EFTA.

shadowed by an embarrassing situation to Franco's regime. The Spanish dictatorship was shaken by a financial scandal involving the minister of finance, the minister of commerce, the Bank of Spain's governor, Opus Dei, and Matesa, a firm that was being used for illegal use of export subsidies (Tortella, 2000). Curiously, at this time Portugal also experienced its first glimpse toward the end of dictatorship - illness led to the replacement of Prime Minister Salazar by Marcelo Caetano. Henceforth, the latter and President Américo Tomás assumed a somewhat less oppressive posture, particularly in relation to the freedom of expression.

In the early 1970s, Portugal witnessed an 8.4 percent increase in population prompted by the return of Portuguese citizens from disrupted colonies and a spreading malcontent about the burden that the colonial war had imposed on the state and families. These issues along with the economic repercussions of the 1973 adverse oil shock, which led to a severe deterioration of the Iberian terms of trade because of the high dependency on imports of crude oil, promoted severe social and political turmoil which ultimately led to the "Carnation Revolution". In 1974, Portugal was caught between industrial Europe and colonial Africa, and between an incipient decline of corporatism and emerging market capitalism (Baklanoff, 1992).

The military coup of April 25th 1974 ousted the long-lived authoritarian regime of António de Oliveira Salazar (1932-68) and Marcelo Caetano (1968-74), whereas the Spanish dictatorship (1939-75) ended with the death of Francisco Franco. According to Huntington (1997), the regime changes in the Iberian Peninsula marked the beginning of the third wave of democratization and the age of democracy in the world.

Both Iberian countries followed a negotiated model of transition to democracy where pacts among political elites and consensus among citizenry sought to avoid acts of revenge, violent confrontations, and civil war (Colomer, 1991). In 1975 for example, Spain's democratization took place by consensus and reconciliation which meant that the new system incorporated the previously clandestine anti-Franco opposition along with important continuities from the Franco era, especially in the security and military areas (Maxwell, 1991).

The struggle for power among newly established political parties, along with incipient democratic institutions, incubated a period of relative political and socioeconomic instability. For example, in the first two years after the revolution there were six provisional governments in Portugal, followed by eight constitutional governments during the 1976-1983 period. Spain, on the other hand, experienced a smoother transition process skillfully managed by the new chief of state, King Juan Carlos I, who had lived in exile in Portugal until Franco's death. But despite the apparent stability during the early years, Tejero's failed coup d'état in 1981 uncovered the political and social fragilities of a young democracy.

The mid-1970s Iberian democratization also led to upheavals in the economic system. The Portuguese revolutionaries nationalized commercial banks and most heavy and medium size industries in order to emasculate the old elite's economic base. Spain, on the other hand, implemented less dramatic changes during the early years of democracy mainly due to the fact that the new middle class was dismayed with the impact that radical economic measures had had on the Portuguese economy (Baklanoff, 1978). Consequently, priority was given to stop-gap economic measures such as the Moncloa Pacts, which assured a degree of moderation for increases in prices and salaries (Tortella, 2000).

Currency and banking crises in the early 1980s shattered both economies. Portugal's balance of payments deficit was the main reason for two consecutive currency crises, namely in 1977 and 1983. In both cases, the Portuguese were assisted by the International Monetary Fund which required it to implement fiscal and monetary policy constraints (Nunes and Valerio, 2005). Across the border, the 1978-1985 banking crisis in Spain was one of the worst in Europe and affected 58 banks, which together accounted for 27 percent of deposits (Chislett, 2008). The crisis originated in a high volume of non-performing loans linked to an industrial meltdown following the inflationary episodes prompted by the adverse oil shocks in the 1970s. The solution comprised, among other things, new regulatory measures by the Bank of Spain regarding solvency requirements and compliance.

Shortly after a sluggish and mild recovery came the joint adhesion to the European Community in 1986. Lower oil prices along with the inflow of European structural funds, foreign direct investment, gradual privatization of state monopolies, deregulation of prices and markets fostered economic performance until the 1992 recession in Western Europe. On top of this widespread contraction, the Maastricht treaty imposed additional constraints on fiscal and monetary policy in order to transition to the euro currency a decade later. The criteria to adhere to the European Monetary Union included: *"inflation over 12 months could not exceed by more than 1.5 percentage points the average rate among the three EC countries with the lowest inflation; long-term nominal interest rates over 12 months could not exceed by more than 2 percentage points the average for the same three countries; the currency had to remain in the narrow band of the exchange rate mechanism for at least two years without devaluation; the budget deficit should not exceed 3 percent of GDP; and total public debt could not exceed 60 percent of GDP"* (Maxwell and Spiegel, 1994, p.51).

The Maastricht rules along with the continuous inflow of EU transfers helped to reduce the public sector deficit but the 1994 establishment of the European Single Market and resulting free mobility of goods, services, capital and labor, marked the beginning of an era characterized by increasing exposure of domestic industries to international competition.[7] The latter along with several reforms imposed by joining the single market, spanning from environmental quality to consumer protection, further exacerbated the challenges facing domestic firms (Torres, 2000). The competitiveness of some Iberian businesses could not be more bluntly tested. One of the outcomes was the relocation of less competitive businesses to countries with lower labor costs (Lopes, 2004b) and a deepening of the trade deficit, particularly after 1997 (WDI, 2006).

Despite these challenges, both countries experienced modest growth in the late 1990s, probably nourished by the continuing privatization of parastate industries and market deregulation.[8] It is worth mentioning that Portugal was at the time one of the largest "privatizers" in the OECD, with revenues amounting to approximately 2.8, 4.7, 3.9, and 1.5 percent of GDP between 1996 and 1999 (Torres, 2000).

Between 2000 and 2004, a series of international adversities impacted the Iberian economies. These included, for example, the international stock market crash in March of 2000 and the gradual increase in oil prices along with worsening terms of trade. Relatively, Spain ended up better off probably due to its lower degree of openness.

1.4.2. Macroeconomic Indicators

Given the Iberian political and socioeconomic history just outlined, this essay proceeds by studying its potential relationship with the path of macroeconomic indicators. This section begins by assessing output per capita and employment rates followed by an analysis of the levels

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[7] In Portugal and Spain, EU transfers accounted for 1.5 to 3 percent of GDP per year during the second half of the 1990s (Allard *et al.*, 2008).

[8] Parastate industries are those not reporting directly to the state but funded by the state.

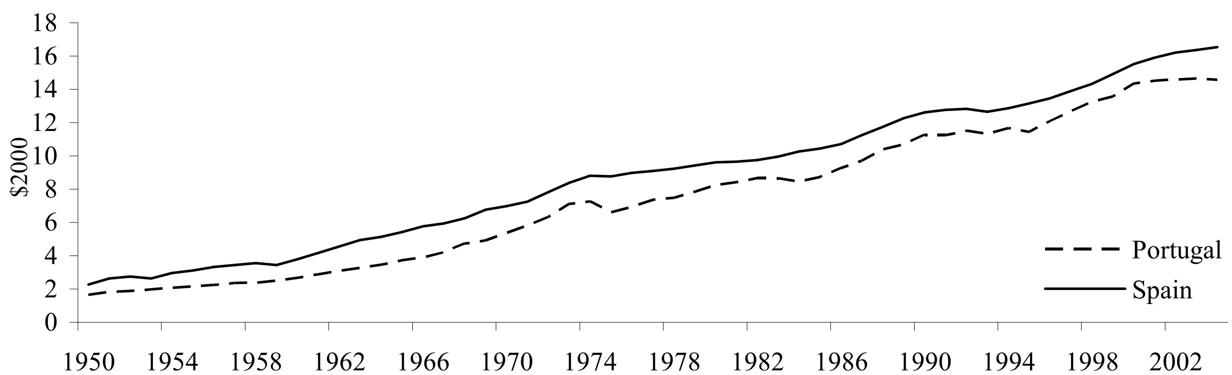
of consumption, investment, and the estimated levels of capital-output and TFP during the period of interest.

1.4.2.1. Output per Capita

Figure 1.A depicts real GDP per hour of work available, which is being used as a proxy for real GDP per capita. As shown below, there are striking similarities in the path of output per capita, despite Spain's being always higher than Portugal's.

The 1950s were harsh times for most economies around the world and the Iberian experiences were no exception. The economic repercussions of WWII and the long reconstruction process constrained the economic performance of most countries. Despite the overall sluggish performance, Spain was able to perform better than Portugal. In 1950, the Spanish's output per capita was 37 percent higher than the Portuguese and this gap increased by 1960, reaching 41 percent.

Figure 1.A Output per Capita



In the 1960s most of the European economic base had been rebuilt leading to an overall recovery in the demand for goods and services. These facts along with the continued Iberian industrialization efforts fostered a period of unprecedented growth. As mentioned in the previous section, during the 1960s Portugal and Spain had a different view about the role of international trade. While Portugal engaged in the progressive opening of its economy to the world, Spain remained focused on import substitution policies. Consequently, it is not surprising that the Portuguese merchandise export growth rate averaged 11 percent per year over the 1959-1973 period while in most industrialized countries it was 8.9 percent (Baklanoff, 1992). Spain, on the other hand, while not experiencing such a high overall growth rate in exports, saw its automobile production increasing at an extraordinary pace of 22 percent per year (Tortella, 2000). Using output per capita as a measure of comparative policy success, it appears that the Portuguese did a better job because the output per capita gap shrunk to 21 percent by 1974.

As shown in Figure 1.A, the democratization process impacted the Portuguese economy more severely than the Spanish, especially during the first two years. This occurrence might have been related to the fact that, besides political instability and economic reforms, the dismemberment of the colonial empire resulted in the loss of a significant source of income for the Portuguese (Baklanoff, 1992). Spain, on the other hand, was able to buffer the potential adverse shock of democratization on output per capita because it had a smoother political transition and implemented less dramatic economic reforms (Baklanoff, 1978). Overall, the political and economic turbulence during the first decade of democracy resulted in a relative stagnation in the levels of output per capita in the Iberian countries. However, in the midst of the turmoil, Portugal was able to gain on the Spanish output per capita by cutting the Spanish advantage to only 16 percent by 1986. This gain probably arose because of the increase in unemployment in Spain, as it will be discussed later on.

Soon after the adhesion to the European Community both economies went through a new expansionary period, this time prompted by a favorable oil shock, the inflow of structural funds and privatizations. Portugal was able to shrink the output per capital gap against Spain further, driving the disparity to 14 percent by 1991. Alas, by the next year a widespread recession hit Western Europe, the Maastricht Treaty was signed and the Iberian economies were obliged to comply with fiscal and monetary constraints. All these events led to a reversal in the output per capita curve. Interestingly, the relative level of output per capita in the Iberian economies shrunk further, reaching 12 percent in 1992.

The year 1994 marks the beginning of a new era characterized by increased exposure to international competition and free mobility of goods, services, labor and capital among the European Union member states. In this year, Spain had a level of output per capita merely 10 percent higher than Portugal. As portrayed in Figure 1.A., it seems that Spain was better prepared for this challenge and consequently was able to grow faster than Portugal during the first decade of European Single Market membership. The relatively better Spanish performance pushed the gap in output per capita back up to 13 percent by 2004.

Given that both Iberian countries benefited from the inflow of structural funds, were obliged to implement identical reforms, and faced similar external shocks, one speculative explanation for the Portuguese inability to perform as well as Spaniards in recent years might be related to the scarcity of skilled labor. In fact, between 1993 and 2003, only 10 percent of the Portuguese labor force had tertiary education whereas in Spain this share accounted for 24 percent (WDI, 2006).

1.4.2.2. The Employment Rate

In terms of employment, the situation was relatively stable in the Iberian economies throughout the entire 1950-1974 period, as depicted in Figure 1.B.[9] However, massive emigration motivated by attractive worker programs during the reconstruction of Central Europe may have buffered any potential adversities, particularly in Portugal. As Baklanoff (1992) noted, Portuguese emigration provided a safety valve for open and disguised unemployment, particularly in rural areas. It is noteworthy, that Portuguese emigration was not only fostered by attractive foreign remuneration packages, but also the willingness of many young men to avoid recruitment for the colonial war, initiated in 1961 with the outbreak of guerilla warfare in Angola and in the other African territories.

On the other hand, massive public investment associated with development plans implemented throughout the 1950-1974 period probably prompted the creation of jobs. Whatever the true reasons behind the stability of the Portuguese employment rate, the fact is that 15.6 percent of the Portuguese population emigrated during the 1960-1973 period whereas in Spain this figure accounted for only 2.2 percent of the population during the 1960s (Appendix A).

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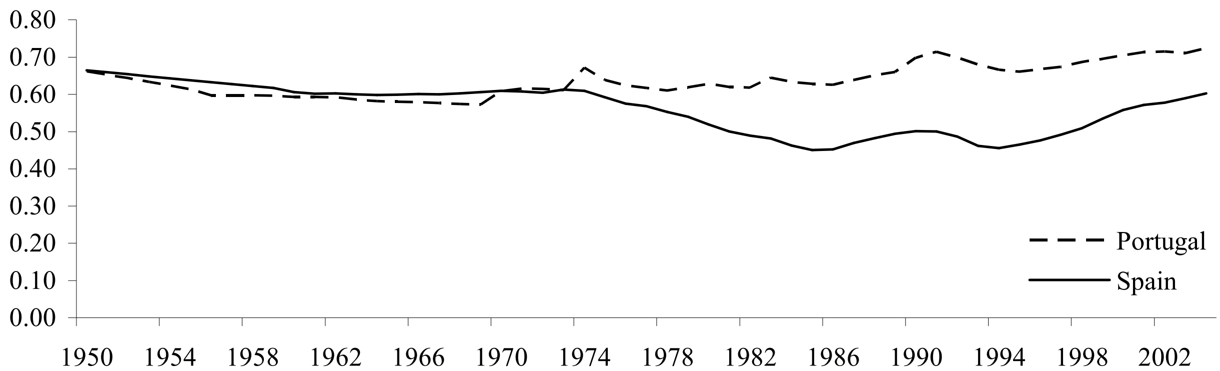
[9] The ratio of hours actually worked versus available hours to work is being used as a proxy for the employment rate.

Figure 1.B Employment Rate



The Iberian democratization process initiated in the mid 1970s marked the beginning of a period where the volatility of the employment rate increased, especially in Spain. During this period, the latter experienced high and persistent unemployment rates probably due to relatively higher levels of unemployment benefits which fostered the agent's preference for leisure. Blanchard's (1995, p.216-7) argument for the different labor market experiences in Spain and Portugal goes as follows:

> *"In Spain, high employment protection and unemployment benefits have led to small effects of labor market conditions on wages. This led to large adverse effects of disinflation on unemployment in the first half of the 1980s. And high persistence since then explains why unemployment has remained high since. In Portugal, in contrast, low unemployment benefits have led, despite the presence of high employment protection, to a higher response of wages to unemployment. This has led to smaller adverse effects of disinflation on unemployment. And it has led to less unemployment persistence."*

Adhesion to the European Community in 1986 and the resulting structural investments may have been behind the shortly lived upswing in the employment rate. Unfortunately, the 1992 European recession facilitated the return of the downward pressure. However, the previously noted relative readiness of Spanish firms for the European Single Market could be one of the factors explaining the upward trend on Spanish employment over the next decade.

1.4.2.3. Consumption and Investment

The striking similarities between Portugal and Spain observed in the output per capita ratios also hold in the levels of consumption and investment per capita, as depicted in Figure 1.C.[10] Not surprisingly, given that Spain experienced higher levels of output per capita than Portugal, the same higher levels are seen in the consumption and investment data. Another interesting observation is that the Iberian consumption and investment data confirms a stylized fact in macroeconomics: consumption is less volatile than investment.

Notwithstanding the similarities delineated above, the path of investment in Portugal and Spain exhibits some relevant disparities, particularly during the post-dictatorship period. In the 1974-1986 period, investment per capita in Spain experienced a steady decline probably due to the similar trend in the employment rate while Portugal's investment level recorded a rapid decrease in the first two years of democracy, followed by a significant increase until 1983 and another steep decline during the next three years. These fluctuations seem to indicate that the Carnation Revolution created a two-year wave of unusual willingness to consume (shown later on in Figure 1.D), probably due to high expectations about future income during democratic times and the ensuing economic reforms. However, these changes were short-lived as the Portuguese perceptions adjusted and investment per capita returned to the early 1970s levels.

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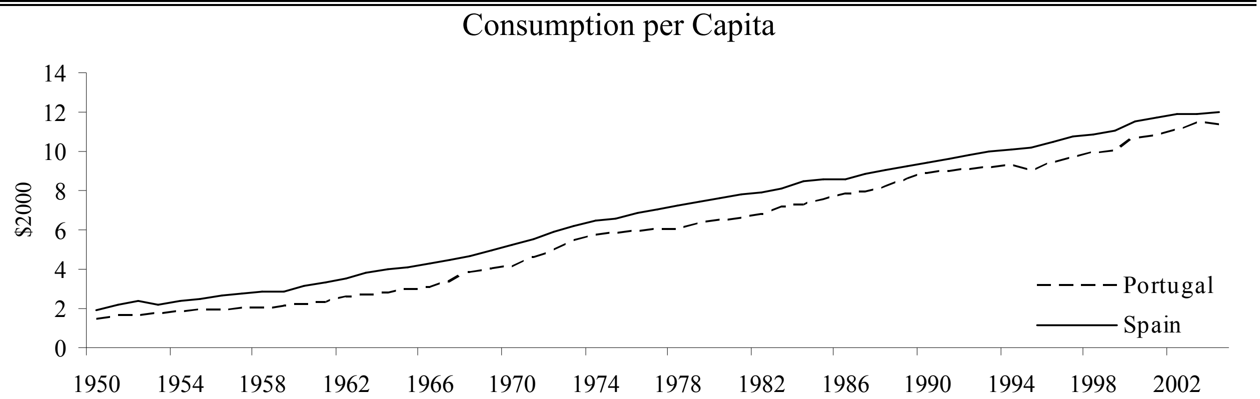
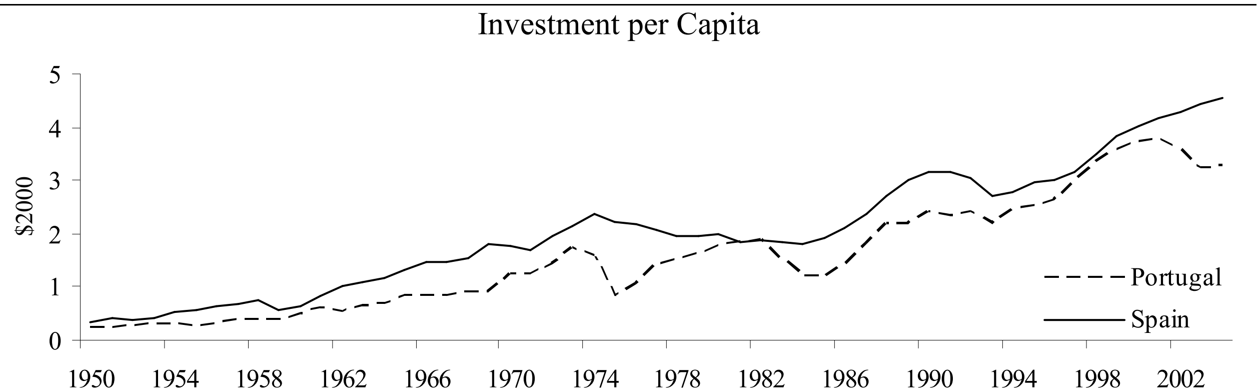
[10] Computed based on Penn World Table (2006) and GGDC (2008) data and author's computations

Figure 1.C Consumption and Investment per Capita

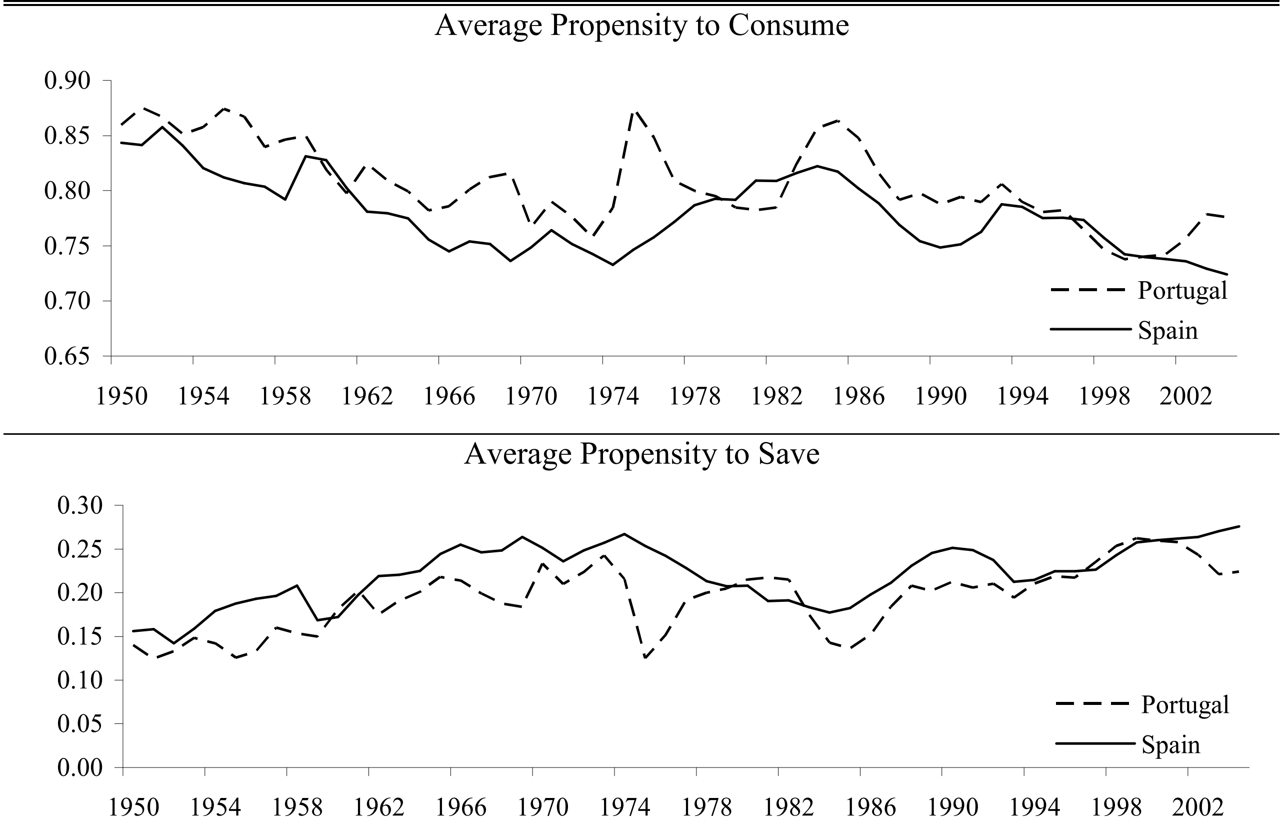




The decline in investment per capita experienced during the 1983-1986 period in Portugal could have resulted from the IMF intervention following the 1981-1983 currency crisis, which imposed serious fiscal and monetary constraints to offset the balance of payments deficit and in turn constrained the levels of public investment. Later on, the divergence recorded in the post-2000 period was mostly likely related to the higher degree of openness of the Portuguese economy relative to the Spanish because the series of adverse international shocks recorded at this time, namely the stock market crash in March of 2000 and the gradual worsening of the terms of trade due to higher energy costs, left the Portuguese economy relatively worse off.

In order to further investigate these fluctuations, the average propensities to consume and to save were computed using the consumption-output and investment-output ratios as proxies for those measures. The results are displayed in Figure 1.D.

Figure 1.D Average Propensities to Consume and Save



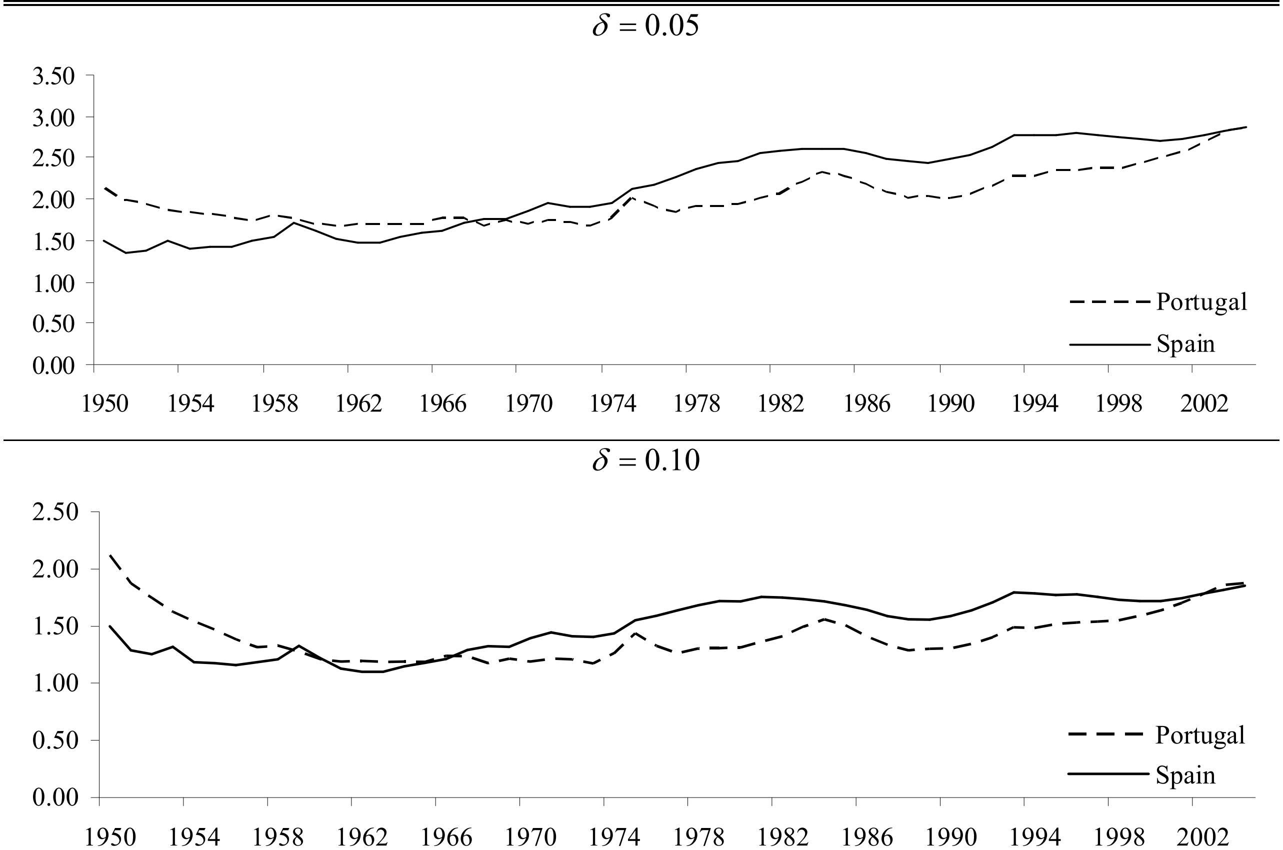
The figure corroborates the discussion just outlined for the observed fluctuations in the investment per capita ratios during the post-1974 period by revealing the tradeoffs between the willingness to consume and invest during each cycle. In particular, the spikes in the Portuguese average to consume initiated in 1974, 1983 and 2000, and the resulting crowding-out effects in the saving rate. Figure 1.D also indicates that on average the Spaniards have a lower propensity to consume and a higher propensity to save than the Portuguese. The latter inference could explain the persistent higher level of output per capita in Spain because the higher savings rate yields greater investment and production capacity. We now turn to this possibility by investigating the capital to output ratios.

1.4.2.4. Capital-Output Ratio

The Iberian capital-output ratios presented here are based on the calibration procedure described in Section 1.3. Briefly, these ratios were computed based on four different potential scenarios widely used in macroeconomic analysis which basically combine the assumptions that capital accumulation could follow a linear or exponential process and that the depreciation rate is expected to be between 5 to 10 percent. Following this approach, four different series for capital-output ratios will be suggested below in order to give a more detailed description about the potential true values of the capital-output ratios in the Iberian economies. The presentation first investigates simulated series for the capital-output ratios under a linear accumulation process allowing the depreciation rate to be either 5 or 10 percent and then investigates two additional series based on the assumption that capital accumulation follows an exponential process constrained by the same two levels of depreciation rate.

Figure 1.E plots the estimated capital-output ratios based on the assumption that capital is accumulated in a linear fashion. Regardless of the calibrated depreciation rate, throughout the 1950s and most of the 1960s, the estimated capital-output ratio was relatively higher in Portugal, suggesting that during this period output production in Spain was less capital-intensive. However, the late 1960s indicate a switch in positions, with Spain becoming consistently more capital-intensive than Portugal until the early 2000s.

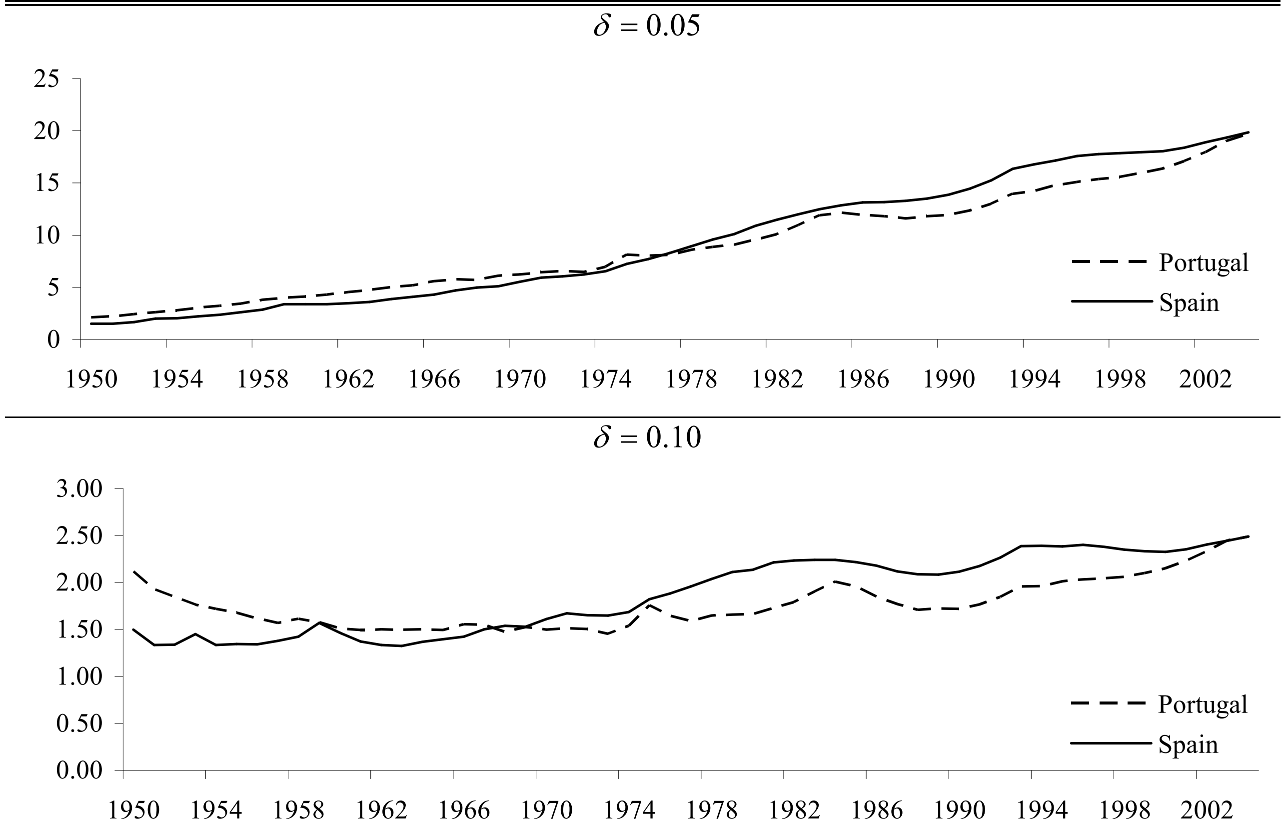
Figure 1.E Capital-output Ratio with Linear Accumulation Process



The switch in relative capital-intensity in the late 1960s is consistent with the political and socioeconomic history delineated in Section 1.4.1. as well as with the divergence in the levels of investment per capita observed throughout the 1960s (Figure 1.C). At this time, Franco implemented several policies aimed at industrialization and import substitution such as the 1960 highly protectionist tariffs, the 1961 law on Top Priority Industries, and the 1964 Development Plan (Appendix A). The fact that Spain overcame the Portuguese capital-output ratio advantage is probably an indicator of these policies' success.

The argument just outlined is also valid when capital is assumed to follow an exponential accumulation process and a 10 percent depreciation rate, as depicted in Figure 1.F. For the case when the depreciation rate is set at 5 percent, the leadership switch in the levels capital-output ratios is delayed until 1978. Nonetheless, despite the timing, all simulations indicate a switch in the relative ratios of capital-output during the 1950-2004 period, and Portugal catching-up by 2003-2004.

Figure 1.F Capital-output Ratio with Exponential Accumulation Process



By comparing the estimates obtained under the two different assumptions for the capital accumulation process it is clear that the levels of the ratios are higher for the latter simulations. This is a direct result of the exponential capital accumulation process, $K_{t+1} = A_k K_t^{1-\delta} I_t^{\delta}$, because it imposes an adjustment cost and therefore implies a preference for smoother investment patterns. As depicted in Figure 1.C, the data suggests that this assumption about the capital accumulation process probably does not hold since the investment per capita ratios present some degree of volatility. Therefore, it might be the case that the capital-output ratios estimated under the linear accumulation process are closer to the true values.

1.4.2.5. Total Factor Productivity

Given the capital-output ratios, data on aggregate output, labor markets, and the marginal contribution of capital, four different series for TFP were computed based on the calibration procedure described in Section 1.3. If TFP, in the standard Cobb-Douglas production function, can be interpreted as a proxy for available technology and loosely defined as everything else, "residual growth", that enables a certain level of output except for the observed contributions of capital and labor, then there is a myriad of factors than can impact it. Hall and Jones (1999) argue that TFP depends heavily on the quality of the social infrastructure because in their view a good infrastructure facilitates the adoption of new ideas and technologies. On the other hand, Parente and Prescott (1994, 2000, 2005) claim that TFP is primarily driven by potential barriers to technological adoption such as regulatory and legal constraints, bribes that must be paid, violence or the threat of violence, outright sabotage, and worker strikes. In this essay, we will focus on estimating the path of TFP and briefly speculate about its fluctuations. However, Essay 2 will study this issue in-depth

The presentation of the estimated levels of TFP will follow the previous layout, i.e. we will start by assessing the estimated levels when capital is assumed to accumulate in a linear fashion and then we will discuss the TFP estimates attained when imposing capital accumulation to follow an exponential process.

As depicted below, Figure 1.G indicates that Spain consistently had better technology than Portugal over the 1950-2004 period if we assume that the capital accumulation process is linear. These estimates could also corroborate the Spain's ability to consistently achieve higher levels of output per capita than the Portuguese since the former would be able to produce more even if they had just the same amounts of inputs as the latter.

Figure 1.G Total Factor Productivity with Linear Capital Accumulation

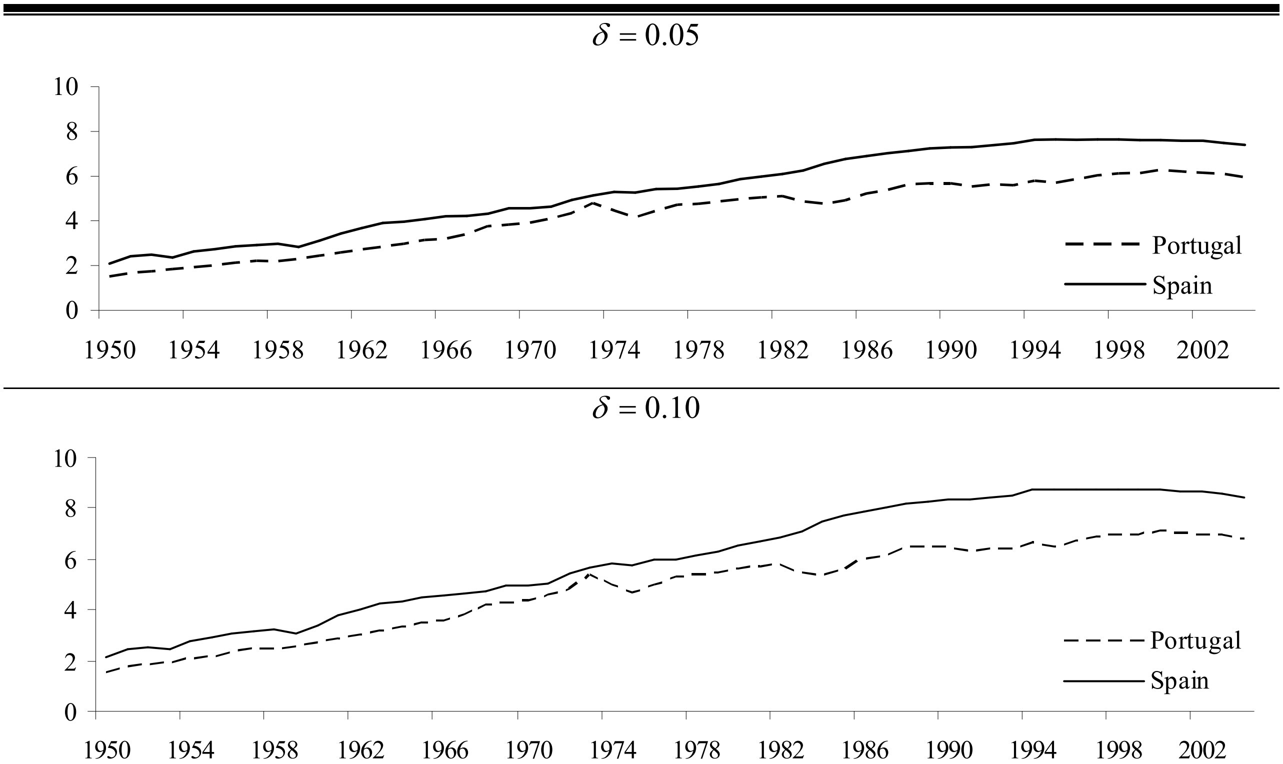
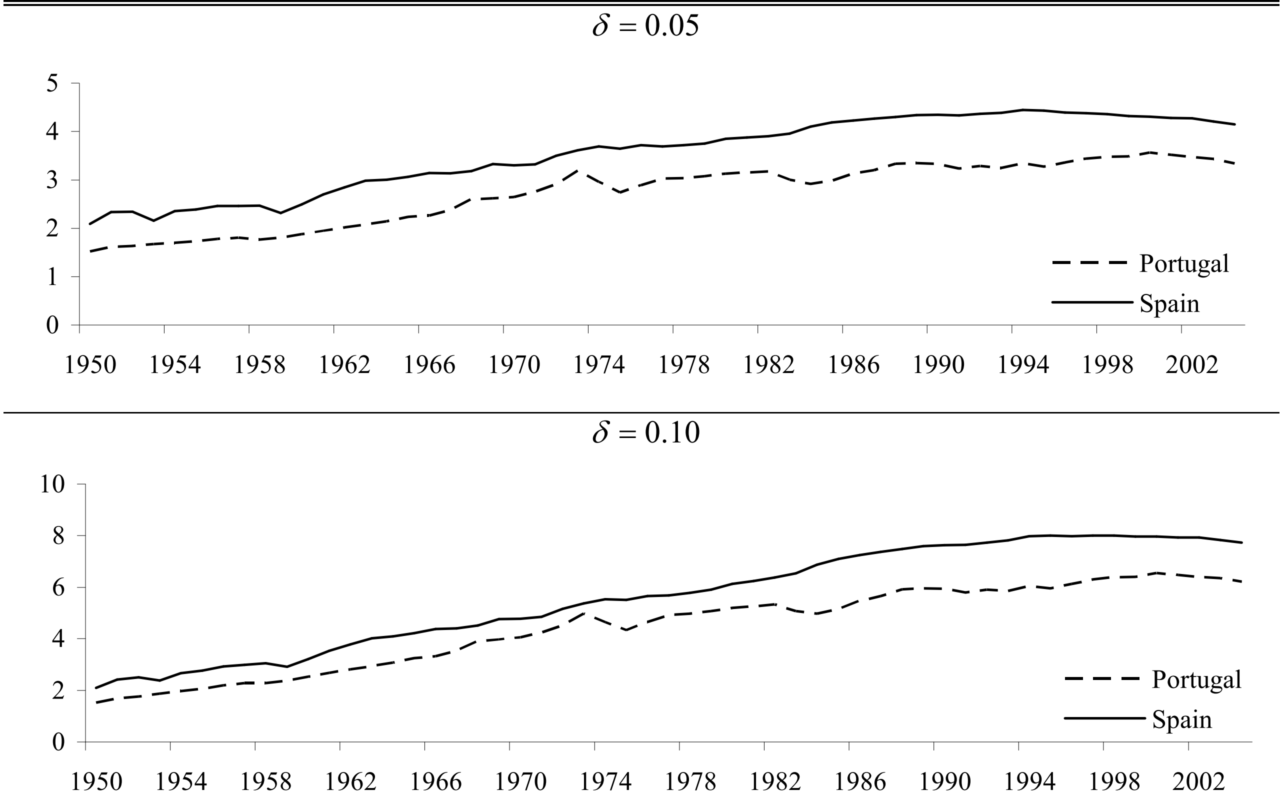


Figure 1.G. also shows that in the 1974-1976 and 1982-1984 periods there were significant declines in the Portuguese levels of TFP. Before turning to the discussion of these downturns, let us verify if these also hold when the motion of capital is assumed to follow an exponential formulation. Figure 1.H plots the estimates under the latter assumption.

Figure 1.H Total Factor Productivity with Exponential Capital Accumulation



Comparing both Figure 1.G and 1.H we can confirm that regardless of the capital accumulation process, the estimated levels of TFP are inversely related to the depreciation rates assumed, and as expected, this relationship being more explicit for the case of an exponential capital accumulation process.[11] Moreover, all the scenarios delineated above indicate the 1974-1976 and 1982-1984 TFP divergences previously mentioned. The variation in available technology is probably associated with the social and economic stress experienced in each period. The 1974-1976 period corresponds to the start of the democratization in Portugal and the process of massive nationalizations aimed at emasculating the old elite's economic base.

[11] This is obvious because the series were constructed based on the methodology outline in Section 1.3.

Moreover, as previously outlined, this increased economic uncertainty and investment per capita shrunk (Figure 1.C). Hence, it is not surprising that these changes may have disrupted TFP. In the 1982-1984 period Portugal was in the midst of a currency crisis which required the correction of the balance of payments deficit through strict fiscal and monetary policies. Among the widespread repercussions, there was a significant decrease in public investment along with the overall decrease in investment per capita (Figure 1.C) which in turn may have had an adverse effect on TFP.

Despite the similar political and socioeconomic context, Spain was able to keep its relative technological advantage throughout the 1950-2004 period, regardless of the assumption employed to compute TFP estimates. Overall, it appears that when it comes to technological adoption Spain has been able to do a better job than Portugal despite potential economic and political challenges. As discussed earlier, the democratization process and the adhesion to the European Single Market were some examples of how the Spanish skillfully managed adversities.

1.5. Growth Accounting Results

Besides the analysis of the political and socioeconomic context and the performance of key macroeconomic indicators, the decomposition of the observed growth in output per capita into the contributions of factor inputs and technological change adds depth to our understanding of the Iberian experiences. The estimates proposed in this section are mostly grounded on the growth accounting methodology developed in Bergoing *et al.* (2002) and Hayashi and Prescott (2002), as described in sections 1.2. and 1.3. The discussion starts by identifying periods of fundamental changes in the economic structure of Portugal and Spain based on the political and socioeconomic background and the corroborating view of others, followed by the presentation of the growth accounting results for each of the four scenarios delineated in the previous section.

1.5.1. Regime Changes

Regime changes occur when there are fundamental changes in the modus operandi of a given economy.[12] These can be motivated by different events such as profound changes in regulation, radical fiscal and monetary reforms, democratization, technological shocks, military conflict, natural disasters, etc., all of which have the potential to significantly alter the pattern of economic behavior.

The political and socioeconomic history and macroeconomic indicators of the Iberian economies point to four regime changes during the 1950-2004 period for each country. The first relevant change occurred in 1960 when Portugal adopted a policy of progressive opening of its economy to the world while Spain implemented highly protectionist tariffs and deepened its focus on import substitution and industrialization of the economic base. Despite the different economic outlooks, both countries experienced an extraordinary period of growth which became known as the Iberian golden years. Another radical change was prompted by the democratization process and its social and economic repercussions. However, these happened in different years for each country. For Portugal the regime change came in 1974 while for Spain it began in 1975.

Later on, both countries joined the European Community in 1986 and submitted themselves to radical reforms, either through market liberalization policies or major infrastructure projects subsidized by European structural funds. The process continued

[12] Not necessarily due to a change of government.

throughout the 1990s and more significant changes were yet to come. The 1994 adhesion to the European Single Market and European Union sustained another regime change since it exposed domestic firms to an unprecedented exposure to international competition and severely constrained fiscal and monetary policy in order to join the Eurozone.

The regime changes just delineated are supported by the analysis of other researchers. Lopes (2004a) defines the period 1960-1973 as the Portuguese golden years and Blakanoff (1992) concludes that the 1974 Portuguese revolution marked the end of the exceptionally rapid economic growth and structural change initiated in 1960. Tortella (2000) argues that 1960 was the beginning of an extraordinary growth period in Spain. Cheung and Chinn (1996), Fulvio (2001), and Escosura e Roses (2007), found that in 1975 there is a statistically significant break in the Spanish growth trend. Lopes (2004a) identifies the period 1986-94 as a complete business cycle for the Portuguese economy. Jimeno *et al.* (2006) point to 1986 as the year when there was a structural break in Spanish labor productivity growth, using a Sup-Wald test. Finally, Gunther *et al*. (2004) state that the Spanish economic expansion of the late 1980s came to an abrupt end by 1994 and was then followed by a strong recovery based on fiscal reform and an influx of structural investment funds from the EU (2004).

Having identified four major regime changes in Spain and Portugal between 1950 and 2004, the next task is to answer the following question: did the disparities in growth between Portugal and Spain arise mostly due to differences in the paths for factor inputs - like capital and labor - or due to differences in TFP?

1.5.2. Growth Accounting Results with Linear Capital Accumulation

The growth accounting exercises provide estimates based on the methodology outlined in Section 1.2. and 1.3, the four scenarios outlined in Section 1.4, and the four regime changes just delineated. We being our analysis with two simulations which focus on the case when capital accumulates in a linear fashion, i.e. $K_{t+1} = (1_t - \delta)K_t - I_t$. The sensitivity of the results is assessed by setting the capital depreciation rate, δ, at 5 and 10 percent, respectively.

Table 1.A shows the growth accounting estimates computed using equation (1.2) and assuming linear capital accumulation with a 5 percent depreciation rate.

Table 1.A Growth Accounting Estimates (δ = 5%; linear capital accumulation)

Country	Time Period	%Δ(Y/N)	Due to TFP	Due to K/Y	Due to L/N
Portugal	1950-1959	4.11	5.97	-0.81	-1.05
	1960-1973	7.01	6.86	-0.06	0.21
	1974-1985	1.53[13]	1.17	0.91	-0.55
	1986-1993	2.51	1.24	0.24	1.03
	1994-2004	2.02	0.36	0.90	0.76
	1950-2004	**3.95**	**3.55**	**0.24**	**0.16**
Spain	1950-1959	4.16	4.33	0.58	-0.75
	1960-1974	5.65	5.05	0.56	0.04
	1975-1985	1.58	3.25	0.81	-2.48
	1986-1993	2.09	1.42	0.41	0.26
	1994-2004	2.28	-0.39	0.13	2.53
	1950-2004	**3.61**	**3.28**	**0.51**	**-0.18**

The first thing to note is that the calculations in the third column (%Δ(Y/N)) and fifth column (Due to L/N) do not depend on the capital motion assumptions and thus hold no matter

[13] Even though the Carnation Revolution was in April 25th 1974, GDP per capita only shrunk significantly by 1975. Consequently, if we were to compare the Iberian growth rates in output per capita during the same 1975-1985 period, the growth rate in Portugal would have been 2.50 percent, which is significantly higher than the 1.58 percent rate experienced in Spain over the same time interval.

which structure for computing capital is applied. We begin by focusing on these two columns. Column three indicates that output per capita grew at an average annual rate of 3.95 percent in Portugal and 3.61 percent in Spain, hence suggesting convergence in output per capita levels among the Iberians over the entire 55-year period. Moreover, the estimates also corroborate the extraordinary growth experienced during the golden years and that Portugal grew significantly more than Spain over that period, attaining an average annual growth rate 24 percent higher than Spain. The democratization turmoil, energy shocks, and currency crises of the 1970s were quite expensive for both countries, with Portugal and Spain growing at a much slower, though similar, pace until the European Community adhesion. Additionally, the output per capita growth rates also support the argument that Spain was better prepared for the European Single Market challenges than Portugal. Whereas Portugal grew relatively faster during the 1986-1993, once both countries joined the single market, Spain was able to grow at an annual average rate that was 13 percent higher than Portugal.

Column five presents the estimates for the labor contribution toward the growth rate in output per capita. On average, for the entire 1950-2004 period, the contribution of labor was rather small in Portugal, and for Spain it ended up being a deterrent. Actually, during the 1950s, labor inhibited growth in both countries and it was relatively more problematic in Portugal since the employment rate was somewhat higher in Spain. During the golden years, labor had a positive contribution to the growth rate in output per capita though rather small, particularly in Spain. This relative performance might have been distorted by the massive emigration of Portuguese citizens during this period which contracted the labor force and disguised unemployment. The democratization process of the mid 1970s along with several adverse shocks also afflicted the Iberian workers, especially the Spaniards. As observed in Figure 1.B, the unemployment rate increased dramatically in Spain since the transition to democracy until the European Community adhesion, whereas in Portugal it was fairly stagnant during the same period.

In the 1986-1993 period labor played a role in the upswing of the average output per capita growth rate, even though it was more relevant in Portugal than in Spain. This fact is consistent with the relative lower unemployment rates in Portugal as well as with its flatter employment curve (Figure 1.B) during this period. Major changes occurred after the adhesion to the European Single Market. Labor became the key engine of growth for the Spanish economy. Even though our accounting methodology does not explicitly takes into consideration the role of labor efficiency, this change might be associated with the 1982-1994 boom in education (Appendix A) and resulting increased ability of the Spanish workers to compete with their European counterparts, and especially against the Portuguese workers. In fact, between 1993 and 2003, only 10 percent of the Portuguese labor force had tertiary education whereas in Spain this share accounted for 24 percent (WDI, 2006).

We now turn to the more uncertain results which are tied to the capital construction approach. The capital construction approach not only impacts the capital-output ratio, but it will also impact the Solow residual (i.e. TFP). If the capital accumulation process is linear and the true depreciation rate is 5 percent, then the adopted methodology indicates that during the overall period TFP was significantly more important than the factor inputs, and it grew relatively faster in Portugal than in Spain.[14] Between 1950 and 2004, the estimated average growth rate for TFP was 3.55 percent in Portugal and 3.28 percent in Spain, accounting for about 90 percent of each

[14] The dominant role of TFP is a stylized fact in economic growth theory.

country's average annual change in output per capita. Moreover, TFP was the main driver of growth in each time interval under consideration, except for the 1993-2004 period.

In relation to the contribution of capital, the numerical experiment indicates that on average it was more relevant in Spain than in Portugal, growing at an average annual rate of 0.51 and 0.24 percent, respectively. Moreover, the results also suggest that Franco was more successful than Salazar in capitalizing the economy. During the early years of democracy, Portugal recovered some ground but fell short again during the 1986-1993 period. Given that both countries received significant structural funds from the European Community in the latter period, it seems that the Spanish were able to implement those projects more efficiently. However, in recent years the contribution of capital toward output per capita has been higher in Portugal than in Spain.

Table 1.B summarizes the results for a 10 percent depreciation rate under the same linear motion of capital formulation. The higher depreciation rate reduces the capital contributions to per capita output, and actually makes its average negative in Portugal for the overall period.

Table 1.B Growth Accounting (δ = 10%; linear investment function)

Country	Time Period	%Δ(Y/N)	Due to TFP	Due to K/Y	Due to L/N
Portugal	1950-1959	4.11	7.32	-2.16	-1.05
	1960-1973	7.01	6.89	-0.09	0.21
	1974-1985	1.53	1.45	0.63	-0.55
	1986-1993	2.51	1.18	0.30	1.03
	1994-2004	2.02	0.34	0.92	0.76
	1950-2004	**3.95**	**3.88**	**-0.09**	**0.16**
Spain	1950-1959	4.16	5.42	-0.51	-0.75
	1960-1974	5.65	5.14	0.46	0.04
	1975-1985	1.58	3.74	0.32	-2.48
	1986-1993	2.09	1.36	0.47	0.26
	1994-2004	2.28	-0.40	0.15	2.53
	1950-2004	**3.61**	**3.62**	**0.17**	**-0.18**

With the smaller capital contributions, TFP becomes larger in both countries and remains the key driver of growth. Specifically, under the 10 percent depreciation rate assumption, the average annual growth rate of capital-output ratio over the entire period was 0.17 percent in Spain and -0.09 in Portugal. On the other hand, the annual average contribution of TFP increased to 3.88 percent in Portugal and 3.62 in Spain.

A comparison of Table 1.A with Table 1.B suggests that capital stock was, on average, a drag on the Portuguese growth experience, whereas for the Spanish it only had an inhibiting effect during the 1950-1960 period.

The correlation of each accounting measure with the overall average annual growth rate in output per capita is provided in Table 1.C.

Table 1.C Correlations with Linear Capital Accumulation

	Y/N			
	$\delta = 0.05$		$\delta = 0.10$	
	Portugal	Spain	Portugal	Spain
TFP	0.97	0.97	0.97	0.97
K/Y	0.83	0.95	0.32	0.87
L/N	0.80	-0.68	0.80	-0.68

One of the key premises for using statistical correlations is that the there must be a linear relationship among the variables. Given that the growth accounting exercise is based on equation (1.2), which assumes a linear relationship between output per capita, TFP, capital-output ratio, and the employment rate, then it is reasonable to employ this statistical tool to speculate about potential correlations. Table 1.C shows that changes in the depreciation rate do not alter the potential degree of correlation between TFP and the employment rate with output per capita in both countries. Moreover, it supports the conjuncture that TFP is the variable most closely related to the path of output per capita and that throughout the 55-year period, the Spanish employment rate had, on average, a negative relationship with the latter. On the other hand, Table 1.C also indicates that higher depreciation rates make the capital-output ratio evolve less closely to output per capita.

Among the results shown in Table 1.C it is interesting that the employment rate in Portugal has a positive relationship with output per capita whereas in Spain this relationship is negative. The opposite correlation signs are in line with the discussion previously presented about the discrepancies between the Portuguese and the Spanish labor markets. For example, the statistical results are consistent with Blanchard's (1995, p.216-7) argument that the relatively higher unemployment benefits in Spain could explain the persistence of higher unemployment rates.

1.5.3. Growth Accounting Results with Exponential Capital Accumulation

To test the consistency of the growth accounting results, two additional simulations were performed. These are based on the assumption that the formulation for the motion of capital, i.e. $K_{t+1} = A_k K_t^{1-\delta} I_t^{\delta}$, incorporates an adjustment cost which motivates the representative agent to prefer smoother investment patterns. Table 1.D presents the growth accounting estimates computed using equation (1.2) and assuming the exponential capital accumulation process with a 5 percent depreciation rate.

In the table below we observe that a smoother investment pattern would inflate the estimated contribution of capital toward the growth rate of output per capita in both countries. In turn, this increase would be offset by a diminished relevance of TFP, which now would account for approximately 52 percent of overall average annual growth rate of output per capita in Portugal and 49 percent in Spain. Another interesting observation under this scenario is that the capital-output ratio became the main driver of growth in each regime interval, except during the golden years.

Table 1.D Growth Accounting (δ = 5%; exponential capital accumulation)

Country	Time Period	%Δ(Y/N)	Due to TFP	Due to K/Y	Due to L/N
Portugal	1950-1959	4.11	2.44	2.72	-1.05
	1960-1973	7.01	5.42	1.38	0.21
	1974-1985	1.53	0.09	1.99	-0.55
	1986-1993	2.51	0.65	0.83	1.03
	1994-2004	2.02	-0.01	1.27	0.76
	1950-2004	**3.95**	**2.05**	**1.74**	**0.16**
Spain	1950-1959	4.16	1.45	3.45	-0.75
	1960-1974	5.65	3.72	1.89	0.04
	1975-1985	1.58	1.81	2.25	-2.48
	1986-1993	2.09	0.66	1.17	0.26
	1994-2004	2.28	-0.90	0.65	2.53
	1950-2004	**3.61**	**1.78**	**2.01**	**-0.18**

In terms of hierarchical relevance for the overall 55-year period, the conclusions are similar to those advocated for the linear capital accumulation scenario with a 5 percent depreciation rate in the case of Portugal. In particular, TFP was the main engine of growth, followed by capital and labor, respectively. However, in the case of Spain there is a significant change associated with the assumption of an adjustment cost in the motion of capital. The latter implies that, on average, capital became the main engine of growth during the 1950-2004 period whereas under the assumption of a linear motion of capital this role belonged to TFP. However, if the true depreciation rate would be 10 percent instead (Table 1.E), then TFP would be again, on average, the main engine of growth in both Iberian countries regardless of the capital accumulation assumptions.

Table 1.E Growth Accounting (δ = 10%; exponential investment function)

Country	Time Period	%Δ(Y/N)	Due to TFP	Due to K/Y	Due to L/N
Portugal	1950-1959	4.11	6.42	-1.26	-1.05
	1960-1973	7.01	6.92	-0.12	0.21
	1974-1985	1.53	1.22	0.86	-0.55
	1986-1993	2.51	1.18	0.30	1.03
	1994-2004	2.02	0.33	0.93	0.76
	1950-2004	**3.95**	**3.66**	**0.13**	**0.16**
Spain	1950-1959	4.16	4.71	0.20	-0.75
	1960-1974	5.65	5.21	0.40	0.04
	1975-1985	1.58	3.30	0.76	-2.48
	1986-1993	2.09	1.35	0.48	0.26
	1994-2004	2.28	-0.41	0.16	2.53
	1950-2004	**3.61**	**3.39**	**0.40**	**-0.18**

The results delineated above suggest that the estimates for the capital-output contribution in Table 1.F might be outliers. In fact, Figure 1.F supports this conjuncture given that the levels of capital-output ratios are relatively much higher when a 5 percent depreciation rate is imposed on the exponential capital accumulation process. Moreover, the actual data for the levels of investment per capita (Figure 1.C) reveal a certain degree of volatility that is buffered by the adjustment cost in the exponential capital accumulation process. Consequently, the resulting smoothness in investment preferences creates a compounding effect on the capital-output levels that is not sufficiently offset by a 5 percent depreciation rate. Nonetheless, when assuming a 10 percent depreciation rate the compounding effect is neutralized by the rapid capital deterioration and the estimates become more consistent with those of the linear capital accumulation scenarios in terms of hierarchical contributions (and levels), i.e. on average, throughout the 1950-2004 period, TFP was the main engine of growth in both countries whereas capital was relatively more important in Spain than in Portugal, and vice-versa for the labor contribution.

The linear growth accounting relationships, implied by equation (1.2) and the adjustment cost assumption in the capital accumulation process, are summarized in Table 1.F.

Table 1.F Correlations with Exponential Capital Accumulation

	Y/N			
	$\delta = 0.05$		$\delta = 0.10$	
	Portugal	Spain	Portugal	Spain
TFP	0.94	0.94	0.97	0.97
K/Y	0.98	0.99	0.71	0.94
L/N	0.80	-0.68	0.80	-0.68

As expected, the preferences for a smoother investment pattern makes the capital-output series more closely related to the output per capita series when compared to those correlations obtained for the scenarios with a linear accumulation process (Table 1. C). Another consequence of these inflated correlations is that under a 5 percent depreciation rate, the capital-output ratio becomes somewhat more correlated to output per capita than TFP, but overall, the insights provided by the correlation summary are the same as those drawn when capital was assumed to accumulated in a linear fashion.

In summary, the four growth accounting simulations suggest convergence in the output per capita levels between Portugal and Spain over the 1950-2004 period and that growth in the Iberian Peninsula was particularly faster before the democratization process. On average, TFP was the main engine of growth for both countries across all scenarios, except in Spain when we assumed the exponential motion of capital with a 5 percent depreciation rate. Despite the potential tradeoff in leading roles between TFP and capital, the latter was more relevant in the Spanish than in the Portuguese growth experience over the last 55 years.

A consistent result across all simulations concerns the relative role of capital and labor in the Portuguese and Spanish performance after the adhesion to the European Single Market. In recent years, Spain has been able to grow relatively faster mainly due to the increasing contribution of labor. Conversely, in Portugal, the contribution of the capital-output ratio became more relevant than labor over the same period. This is particularly interesting given that on average, labor was more relevant than capital in the Portuguese growth experience over the entire 1950-2004 period.

1.6. Conclusion

This essay investigates the Iberian growth and development experiences during the 1950-2004 period based on a detailed assessment of the political and socioeconomic experiences, the performance of macroeconomic indicators, and contributes to the literature because it provides growth accounting estimates for four different capital construction scenarios in Portugal and Spain. The empirical results support the argument that, in general, TFP was the main driver of growth for the Iberian economies during the 55 years of interest.

Besides sharing the Iberian Peninsula, Portugal and Spain engaged in similar social, political, and economic experiences during the post-WWII period.[15] However, even today, Spain's output per capita is significantly higher than Portugal, and the latter remains among the

[15] The exceptions are, for example, the different international trade policies during the 1960s.

poorest countries in Europe despite growing somewhat faster than Spain. Nonetheless, the speed of convergence was not fast enough to offset the gap in output per capita levels.

The Spanish ability to ameliorate its relative economic status in recent years might be due to the skillful management of political and socioeconomic challenges, such as the democratization and adhesion to the European Single Market. The future does not appear to be any brighter for Portugal given the historical relevance of labor contributions toward output per capita growth and the current scarcity of skilled labor, which might constrain the adoption of new technologies.

ESSAY 2 - Iberian Barriers to Technological Adoption

2.1. Introduction

Based on the growth accounting exercise performed in the previous essay, Total Factor Productivity (TFP) has been the main engine of growth for the Iberian economies during the 1950-2004 period. Consequently, to have a more detailed understanding of the Iberian growth experiences it is important to assess which factors may have played a role facilitating TFP augmentation and how these differed between Portugal and Spain. The first challenge in the task at hand is to define which factors may foster TFP growth. In the standard Cobb-Douglas production function, $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$, there are just four variables determining output at any period in time, *t*, namely, the amount of labor employed, L_t, the units of capital used, K_t, the marginal contribution of each factor input (α for capital), and the scalar, A_t, which captures everything else that influences output production and that economists typically refer to as TFP or the Solow residual, in honor of the seminal contribution that Robert Solow (1956) made to economic growth theory. In fact, even today, Solow's model remains the baseline framework from which new theories can be extended and compared.

One recent growth theory that builds on the Solow model has been presented by Parente and Prescott (1994, 2000, 2005). Their theory suggests that countries may reach differing steady states because of barriers to technological adoption - i.e. those factors that inhibit TFP growth - given that the higher the barriers, the greater the investment required to implement new technologies. According to Parente and Prescott (2000), these barriers to technology adoption may take a variety of forms such as regulatory and legal constraints, bribes that must be paid, violence or threat of violence, outright sabotage, and worker strikes.

The barriers theory of Parente and Prescott has led to a number of important follow up studies which confirm the existence of barriers in a number of different settings. Boucekkine and Martinez (1999) introduced barriers to technology adoption in a canonical vintage capital model.[16] Hall and Jones (1999) redefined barriers to technology adoption as social infrastructure and found that good infrastructure encourages "the adoption of new ideas and new technologies as they are invented throughout the world."[17] Acemoglu and Zilibotti (2001) advocated that income disparities between LDCs and DCs arise even in the absence of policy induced barriers to technology adoption due to differences in labor force skills.[18] Ngai (2004) argued that international income disparities were related to different levels of barriers to technology adoption and capital accumulation, and that the latter delay the turning point between growth stages.[19] Harding and Rattsø (2005) investigated the role of barriers to technology adoption on South Africa's growth.[20] And, Comin and Hobijn (2007) set up a tractable model of endogenous growth in which the returns to innovation are determined by the technology adoption decisions.[21]

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[16] Using numerical methods, the author validated the dynamics of the model and found that higher adoption costs constrain output levels in the long run, augment short run fluctuations, and decrease the convergence speed to steady state.

[17] Quantitative analysis of data for 127 countries suggested that differences in social infrastructure led to large disparities in income across countries.

[18] Using 1997 U. N. General Industrial Statistics data for 22 countries, the authors conclude that technology adoption also depends on supplies of factors of production, since different technologies fit better different factors of production.

[19] Ngai's findings were based on the development experiences of the 124 countries from Maddison's 2001 dataset.

[20] The authors concluded that reduced barriers pre- and post- sanctions and the high barrier during sanctions explained the development of productivity.

[21] Calibrating it to U.S. data, the authors found that policies inducing lower barriers increase growth.

This essay contributes to the above growing body of work. In particular, it adopts the Parente and Prescott (2000) growth theory to estimate the level of barriers to technological adoption in Spain and Portugal and provides corroborating evidence for disparities between these values.

The key difference between the Solow model (1956) and the Parente and Prescott (2000) framework is the inclusion of a technological capital stock. Here, we build on the Parente and Prescott (2000) structure by modifying the model to include adjustment costs in capital investment. This addition results in a model in which closed form solutions can be computed. More importantly, it results in an improved simulation structure where no attention to negative investment levels is needed. Next, this model is applied to post World War II development experiences in Spain and Portugal and shown that it is able to explain these experiences well. Finally, a value for the level of barriers in the Iberian economies is proposed.

The text is organized as follows. In section 2.2, the model is described and the closed form rules for the competitive economy are presented. Section 2.3 applies a Parente and Prescott type routine to calibrate the model using U.S. and Japanese data. Section 2.4 reviews the Iberian political and socioeconomic experiences during the post World War II period and assesses its fit to the results of our numerical experiments, and the implied levels of barriers to technological adoption are supported by the corroborating view of others. Section 2.5 concludes.

2.2. Modelling Barriers to Technological Adoption

The model presented in this section builds on the framework of Parente and Prescott (2000) and most of their structure and notation is preserved.[22] The main difference is the formulation for the motion of both physical and technological capital. Here, the capital accumulation process incorporates and adjustment cost component, similar to Lucas and Prescott (1971), which enables closed form solutions for the social planning problem, hence making the model analytically tractable. In addition to making the simulations much easier, the adjustment cost component also implies that there is a preference for smoother investment patterns and this fact eliminates the concern over negative investment values that is present in the various Parente and Prescott models.

2.2.1. The Corporate Sector

Here, everything is envisioned on a per worker basis. A firm that operates h_t hours per workweek, uses k_t units of physical capital per worker and z_t units of intangible capital per worker, has a level of output per worker given by

$$y_t = \mu A(\pi) h_t k_t^{\theta_k} z_t^{\theta_z}, \tag{2.1}$$

where $\mu = (1+\gamma)^{(1-\theta_k-\theta_z)}$ is related to the exogenous rate of growth for world knowledge, γ, and is assumed to be greater than zero. In addition, TFP is assumed to be governed by

[22] The 1994 version of Parente and Prescott model includes the government sector and a somewhat different modelling technique for the barriers to technological adoption. The version adopted here does not contemplate an explicit role for the government.

$A(\pi) = (1+\pi)^{-\theta_z}$ where π is a measure of the barriers to technology adoption in a given country and higher values of π are interpreted to correspond to countries where the barriers to technology adoption are higher. Output elasticity parameters θ_k and θ_z are assumed to be positive and $\theta_k + \theta_z < 1$. It is noteworthy that our production function may suggest that it has increasing returns to scale because the sum of the exponents adds up to more than 1, however this is not the case as this is a per worker production function. Hence, additional workers are handled simply through replication of this production function and therefore the aggregate production function exhibits constant returns to scale.

Firms are assumed to hire labor and rent physical capital through competitive markets but to invest in intangible capital on their own. Investment in intangible capital in the amount i_{zt} is combined with the existing intangible capital stock z_t and leads to future intangible capital stocks given by

$$z_{t+1} = A_z(\pi) z_t^{1-\delta_z} i_t^{\delta_z}, \tag{2.2}$$

where $0 < A_z$ and $0 < \delta_z < 1$. This formulation in exponential form imposes an adjustment cost element as in Lucas and Prescott (1971).

The choices of firms are governed by a desire to maximize the value of the dividend stream paid to its owners. The firm's dividends are simply revenues minus expenses and are given by

$$v_{ft} = y_t - w_t h_t - r_{kt} k_t - i_{zt}, \tag{2.3}$$

where $w_t(h_t)$ is the wage rate per worker at time *t* and is a function of the number of hours the firm is in operation, r_{kt} is the rental rate on physical capital at time *t* and i_{zt} is the number of units of intangible capital that the firm invests in at time t. The labor and capital markets are assumed to be competitive, which implies wage and rental rates given by

$$w_t = (1-\theta_k-\theta_z)\frac{y_t}{h_t}, \tag{2.4}$$

$$r_{kt} = \theta_k \frac{y_t}{k_t}, \tag{2.5}$$

$$r_{zt} = \theta_z \frac{y_t}{z_t}, \tag{2.6}$$

where r_{zt} is the implicit rental rate on technological capital. The firms behave in the best interest of their stockholders and thus their optimization problem is to maximize

$$v(z_0) = \sum_{t=0}^{\infty} p_t v_{ft},$$

subject to (2.1), (2.2.) and (2.3) where p_t is the price of output at date t.

2.2.2. The Consumer Sector

The consumer sector consists of a large number of identical agents who own equal initial shares of the two marketable assets in the economy. These marketable assets consist of physical capital, denoted k_t for holdings at date t, and ownership rights to one firm.[23] In addition, each household has one unit of time at each date which is allocated between labor supply and leisure consumption. Households have preferences for consumption and leisure over time given by

$$\sum_{t=0}^{\infty} \beta^t \ln\left(c_t - B(1+\gamma)^t h_t^{\eta}\right), \tag{2.7}$$

[23] Technology capital is invested in by firms and is not traded in a market.

where $0 < \beta < 1$, $0 < B$ and $0 < \eta$. In this set up, c_t denotes consumption of goods at date *t*. The term $(1+\gamma)^t$ is present in the utility function in order to keep the labor supply h_t stationary over time. Without this element, as c_t grows, the labor supply would be driven to a boundary. This term can be interpreted as implying that the value of time in home production increases over time at a rate equal to the balanced growth rate for the economy.

The household physical capital stock changes over time when new investment i_{kt} is combined with the existing capital stock k_t according to

$$k_{t+1} = A_k(\pi) k_t^{1-\delta_k} i_t^{\delta_k}, \tag{2.8}$$

where $0 < A_k$ and $0 < \delta_k < 1$. As in the technological capital, this formulation is motivated by Lucas and Prescott (1971).

Then we can formulate the representative agent's objective as maximizing (2.7) subject to (2.8) and the budget constraint

$$c_t + i_{kt} = w_t h_t + r_{kt} k_t + v_{ft}. \tag{2.9}$$

Moreover, because households are assumed to be numerous, each household is a sufficiently small part of the economy so that they are price takers.

2.2.3. Competitive Equilibrium

The competitive equilibrium for this economy consists of prices $\{p_t, r_{kt}, w_t : t \geq 0\}$ and allocations $k_0, z_0, \{y_t, c_t, h_t, i_{kt}, i_{zt}, v_{ft}, k_{t+1}, z_{t+1} : t \geq 0\}$, such that:

1. Agents optimize:

i. Given $\{r_{kt}, w_t, v_{ft} : t \geq 0\}$ and k_0, the allocations $\{c_t, h_t, i_{kt}, k_{t+1} : t \geq 0\}$ solve the consumer's optimization problem.

ii. Given $\{p_t, r_{kt}, w_t : t \geq 0\}$ and z_0, the allocations $\{y_t, h_t, k_t, v_{ft}, i_{zt}, z_{t+1} : t \geq 0\}$ solve the firm's optimization problem.

2. Markets clear:

i. Goods market: $c_t + i_{kt} = y_t - i_{zt}$, for t=0,1,...

ii. Labor market: $h_t = h_t$, for t=0,1,...

ii. Physical capital market: $k_t = k_t$, for t=0,1,...

2.2.4. Decision Rules

Although it is numerically feasible to solve for the competitive equilibrium using the expressions implicit in its definition, it is much easier to work with the social planning decision rules. The social planner is simply an integrated consumer-producer that makes all consumption, investment and production decisions simultaneously. The planner takes as its objective the consumer utility function and maximizes this subject to all the consumer and producer constraints described above. In the appendix, the formal specification of the social planning problem is given and solved. The decision rules that solve this problem are given by:

$$i_{kt} = a_k y_t \text{ where } a_k = \frac{\beta \delta_k \theta_k}{1 - \beta(1 - \delta_k)},$$

$$i_{zt} = a_z y_t \text{ where } a_z = \frac{\beta \delta_z \theta_z}{1 - \beta(1 - \delta_z)},$$

$$c_t = (1 - a_k - a_z) y_t,$$

and

$$h_t = \left[\frac{(1-\theta-\theta)A(\pi)k_t^{\theta_k} z_t^{\theta_z}}{B\eta(1+\gamma)^{(\theta_z+\theta_k)t}} \right]^{\frac{1}{\eta-1}}.$$

2.3. Calibration

The model is calibrated similarly to Parente and Prescott (1994, 2000). The routine begins by setting the barrier parameter π equal to zero to correspond to the U.S. economy baseline. Then values for most parameters are assigned based on observations of the U.S. economy. For those parameters corresponding to variables for which there are no data, values are determined based on convergence information between U.S. and Japan during the post World War II period. Finally, as in Parente and Prescott (2000), the principle of common technology across countries is adopted, hence all model parameters except π are the same in the U.S., Spain and Portugal.[24]

The parameter γ is set to 0.02 to correspond to the observed 2 percent annual growth rate of per capita output and β is set to 0.9716 to correspond to a 5 percent risk free interest rate.[25] Next, η is set to 10.00 to correspond to a labor supply elasticity of 0.11.[26] Given these parameters, the remaining parameters were jointly calibrated to match other statistics. Table 2.A

[24] As the authors explained on p.67, without this principle there would be no discipline to the analysis. Moreover, they demonstrated that this should not raise any controversy as barriers at the plant level lead to differences in TFP at the aggregate level.

[25] The risk free interest rate r is defined by introducing privately issued real bonds into the household budget constraint. These bonds have a zero net supply, and in balance growth the first order condition for bonds implies $r = \exp(\gamma - \ln\beta) - 1$

[26] This elasticity value is relatively low and corresponds to most empirical estimates of the male supply elasticity. Such a value seemed more appropriate for our purposes where the focus is on long run outcomes rather than business cycle outcomes. With more elastic labor supply calibrations, the model will imply bigger changes in labor hours in transitional economies.

indicates the outcome of the calibration procedure along with the other statistics which were matched.[27]

Table 2.A Calibrated Values

Parameter	Value	Empirical Fact to Match
π	0	Normalized for U.S. baseline
θ_z	0.30	Rate of convergence matches Japan
θ_k	0.20	Rate of convergence matches Japan
γ	0.02	Growth rate for per capita GDP is 2%
A_z	1.585	Implied by the output production function
δ_z	0.0974	Average i_{zt} / y_t ratio 0.30
A_k	1.305	Average k_t / y_t ratio 2.5
δ_k	0.0974	Average i_{kt} / y_t ratio 0.20
β	0.9716	After tax interest rate of 5%
B	620	Fraction of time devoted to labor of 0.4
η	10.00	Labor supply elasticity $(\gamma - 1)^{-1} = 0.11$

Most of the calibrated parameters are consistent with those found in Parente and Prescott (2000). Nonetheless, there are some differences. In this essay θ_k is equal to 0.20 whereas their value was 0.16. This discrepancy does not require much attention since 0.20 is closer to the standard Cobb-Douglas production function estimates of 0.3 to 0.4. For θ_z, the calibration routine estimated a value of 0.3 which is quite a bit smaller than Parente and Prescott's value of 0.55. This reflects differences in the capital accumulation modeling structures. Since the model

[27] Most of these calibration statistics come from Parente and Prescott (2002). The growth rate for per capita GDP in the U.S of 2%, the k_t / y_t ratio of 2.5, the i_{kt} / y_t ratio of 0.20, the after tax interest rate of 5% and the fraction of time devoted to labor of 0.4 come from page 75, while the average i_{zt} / y_t ratio of 0.30 is within the range defined on page 76.

in this essay has an adjustment cost technology built into the capital accumulation formulations for the two capital stocks, the rate of convergence is dampened because the adjustment cost formulation induces slower investment patterns. As discussed in Barro and Sala-I-Martin (1995), the rate of convergence is also related to the sum of θ_k and θ_z, with higher values for this sum implying slower convergence. Since the adjustment cost formulation already induces slower convergence, the sum of θ_k and θ_z cannot be as large as in Parente and Prescott or convergence rates would not match those observed between the U.S. and Japan.

2.4. Iberian Development Experiences

This section investigates the postwar development experiences of Spain and Portugal in order to provide insight into turning points in which the barriers to technology adoption changed in each of these countries. With this history in mind, we then turn to the evaluation of each economy. Finally, a review of some recently collected data is presented and reconciled with the suggested levels of barriers in Portugal and Spain.

2.4.1. Background

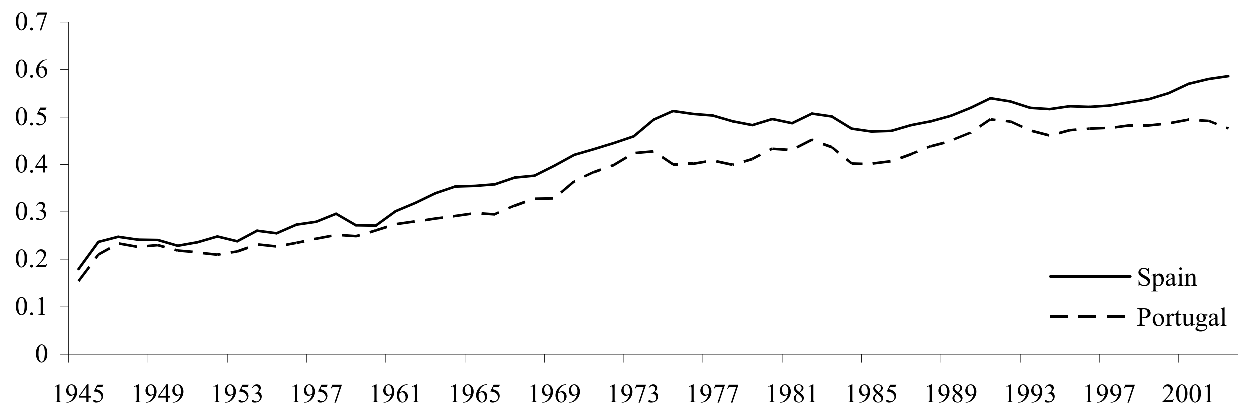
Even though geographic proximity is really not enough to imply similar economic outcomes, the Portuguese and Spanish development experiences have been quite alike.[28] Probably most important to the similar economic paths is the long shared history of the two countries and the brotherly rapport they have with each other. These countries seem to routinely do what the other does. So both spent most of the 20th century under a dictatorship, had their

[28] Obvious counter examples abound such as the U.S. and Mexico.

golden years in the post World War II period, became democratic in the mid 1970s, joined the European Community in 1986, the European Single Market and European Union in 1993, and were among the 12 European countries that adopted the Euro currency in 2000.

In Figure 1, output per worker in Portugal and Spain relative to the U.S. over the postwar period is plotted based on data from Maddison (2007). It shows striking similarities between the Iberian economies. This recent economic history played out as follows.

Figure 2.A GDP per capita relative to U.S. level



Between World War II and the OPEC-induced international energy crisis in 1973, the Spanish economy experienced an unprecedented period of growth boosted by the massive and profound transformation of the industrial sector. Industrial productivity increased by 100 percent between 1964 and 1973. Consequently, Spain's industry became technologically sophisticated (Tortella, 2000). In contrast, Portugal focused more on the progressive opening of its economy to the world; the merchandise export growth rate between 1959 and 1973 was 11 percent per year whereas in industrialized countries it was 8.9 percent (Baklanoff, 1992).

Soon after the 1973 oil shock, both countries went through a period of social and economic turmoil. The military coup of April 1974 ousted the long-lived authoritarian regime of António de Oliveira Salazar (1932-1968) and Marcelo Caetano (1968-1974), whereas the Spanish dictatorship (1939-1975) ended with the death of Francisco Franco. In addition, both countries followed a negotiated model of transition to democracy where, according to Colomer (1991), pacts among political elites and consensus among citizenry sought to avoid acts of revenge, violent confrontations, and civil war.

Along with democratization came changes in the economic system. The Portuguese revolutionaries nationalized commercial banks and most heavy and medium size industries in order to emasculate the old elite's economic base. Moreover, the dismemberment of the colonial empire resulted in the loss of a significant source of income (Baklanoff, 1992). Spain, on the other hand, experienced a smoother transition process skillfully managed by the new chief of state, King Juan Carlos I, who had lived in exile in Portugal till Franco's death. During the early years of democracy, Spain focused on stop-gap economic measures such as the Moncloa Pacts, which assured a degree of moderation for increases in prices and salaries (Tortella, 2000).

The turbulent road to stability culminated with the accession of the Iberian countries to the European Community in 1986. This step boosted economic growth in both countries mainly due to the inflow of structural funds, foreign direct investment, and gradual privatization of state monopolies along with deregulation of prices and markets. These economic "good times" proved short lived and ended in 1992-93 when most West European economies were caught in the midst of economic recessions and struggled to implement the provisions of the Maastricht Treaty, which imposed serious constraints on fiscal and monetary policies. The criteria to adhere to the European Monetary Union included: *"inflation over 12 months could not exceed by more than*

1.5 percentage points the average rate among the three EC countries with the lowest inflation; long-term nominal interest rates over 12 months could not exceed by more than 2 percentage points the average for the same three countries; the currency had to remain in the narrow band of the exchange rate mechanism for at least two years without devaluation; the budget deficit should not exceed 3 percent of GDP; and total public debt could not exceed 60 percent of GDP" (Maxwell *et al.*, 1994, p.51).

The Maastricht rules may have reduced the public sector deficit, but the decline in public investment in physical capital and research and development inhibited economic growth in both countries. On the other hand, the adhesion to the European single market in 1993 (i.e. free movement of labor, capital, goods and services), may have aggravated the European Monetary System's impact as it exposed domestic firms to increasing foreign competition. In fact, Gunther *et al.* (2004) advocate that these were the major causes for stagnation of Spanish productivity during the 1996-2001 period. Despite these deterrents, both countries experienced modest growth in the late 1990s, probably nourished by the continuing privatization of parastate industries and market deregulation. It is worth mentioning that Portugal was at the time one of the largest "privatizers" in the OECD, with revenues amounting to approximately 2.8, 4.7, 3.9, and 1.5 percent of GDP between 1996 and 1999 (Torres, 2000).

Most recently, between 2000 and 2003, a series of international adverse shocks impacted the Iberian Economies. These events included, for example, the international stock market crash in March of 2000, and a gradual increase in oil prices along with worsening terms of trade. Relatively, Portugal ended up worse off probably due to its higher degree of openness.

Based on this history, four regime changes were identified for the Iberian economies. First, in 1960, due to radical changes in industrial and foreign trade policies. Second, 1974 in

Portugal and 1975 in Spain, due to the social and economic turmoil and its repercussions. Third, in 1986 when European Community membership meant changes in domestic fiscal and monetary policies and massive inflows of structural funds. And fourth, in 1994, because of the European Single Market and EU entries and inherent domestic policy constraints.

These regime changes are also identified by other authors. Lopes (2004a) defines the period 1960-1973 as the Portuguese golden years and Blakanoff (1992) concludes that the 1974 Portuguese revolution marks the end of the exceptionally rapid economic growth and structural change initiated in 1960. Tortella (2000) indicates that 1960 was the beginning of an unprecedented growth period in Spain. Cheung and Chinn (1996), Fulvio (2001), and Escosura e Roses (2007), found that in 1975 there is a statistically significant break in the Spanish growth trend. Lopes (2004a) identifies the period 1986-94 as a complete business cycle for the Portuguese economy. Jimeno *et al*. (2006) point to 1986 has the year when there was a structural break in Spanish labor productivity growth, using a Sup-Wald test. Finally, Gunther *et al.* (2004) state that the Spanish economic expansion of the late 1980s came to an abrupt end by 1994 and was then followed by a strong recovery based on fiscal reform and influx of structural investment funds from the EU (2004).

2.4.2. Spain

Given the political and socioeconomic background, and the corroborating views of others, we now turn to assessing the postwar economic experiences in Spain and Portugal based on barriers to technology adoption during each regime outlined above. We begin by focusing on the Spanish experience. Using data from Maddison (2007), the 1945 Spanish output per worker was 21.63 percent of the U.S. level.[29] To initialize our model economy to this output level, the relative levels of physical and technological capitals were set at 15.66 and 11.76 percent, respectively. From this initial condition, the model was simulated several times in order to determined the levels of barriers that would allow the best fit to the observed based postwar Spanish experience.[30] Table 2.B. displays the implied levels of barriers and Figure 2.B shows the model's fit.

Figure 2.B Spain: Model's Fit

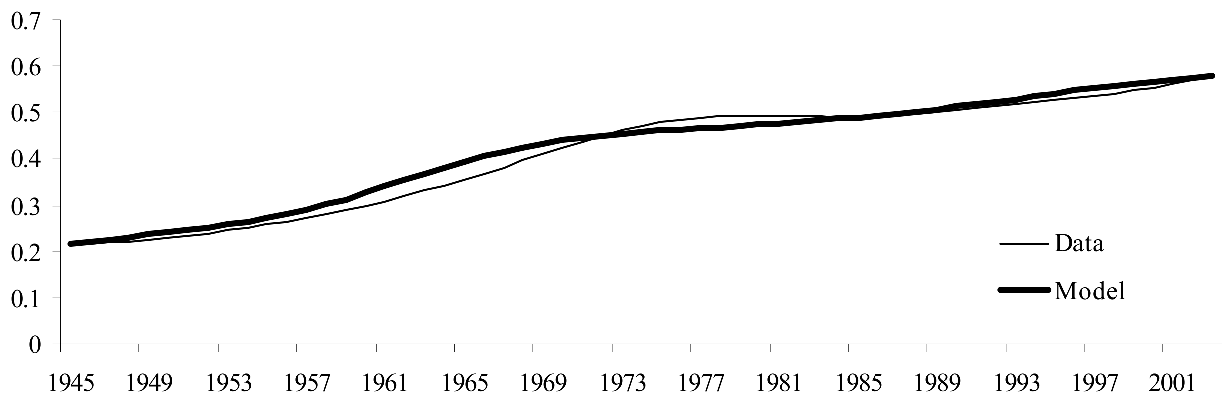


Table 2.B Level of Barriers in Spain

	π	$y^{Spain} / y^{U.S.}$
1945-1959	2.3377	0.2878
1960-1974	0.7741	0.4714
1975-1985	1.1191	0.4909
1986-1993	1.0731	0.5180
1994-2003	0.7849	0.5772

[29] As in Parente and Prescott (1994), both the Spanish, Portuguese and U.S. data were smoothed using the Hodrick-Prescott filter. We used a smoothing parameter of 100.

[30] Simulations were done using Gauss, version 8.0.

The simulation outcome is consistent with the observed economic path and the barriers show an expected pattern. After an initial high level of barriers, these decreased by 67.44 percent between 1960 and 1974. At this time, Spain was experiencing an average 7 percent growth in output per capita, and in particular, automobile production was increasing at an extraordinary pace of 22 percent per annum (Tortella, 2000). In fact, Tortella (2000) characterizes this period as the Spanish industrial revolution, and the automobile sector its leading source because it fostered the development of at least three additional industries: rubber production, iron and steel, and petroleum refining. In the mid 1970s, the social and economic turmoil linked to democratization decreased the ease of adopting new technologies and the barriers increased. Once the country stabilized and gained its EC membership in 1986, the barriers diminished slightly. But it was not until the post Single European Market and EU enforcement that the barriers to technology adoption returned to a level similar to that recorded during the 1960s.

2.4.3. Portugal

Again, using data from Maddison (2007), Portugal's 1945 output per worker was 19.21 percent of the U.S. level. Given the framework used in this essay, this is consistent with relative levels of physical and technological capitals of 13.11 and 11.10 percent, respectively. Next, using barrier parameters given in Table 3, the model was simulated. Figure 3 compares the simulation results with the observed data for the Portuguese economy.

Similar to the Spanish economy, Portugal had a high level of barriers to technology adoption immediately after WWII. This is not surprising since both dictatorships had protectionist policies in place and their industries were relatively uncompetitive. Changes in international trade policies associated with EFTA in 1960 and OECD entry in 1961, along with the success of "Foment Plans", radically transformed the Portuguese industry in the 1960s, leading to a 57.26 percent decrease in the barriers to technology adoption. The lower barriers associated with the 1960-73 period corroborate Parent and Prescott's (1994) conjecture that greater trade openness weakens deterrents to technology adoption. Nonetheless, this is a relatively lower decrease in barriers than the one captured for Spain. The reason might lie on the sources of growth, as Portugal did not have very many spillovers like the ones generated by the Spanish automobile industry.

Figure 2.C Portugal: Model's Fit

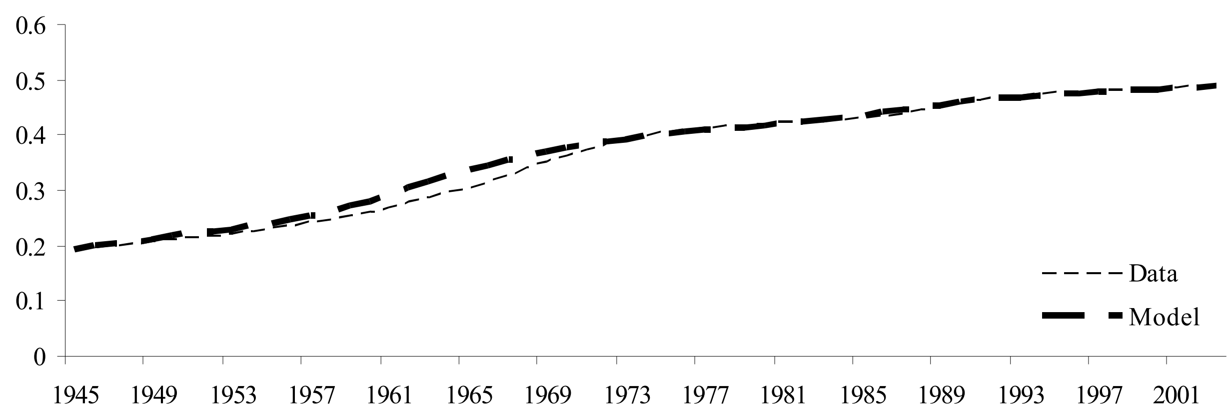


Table 2.C Level of Barriers in Portugal

	π	$y^{Spain} / y^{U.S.}$
1945-1959	3.0424	0.2537
1960-1974	1.3002	0.3917
1975-1985	1.4836	0.4294
1986-1993	1.2523	0.4702
1994-2003	1.3314	0.4876

Alas, the golden years were over by 1973. The international oil crisis and the social and economic repercussions of the "Carnation Revolution" were shocks in the 1970s that decreased firms' ability to adopt new technologies. As in the Spanish economy, Portugal's entrance in the European Community eventually lowered the barriers again. But, contrary to its neighbor, Portuguese barriers increased after 1994. The reason for this disparity might be due to the relatively lower ability of the Portuguese industry to adopt new technologies, given the scarcity of skilled workers. According to the World Development Indicators 2006, between 1993 and 2003, only 10 percent of the Portuguese labor force had tertiary education whereas in Spain this share accounted for 24 percent.

2.4.4. Recent Evidence of Barriers

Recently a number of sources have begun collecting data which can be used to infer barrier levels. Unfortunately, the data does not go back to 1945, so it is not possible to use it as a confirmation of the proposed barrier values over the entire interval. However, it does provide a useful snapshot of recent barrier experiences.

According to the World Bank Development Indicators database, in 2006 the percentage of managers surveyed that considered corruption as a major business constraint was 7.8 and 15.4 percent in Portugal and Spain respectively. This same survey found that the percentage of managers lacking confidence in courts to uphold property rights was 47.7 and 16.6 percent respectively and for overall court related issues that pose business constraints, 17.8 and 7.9 percent. This survey also found that crime was considered a barrier for 15.7 and 9.8 percent of the managers respectively.

Another indicator of the barriers to adopt new technologies might be the time required to enforce a contract. In Portugal the time is 320 days, while Spain is about half that at 169 days. In addition, the lower availability of R&D technicians in Portugal, 246 per million people on average between 1996 and 2003 versus Spain with 607, might dissuade technology adoption (WDI, 2006).

Worker strikes are another source that Parente and Prescott (1994) regard as a barrier to technology adoption. Data published by the European Industrial Relations Observatory in 2000, 2003 and 2005 indicates that Spain lost more working days than Portugal. Between 1997 and 2003, Spain lost an annual average of 176 days per 1000 employees whereas Portugal only 26 days. This created an upward pressure on the Spanish barriers to technology adoption but not sufficiently enough to offset the comparative advantage on the other barriers that comprise the total level of barriers.[31]

Finally, data published by the Global Entrepreneurship Monitor Reports is analyzed. In order to use these datasets, deterrents to entrepreneurship are loosely assumed as a proxy for barriers to technology adoption. In terms of access to venture capital, the Spanish perceived it to be better than the Portuguese, even though both considered it inadequate (De Castro *et al*., 2002). The survey averages were -0.94 for Spain and -1.10 for Portugal where very bad was coded -2.5, adequate was coded 0 and very good was coded 2.5. Another GEM measure of interest is the perceived adequacy of governmental programs in assisting new and growing firms. Again, Portugal scores lower than Spain, but the difference is rather small. However, both would be considered as slightly inadequate (Medina *et al*., 2001). On the other hand, when assessing the adequacy of governmental regulations the Spanish clearly perceived them better than the Portuguese, giving an average score of 0.42 and --0.82, respectively (De Castro *et al*., 2002).

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[31] It should also be noted that most of these lost days were related to "Accidents, health and safety", while Portuguese strikes were driven by "Pay" disputes, so to some extent this lopsided data may not be very reliable for indicating barriers.

Based on these recent sources, it is hard to argue that the level of barriers in the Iberian economies were largely different. However, they do mostly indicate that they are somewhat higher in Portugal than in Spain. More importantly, they indicate that both countries still need to reduce their barriers.

2.5. Conclusion

A new growth theory presented by Parente and Prescott (1994, 2000, 2005) suggests that countries may converge to different steady states due to barriers to technological adoption. This paper contributes to the existing literature because it applied this new theory to assess the Spanish and Portuguese development experiences in the post World War II period. Moreover, in order to get a model with closed form solutions a new formulation for the capital investment functions that accounted for an adjustment cost was imposed, as advocated by Lucas and Prescott (1971). This innovation on the Parente and Prescott's model resulted in an improved simulation exercise because it eliminated the concern about negative investment values.

The numerical experiments indicated that the barriers levels have been persistently higher in Portugal than in Spain. More importantly, the barriers levels of these countries have been positively correlated till 1993, when both joined the European Single Market. Afterwards, the barriers evolved in opposite directions, augmenting the disparity in output per worker among the Iberian economies. Finally, evidence was shown to corroborate the conjuncture that at least in recent years the barriers levels were higher in Portugal than in Spain.

We suggest that future research on the Iberian barriers should comprise an econometric study aimed at providing statistical evidence for the proposed levels of barriers and identifying the key deterrents in the process of adopting new technologies. Such work could provide additional elements to the growing body of work and ultimately support the elaboration of policy recommendations based on this barriers theory of economic growth. At this point, and to our knowledge, data availability remains the primary constrain for such work.

ESSAY 3 - Effective Tax Rates on Capital and Labor Income in the Post-dictatorship Iberian Economies

3.1. Introduction

We now turn to the analysis of fiscal policy in the Iberian growth and development experiences. Even though TFP has been the key engine of growth during the 1950-2004 period, changes in capital-output ratios and the employment rates cannot be neglected since changes in these ratios contributed to output's volatility. This essay investigates whether distortionary taxes on capital and labor income may have been a key factor behind the observed volatility on the path of factor inputs during the post-dictatorship era.

In Spain, the employment rate initiated a steep decline once the democratization process was initiated in 1975, only to stop upon adhesion to the European Community by 1986. Conversely, a dramatic increase occurred after joining the European Single Market in 1993. The Portuguese labor path was less turbulent, but despite the upward trend during the 1975-2004 period, it has also experienced several spikes. The capital input time path has been more stable in the Iberian countries with it showing an upward trend during the thirty years following the fall of the dictatorships, but nonetheless, both observed some cyclical spikes. One question we address here is: were the Iberian paths of factor inputs coincidental with changes in fiscal policy?

To have a better understanding of the Iberian tax policies and their relationship with the levels of factor inputs, it is important to go beyond the analysis of statutory taxes as these often provide insufficient insight about the rates actually paid. In this paper the analysis is focused on effective tax rates because those are the ones relevant for decisions related to productive activities, such as working and investing (Devereux, 2004).

In order to estimate the effective rates on labor and capital income, we use the workhorse of modern macroeconomics and adopt the methodology employed by Bergoing *et al*. (2002) to study the impact of tax reforms on the economic performance of Mexico and Chile during the

1980s. Despite the availability of several other frameworks to assess effective tax rates, the results inferred under different methods tend to be highly correlated overtime, though significantly different in terms of estimated levels (De Hann *et al.*, 2004).[32] Consequently, because the primary goal of this essay is to assess the potential relationship between fiscal policy (i.e. contractionary or expansionary) and the path of factor inputs, it is expected that other methods would lead to largely the same conclusions as the Begoing *et al.* (2002) approach used here.

The results presented in this essay corroborate the view that fiscal policy might have impacted the path of labor and capital in the Iberian economies. In addition, this study contributes to the existing literature by providing a set of estimated time series for effective tax rates on factor inputs in Spain and Portugal during the 1975-2004 period. However, the main contribution is the estimated changes in average effective tax rates on capital and labor income under several scenarios and the evidence that these are consistent with the changes in fiscal policy asserted in the literature.

The text is organized as follows. Section 3.2 introduces a Bergoing *et al.* (2002) type model with capital income taxes, the model is then calibrated and preliminary results for effective tax series on capital income are provided. The assessment of the results shows that this model is unable to capture the path of labor. Section 1.3 extends the model by adding a tax on labor income. Analysis of these results continues to show that the model does not fit very well. To remedy this, a model in which tax rates frequently change is investigated and the fit with the actual data is improved. In Section 1.4, the results of this latter model are connected to the

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[32] For other frameworks used to assess effective tax rates see Hall and Jorgenson (1967), King (1974); King and Fullerton (1984), Devereux (1987, 1989, 2003), Alworth (1988), Keen (1991), Mendoza, Razin, and Tesar (1994), and McKenzie, Mintz and Scharf (1997).

political and socioeconomic history and data on statutory taxes to investigate plausibility. The literature corroborates the estimated fluctuations in effective tax rates but the estimated levels are not fully supported. Section 3.5. concludes.

3.2. Model with only Capital Income Taxes

In this section we use a framework that Bergoing *et al.* (2002) suggested to assess the role of capital income taxes in Mexico and Chile during the 1980s. Our version of the model features a representative agent that has perfect foresight over the sequence of TFP shocks and chooses the optimal allocations of consumption, C_t, leisure, $N_t - L_t$, and investment, I_t, in order to maximize the following utility function

$$\sum_{t=1975}^{\infty} \beta^t \{\gamma \ln C_t + (1-\gamma)\ln(N_t - L_t)\}, \tag{3.1}$$

subject to a budget constraint given by

$$C_t + K_{t+1} - K_t = w_t L_t + (1-\tau_t^k)(r_t - \delta)K_t + T_t, \tag{3.2}$$

an initial capital endowment, K_{1975}, and non-negativity constraints on consumption, denoted by C_t. The parameters are constrained so that 0<β<1, 0<γ<1, and 0< δ <1 where β stands for the discount factor, γ represents relative preferences for consumption and leisure, and δ is the depreciation rate. In this setup we have denoted the total number of hours available for work and leisure by N_t and used L_t to denote the actual number of hours worked. In the budget constraint, K_t denotes capital at time t, τ_t^k is the effective tax rate on capital, w_t is the wage rate, r_t is the rental rate, and T_t is a lump-sum transfer. It is assumed that the government refunds all tax collections, hence

$$T_t = \tau_t^k (r_t - \delta) K_t . \tag{3.3}$$

Firms hire labor and rent physical capital through competitive markets and have a standard Cobb-Douglas production function with constant returns to scale, $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$, where Y_t is total output, A_t is total factor productivity (TFP), and α is the output elasticity with respect to the capital stock. Competitive markets for capital and labor imply that wages and rental rates equal their marginal products and are given by

$$w_t = (1-\alpha)\frac{Y_t}{L_t}, \tag{3.4}$$

and

$$r_t = \alpha \frac{Y_t}{K_t} . \tag{3.5}$$

Substituting (3.3), (3.4) and (3.5) into (3.2) implies that in equilibrium the feasibility constraint simplifies to

$$C_t + I_t = A_t K_t^{\alpha} L_t^{1-\alpha} , \tag{3.6}$$

where $I_t = K_{t+1} - (1_t - \delta) K_t$ and denotes investment spending at time t.

Based on the above, given K_{1975}, A_t and N_t, the competitive equilibrium consists of prices $\{r_t, w_t : t \geq 0\}$, fiscal policy $\{t_t^k, T_t : t \geq 0\}$, and allocations $\{K_{t+1}, L_t, Y_t, C_t, I_t : t \geq 0\}$, such that:

1. Agents optimize:

i. Given $\{r_t, w_t, t_t^k, T_t, N_t : t \geq 0\}$ and K_{1975}, the allocations $\{K_{t+1}, L_t, C_t, I_t : t \geq 0\}$ solve the consumer's optimization problem.

ii. Given $\{r_t, w_t, A_t : t \geq 0\}$, the allocations $\{K_t, L_t, Y_t : t \geq 0\}$ solve the firms's optimization problem.

2. Markets clear:

i. Goods market: $C_t + I_t = Y_t$, for t = 0,1,...

ii. Labor market: $L_t = L_t$, for t = 0,1,...

iii. Capital market: $K_t = K_t$, for t = 0,1,...

3. The government budget constraint holds:

$T_t = \tau_t^k (r_t - \delta) K_t$, for t = 0,1,...

The competitive equilibrium in this case can be computed simply by solving the feasibility condition (3.2) for C_t and replacing it in the utility function (3.1) to get

$$\sum_{t=1975}^{\infty} \beta^t \left\{ \gamma \ln\left(w_t L_t + \left[(1 - \tau_t^k)(r_t - \delta) + 1 \right] K_t - K_{t+1} + T_t \right) + (1 - \gamma) \ln\left(N_t - L_t \right) \right\}, \qquad (3.7)$$

and then taking the first order conditions with respect to labor and capital to get

$$\frac{\partial U_t}{\partial L_t} : \frac{C_t}{C_t + w_t (N_t - L_t)} - \gamma = 0, \qquad (3.8)$$

and

$$\frac{\partial U_t}{\partial K_{t+1}} : \frac{C_t}{C_{t-1}} - \beta \left[(1 - \tau_t^k)(r_t - \delta) + 1 \right] = 0. \qquad (3.9)$$ [33]

Note that the capital income tax shows up in one of the optimality conditions for the representative agent, hence it has a distortionary effect because it alters the margins that

[33] Technically the capital derivative corresponds to the derivative with respect to K_t, but because first order conditions hold at all dates, we can write it as given here.

determine capital decisions. This implies that fiscal policy may change the allocations of factor inputs and thus aggregate output.

3.2.1. Calibration

In order to conduct numerical simulations the model is calibrated analogously to Bergoing *et al.* (2002). The discount factor, β, is set equal to 0.98 and the depreciation rate, δ , is set equal to 5 percent for both countries. The output elasticity parameter α was set at 0.3. These are values widely used in macroeconomic analysis. Simulations are based on data for Y_t, C_t, and I_t during the 1950-2004 period which were collected from the Penn World Table (2006).[34] Because the focus is on short run fluctuations, these data were detrended using a common 2% growth rate. To obtain a capital series the expression $K_{t+1} = (1_t - \delta)K_t - I_t$ was used starting from a K_{1950} value obtained from Nehru and Dhareshwar (1993) for Spain and Portugal, respectively. Data on N_t and L_t were collected from the Groningen Growth and Development Centre's Total Economy Database (2008). Given α, K_t, L_t, and Y_t, the production function can be used to compute a series for A_t. This series was then detrended at 1.4% per year because, in balanced growth, if output and capital per worker are assumed to grow at 2% per year, then TFP would have to grow at $1.02^{1-0.3} = 1.014$.

To calibrate γ, data for individual countries were used. First, the equilibrium real wage rate condition (3.4) was substituted into the condition for labor (3.8). Next, observed values for Y_t, C_t, L_t and N_t were used to compute annual values for γ during the 1950-1975 period. These

[34] Calibrated similarly to Essay 1.

values were then averaged for each country. This procedure resulted in γ equal to 0.6427 in Portugal and 0.6416 in Spain. Similarly, initial guesses for the effective tax rate on capital income, τ_t^k, were computed by first substituting the real rental rate condition (3.5) into the first order condition for capital (3.9) and setting β, δ, α, and K_t to the previously calibrated values. Next, observed values for Y_t and C_t were used to estimate an annual series for τ_t^k during the 1950-1975 period. Then these series were averaged and the guesses for τ_t^k set at 0.4524 for Spain and 0.4271 for Portugal.

Finally, the numerical experiments were conducted by using K_{1975}, C_{1974}, the parameters described above, along with the time series for A_t and N_t, and then solving for the competitive equilibrium levels of K_{t+1}, L_t, and C_t using (3.6), (3.8), and (3.9). Given the model estimates for K_{t+1}, L_t, and C_t, the guesses for τ_t^k were reset based on an endogenous computational approach so that the model would match the observed levels of employment rates and capital-output ratios.

The simulation exercises were programmed for a length of sixty-years, from which the first thirty corresponding to 1975-2004 period were the focus of our analysis. The additional years were included in order to insure that the equilibrium values during the period of interest are not influenced by the agent's willingness to consume all his resources in the last period simulated.

3.2.2. The Implied Capital Tax Rates

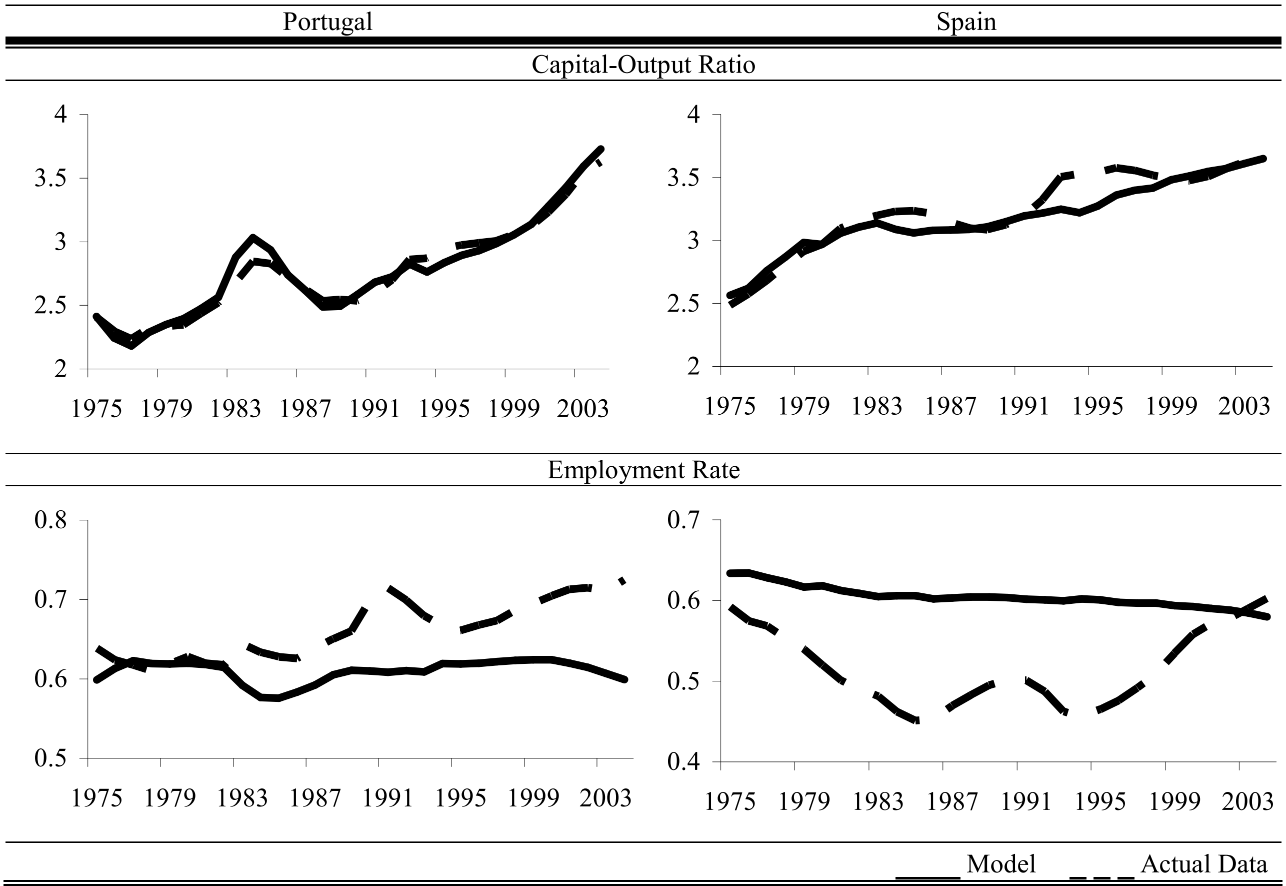
In order to assess the fit of the model to the Iberian economic data, the approach used in Essay 1 was adopted. In particular, two regime changes for taxes were posited. These regimes were separated by 1986, the date when European Community membership meant changes in domestic fiscal and monetary policies and massive inflows of structural funds, and 1994, the date when European Single Market and EU entries led to relevant domestic policy constraints.[35] Imposing these regimes on the numerical experiments ensured an exercise where the levels of the effective tax rate on capital income would enable each economy to achieve the observed capital-output ratios and employment rates.

Figure 3.A. shows the computed capital-output ratio and the employment rate results for the period of interest in Spain and Portugal. The figure below shows that the model produces a fairly good fit for the Portuguese capital-output ratio but is not so accurate in the Spanish case. For Portugal, the main weakness is a small underestimate during the 1983-1987 period and a small overestimate between 1994 and 1999. For Spain, the fit is worse with the model frequently underestimating the capital-output ratio.

For the employment rates, the model's fit is quite poor for both countries. Despite the fairly good fit for the 1977-1983 period, the model underestimates it in the subsequent periods by a considerable margin In contrast, the model's results for the Spanish employment rate are significantly overestimated (and quite inelastic) for most of the simulated period.

[35] Based on Blakanoff (1992), Cheung and Chinn (1996), Tortella (2000), Fulvio (2001), Gunther *et al.* (2004), Lopes (2004a), Jimeno *et al.* (2006), Escosura and Roses (2007).

Figure 3.A Simulation Results for the Model with only Capital Income Taxes



The average effective capital income taxes associated with each of the three regimes is summarized in Table 3A. This table shows a steadily increasing tax rate in Spain that reaches 75 percent in the later period and a hump shaped pattern for Portugal which has a peak tax rate of 75 percent in the middle period.

Table 3.A Effective Tax Rates on Capital Income

	Portugal	Spain
1975	0.427	0.150
1986	0.750	0.550
1994	0.500	0.750

Because the fit for the capital-output ratios and employment rate were not very good, a labor income tax was added to the baseline model to see if this might improve the performance. This addition is explored in the next section. Such an addition seems like a reasonable possibility because the employment data in Figure 3.A appear to be somewhat elastic given the large swings, which could perhaps be due to a distortionary tax on labor income.

3.3. Model with both Capital and Labor Income Taxes

In this section, the previous model is modified by the inclusion of labor income taxes. In the following description the focus is mostly on this change. Adding an income tax only alters the formulation of the consumer's problem and the government budget constraint. The corporate sector structure is unaffected. Furthermore, the utility function is still given by (3.1). The only change in the consumer problem occurs in the budget constraint which is modified to

$$C_t + K_{t+1} - K_t = (1-\tau_t^l) w_t L_t + (1-\tau_t^k)(r_t - \delta) K_t + T_t, \tag{3.10}$$

where τ_t^l is the effective tax on labor income. The government budget is also modified so that the lump sum tax rebate, T_t, is now given by

$$T_t = \tau_t^l w_t L_t + \tau_t^k (r_t - \delta) K_t . \tag{3.11}$$

The competitive equilibrium for this economy is defined as follows. Given K_{1975}, A_t and N_t, the competitive equilibrium is prices $\{r_t, w_t : t \geq 0\}$, fiscal policy $\{t_t^l, t_t^k, T_t : t \geq 0\}$, and allocations $\{K_{t+1}, L_t, Y_t, C_t, I_t : t \geq 0\}$, such that:

1. Agents optimize:

i. Given $\{r_t, w_t, t_t^l, t_t^k, T_t, N_t : t \geq 0\}$ and K_{1975}, the allocations $\{K_{t+1}, L_t, C_t,$ $I_t : t \geq 0\}$ solve the consumer's optimization problem.

ii. Given $\{r_t, w_t, A_t : t \geq 0\}$, the allocations $\{K_t, L_t, Y_t : t \geq 0\}$ solve the firms's optimization problem.

2. Markets clear as stipulated in the previous model.

3. The government budget constraint holds:

$T_t = \tau_t^l w_t L_t + \tau_t^k (r_t - \delta) K_t$, for t = 0,1,...

The competitive equilibrium is now computed by solving the feasibility condition (3.10) for C_t and replacing it in the utility function (3.1) to get

$$\sum_{t=1975}^{\infty} \beta^t \left\{ \gamma \ln\left((1-\tau_t^l) w_t L_t + \left[(1-\tau_t^k)(r_t - \delta) + 1 \right] K_t - K_{t+1} + T_t \right) + (1-\gamma) \ln\left(N_t - L_t \right) \right\}, \tag{3.12}$$

and solving the first order conditions with respect to labor and capital to get

$$\frac{\partial U_t}{\partial L_t} : \frac{C_t}{C_t + (1-\tau_t^l) w_t (N_t - L_t)} - \gamma = 0, \tag{3.13}$$

and

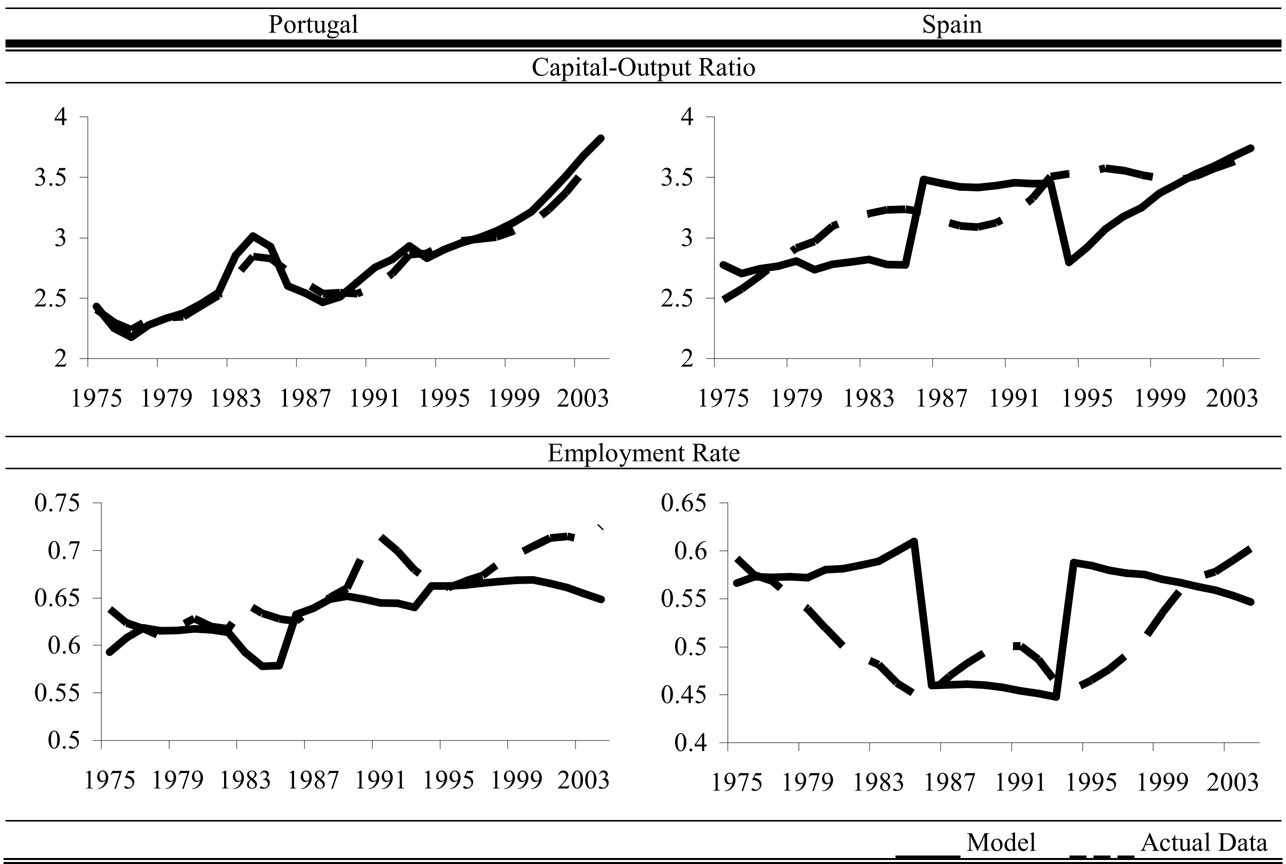
$$\frac{\partial U_t}{\partial K_{t+1}} : \frac{C_t}{C_{t-1}} - \beta\left[(1-\tau_t^k)(r_t - \delta) + 1 \right] = 0. \tag{3.14}$$

Because capital and labor income taxes impact the optimality conditions, they play a role in the agent’s decision-making process and generate a distortionary effect on the decisions for K_{t+1} and L_t. In what follows we adopted an endogenous computational approach, only this time, guesses for τ_t^l are computed too following a calibration procedure similar to the one used for τ_t^k. Specifically, guesses for τ_t^l were computed by substituting the real wage rate condition (3.4) into the first order condition for labor (3.13) and using the previously calibrated values for γ in each country along with the observed values for C_t, Y_t, N_t and L_t during 1950-1975.

3.3.1. The Implied Capital and Labor Tax Rates

In the following analysis, the same parameter calibration from the earlier analysis was used as were K_{1975}, C_{1974}, and the series for A_t and N_t. The numerical experiment was similar only this time τ_t^l was also computed. These results are shown in Figure 3.B.

Figure 3.B Simulation Results for the Model with Capital and Labor Income Taxes



In the case of Portugal, the fit has somewhat improved because besides the fairly good job in tracing capital-output ratios, the ability to match the actual unemployment rate has improved. The model's fit for Spain has not improved with the addition of labor income taxes. Figure 3.B shows that there is a clear trade off between the ability of capturing the capital-output ratios and the unemployment rate when imposing only three fiscal regimes. In fitting the model to the lower rates of employment by 1987, there has been a decrease in the model's ability to capture the capital-output ratio over the entire period. As in the model with no labor income tax, the main divergence between the simulated and the actual data arises in the employment rate.

Table 3.B shows the effective income taxes on capital and labor income associated with the simulations displayed in the figure above. The capital income tax for Portugal continues to show a hump shaped pattern, with the middle period displaying the highest tax rate. However, the peak rate is lower, at 56 percent, than in the previous model without labor income taxes. In addition, the model estimates labor income subsidies rather than taxes during the 1986-1975 period. For Spain, the model estimates a steadily decline in capital income taxes instead of the previous increase. In relation to labor, taxes follow a hump shaped pattern which has a peak tax rate of 42 percent in the middle period.

Table 3.B Effective Tax Rates on Capital and Labor Income

	Portugal		Spain	
	Capital	Labor	Capital	Labor
1975	0.470	0.010	0.700	0.100
1986	0.560	-0.140	0.500	0.420
1994	0.500	-0.200	0.480	0.150

Because of the poor fitting performance, the next section investigates the hypothesis that taxes were allowed to change on an annual basis rather than having only three regimes as in the previous analysis.

3.4. Exploiting the Conjuncture of Annual Tax Rates

Although this conjuncture may sound controversial in other contexts, it could be the case that fiscal policy changed frequently in the Iberian economies during the post-1974 period. For instance, Portugal initiated a democratization process in mid 1974. The Carnation Revolution led to a rise in state monopolies, frequent changes in a range of policies and a long period of governmental instability: six provisional governments in the first two years of the post-dictatorship period and eight constitutional governments over the 1976-83 period.[36] The 1981-83 currency crisis and the intervention by the IMF required significant constraints in fiscal and monetary policies. By 1986, EC membership also implied continuous policy changes, for example, membership required deregulation of prices, market liberalization (such as massive privatizations in during the 1989-99 period), and the 1988 tax reform which was the most comprehensive since the 1960s. In addition, adhesion to the European Single Market and E.U. in 1993, promoted ongoing tax competition across E.U. members. And, the long process of conversion to the euro currency, initiated by the 1992 Maastricht Treaty, imposed another series of fiscal and monetary constraints, associated with adopting the euro as an accounting unit in 1999 and to have the currency in circulation by 2002.

[36] See Appendix A.

Spain followed a similar tumultuous experience over this period of time. The death of Franco in November 1975 initiated the democratization process and numerous policy changes. In the early years, the key landmarks were the 1976 law on political reform, 1977 tax reform, and the 1979 EFTA agreement. Despite a short period of relative stability in governing, Tejero's failed coup d'état in 1981 uncovered the political and social fragilities of the young democracy. After 1986, the frequency and nature of policy changes in Spain were similar to those just outlined for Portugal as both joined the E.C., E.U., European Single Market, and Eurozone at the same time.

Because the 1975-2004 period was characterized by significant changes in the Iberian fiscal and monetary policies, it seems reasonable to explore a model with frequent changes on the effective tax rates.

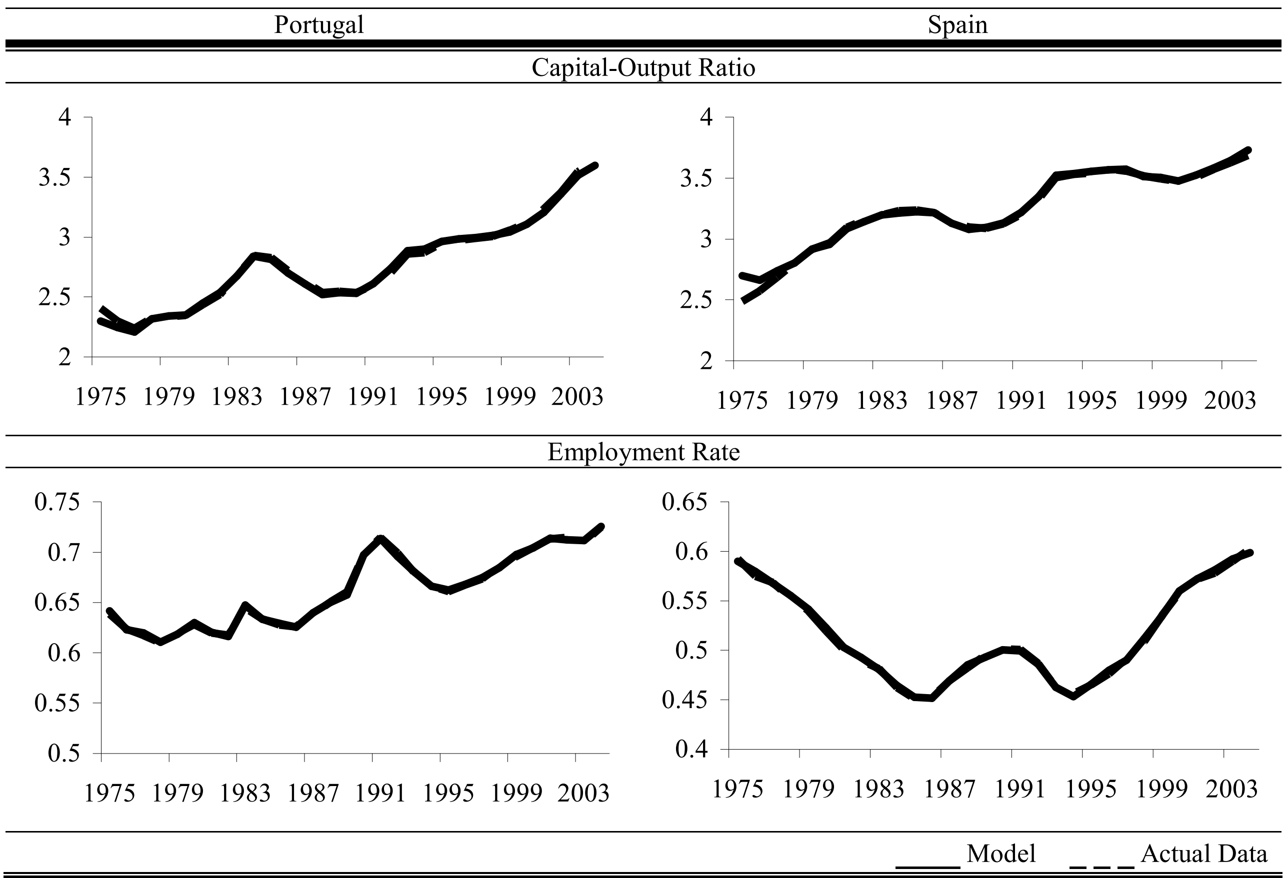
3.4.1. The Implied Annual Capital and Labor Tax Rates

The simulation results associated with annual effective tax rates are displayed in Figure 3.C. The figure shows that allowing annual changes in the average effective tax rates on labor and capital income results in a significant improvement in the model's fit. The only area in which the fit has trouble is for the first three periods.

The effective tax rates associated with the fit portrayed in Figure 3.C. are presented in Table 3.C. Again the capital tax for Portugal follows a hump shaped pattern with the highest rate of 61 percent occurring in 1994. For labor income the model estimates a series of subsidies instead of taxes, except for 1978. The 1978-1982 estimates for labor subsidies are close to nil, and then range around 13 to 20 percent of labor income during the 1983-1989 period.

Thereafter, the subsidies stay above 24 percent, reaching a first peak in 1991 (51 percent) and a second higher peak by 2004 (65 percent).

Figure 3.C Simulation Results for the Model with Annual Capital and Labor Income Taxes



For Spain, as shown in Table 3.C, the model estimates a decreasing pattern for capital income taxes during the period of interest, evolving from 94 percent in 1979 to 1 percent by 2004. In relation to labor income, the estimated tax series exhibits two consecutive hump shapes. The first reaches its peak at 45 percent in 1985 and 1986 whereas the second wave hits a peak of 46 percent by 1994. Interestingly, similar to the capital series, the labor income tax achieves its lower values in the post-2000 period, reaching a 5.5 percent bottom by 2004.

Table 3.C Annual Effective Tax Rates on Capital and Labor Income

	Portugal		Spain	
	Capital	Labor	Capital	Labor
1975	0.310	-0.160	0.990	-0.030
1976	0.420	-0.050	2.100	0.040
1977	0.480	-0.010	1.028	0.140
1978	0.470	0.010	0.850	0.200
1979	0.470	-0.016	0.940	0.237
1980	0.500	-0.050	0.800	0.310
1981	0.500	-0.020	0.740	0.340
1982	0.500	-0.015	0.540	0.370
1983	0.500	-0.200	0.750	0.380
1984	0.480	-0.200	0.360	0.430
1985	0.460	-0.170	0.440	0.450
1986	0.450	-0.130	0.430	0.450
1987	0.450	-0.160	0.420	0.430
1988	0.460	-0.170	0.590	0.410
1989	0.470	-0.200	0.620	0.390
1990	0.530	-0.410	0.590	0.380
1991	0.570	-0.510	0.570	0.390
1992	0.565	-0.420	0.560	0.410
1993	0.600	-0.360	0.465	0.450
1994	0.610	-0.260	0.510	0.460
1995	0.580	-0.240	0.610	0.450
1996	0.530	-0.260	0.300	0.420
1997	0.520	-0.280	0.100	0.390
1998	0.520	-0.320	0.300	0.350
1999	0.520	-0.380	0.170	0.290
2000	0.490	-0.415	0.267	0.230
2001	0.510	-0.500	0.190	0.180
2002	0.510	-0.500	0.200	0.160
2003	0.510	-0.530	0.130	0.120
2004	0.470	-0.650	0.010	0.055

3.4.1.1. Testing for Unit Roots and Structural Breaks in the Simulated Tax Series

To further scrutinize the possibility of significant annual changes in the Iberian fiscal policies, this section uses the estimated tax series for capital and labor income to investigate implications of the series empirically. The framework described in Enders (2004) is employed to assess the presence of deterministic regressors while the tests for structural breaks are based on the methodology outlined in Maddala (2001). Succinctly, we begin by determining the appropriate number of differenced dependent variable terms that should be included in each tax series model.[37] In addition, we plot the tax series outlined in Table 3.C to speculate if a drift, a drift and a trend, or none should be added to the econometric model. However, to avoid misspecification, we initiate the unit root assessment with the most general of models. Next, the Augmented Dickey-Fuller (ADF) test is implemented (or the simple Dickey-Fuller test if the regression does not include lagged differences) and the resulting ADF test statistic is used to determine if the null hypothesis can be rejected, i.e. if we can dismiss the possibility that the tax series follows a unit root process. Failing to reject the null suggests that the series is nonstationary.[38] The final step to econometrically support the conjuncture of significant annual changes in the Iberian fiscal policies comprises Chow tests on each nonstationary tax series to identify a set of potential years in which there were changes in fiscal regime.[39]

We begin with the test for unit roots (i.e. nonstationarity) for the Portuguese tax series. To illustrate the concept of unit root, assume the following AR(1) process

$$y_t = a_0 + \theta\, y_{t-1} + \varepsilon_t\,, \tag{3.15}$$

where a_0 (drift) and θ are the parameters to be estimated, ε_t is assumed to be white-noise, and t stands for the time period. The series (y) is assumed to be stationary if -1< θ <1 because, for example, when θ =1 the variance of y increases with time and converges toward infinity (i.e. a random walk plus drift). Hence, a series is said to be stationary if we can reject the null hypothesis, H_0: θ =1 (against H_1: θ <1), which is equivalent to test H_0: γ = 0 (against H_1: γ <0) if we subtract y_{t-1} from both sides of the equation (3.15),

[37] See Enders (2004), p. 191-4.

[38] See Enders (2004), p. 210-4.

[39] See Maddala (2001), p. 173-5 and 313.

$$\Delta y_t = a_0 + \gamma \ y_{t-1} + \varepsilon_t , \tag{3.16}$$

where Δy_t is equal to $y_t - y_{t-1}$, and γ = 0 only if θ =1. However, the assessment of unit roots is far more complicated if the series is correlated with higher order lags and/or if it has a time trend. In order to contemplate all possible scenarios we adopt the methodology described in Enders (2004), and therefore we begin by assuming the most general of models

$$\Delta y_t = a_0 + \gamma \ y_{t-1} + a_2 \ t + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t , \tag{3.17}$$

where ρ is the number of lagged differences of the dependent variable to be included in the regression, and a_0, γ, a_2, β_i are the parameters to be estimated.

A potential problem associated with the use of the general model is the inclusion of irrelevant variables because these reduce the power of the test. On the other hand, for example, if we do not include enough lags, the regression residuals do not behave like white-noise. Consequently, the model will not capture the actual error process and therefore the parameters and the respective standard errors will not be estimated correctly. To avoid these issues we need to determine the appropriate number of lags to be included (ρ). Enders (2004) recommends the estimation of

$$\Delta y_t = a_0 + \gamma \ y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t , \tag{3.18}$$

with a relatively long lag length and to sequentially reduce the number of lags using the *t*-test. The appropriate lag length is identified when the last lag included in the regression becomes significantly different than zero. Applying this procedure to the Portuguese tax series for capital and labor income suggests that the proper lag length is equal to 1 and zero, respectively.[40] The detailed statistical results are displayed in Appendix C. The estimated regression for the tax series on capital income yields

$$\underset{}{\Delta y_t} = \underset{(0.0479)}{0.0933} - \underset{(0.0941)}{0.1857\, y_{t-1}} + \underset{(0.1361)}{0.3445\,\Delta y_{t-1}} + \varepsilon_t, \qquad \text{RSS} = 0.0127 \tag{3.19}$$

where SSR stands for the sum of the squared residuals for this model. The results indicate a *t*-statistics of 2.53 for β_1, hence the coefficient is significantly different than zero at the 95 percent confidence level ($t_{critical}$ for 25 degrees of freedom is 2.048). For the Portuguese tax series on labor income, the results are given by

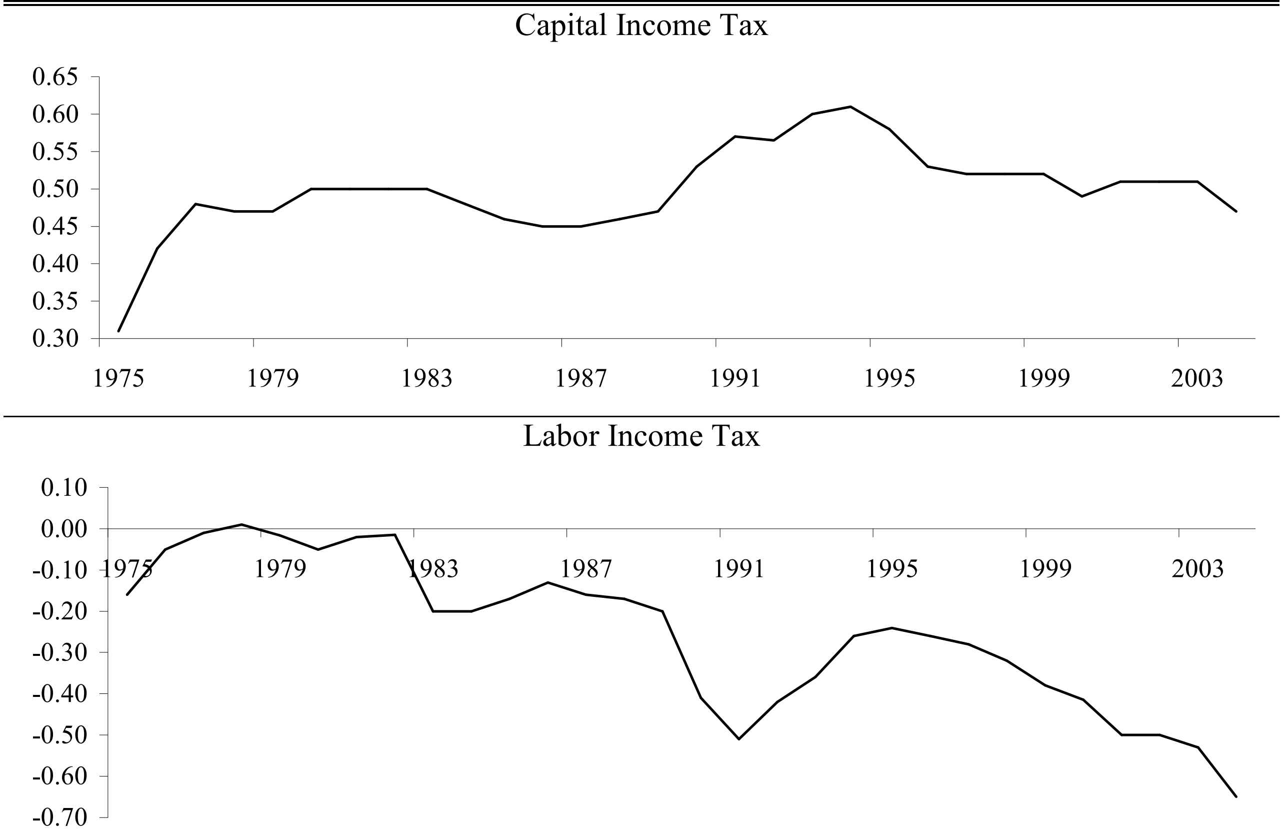
$$\Delta y_t = \underset{(0.0235)}{-0.0311} - \underset{(0.0832)}{0.0580\, y_{t-1}} + \underset{(0.1971)}{0.3271\,\Delta y_{t-1}} + \varepsilon_t, \qquad \text{RSS} = 0.1228 \tag{3.20}$$

therefore we were unable to reject the null that β_1 is significantly different than zero, given that its *t*-statistics is equal to 1.66.

The next step comprises the graphical analysis of the data. The plots of the estimated levels of capital and labor income taxes displayed in Table 3.C are shown in Figure 3.D. The graph for capital income tax seems to indicate that there is no deterministic trend but it is not very helpful to assess the presence of a drift over the entire period, particularly due to the post-1995 path. The plot for the Portuguese labor income tax suggests the presence of a drift and a negative time trend over the entire period. Given that the graphical analysis does not guarantee avoidance of misspecification, we proceed using the most general of models (3.17) as suggested by Enders (2004).

[40] We initiated the exercise with a lag length equal to 6 (a relatively long number of lags since we are investigating annual tax series).

Figure 3.D Annual Effective Income Taxes in Portugal



The estimation of the unrestricted model (3.17) for the Portuguese tax series on capital income yields[41]

$$\underset{}{\Delta y_t} = \underset{(0.0517)}{0.0958} - \underset{(0.1108)}{0.1941}\, y_{t-1} + \underset{(0.0007)}{0.0001}\, t + \underset{(0.1487)}{0.3525}\, \Delta y_{t-1} + \varepsilon_t, \qquad \text{SSR} = 0.0126 \tag{3.21}$$

and therefore we are unable to reject the null that γ is significantly different than zero because its *t*-statistics is equal to -1.75 and the τ_τ critical value is -3.60 for a 95 percent confidence level.[42] Consequently, we need to test if $a_2 = 0$ given $\gamma = 0$ (i.e. if the time trend should be

[41] The detailed estimation results are shown in Appendix C.

[42] The empirical cumulative distribution of τ is given in Enders (2004), p. 439.

excluded given that the series follows a unit root process). To do so, we first have to estimate the restricted model,

$$\Delta y_t = a_0 + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t , \tag{3.22}$$

in order to compute the following ϕ-statistic

$$\phi_i = \frac{\dfrac{SSR(restricted) - SSR(unrestricted)}{r}}{\dfrac{SSR(unrestricted)}{T-k}} , \tag{3.23}$$

where r is the number of restrictions being tested, T is the number of usable observations, k the number of parameters estimated in the unrestricted model, and i = 1, 2, 3. ϕ_1 is used to test H_0: $a_0 = \gamma = 0$, ϕ_2 is used to test H_0: $a_0 = \gamma = a_2 = 0$, and ϕ_3 is used to test H_0: $\gamma = a_2 = 0$. Estimating (3.22) gives

$$\begin{array}{llll} \Delta y_t = -0.0311 & + \; 0.3758\,\Delta y_{t-1} & + \varepsilon_t , & \\ \quad\;\; (0.0009) & \quad (0.1425) & & SSR = 0.0146 \end{array} \tag{3.24}$$

hence ϕ_3 = 1.8836, based on the SSR values from (3.21) and (3.24), r = 2, T = 28, and k = 4. Since the empirical distribution of ϕ_3 indicates a critical value is 7.24, we fail to reject H_0: $\gamma = a_2 = 0$ at the 95 percent confidence level.[43] Consequently we proceed by estimating a new (unrestricted) model which does not include a time trend,

$$\Delta y_t = a_0 + \gamma \; y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t . \tag{3.25}$$

The statistical results derived from applying (3.25) on the Portuguese tax series for capital income are identical to those shown in (3.19), and therefore we are not able to reject the

[43] The empirical distribution of ϕ_i is given in Enders (2004), p. 440.

null that γ is significantly different than zero because its *t*-statistics is equal to -1.97 and the τ_μ critical value is -3.00 (for a 95 percent confidence level).[44] Next, we need to examine if the drift (a_0) should be removed from our model. This can be assessed by testing if a_0 = 0 given γ= 0. Hence, we estimated the following restricted model on the Portuguese data for capital income tax

$$\Delta y_t = \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t \,, \tag{3.26}$$

to get

$$\underset{}{\Delta y_t} = \underset{(0.1365)}{0.3696}\,\Delta y_{t-1} + \varepsilon_t \,. \qquad \text{SSR} = 0.0147 \tag{3.27}$$

Using the SSR values from (3.19) and (3.27), r = 2, T = 28, and k = 3, we found ϕ_1= 1.9690. By comparing the latter value with the ϕ_1 critical value of 5.18 for a 95 percent confidence level, we fail to reject H$_0$: a_0= γ= 0. Based on all of the above, the final step to assess the presence of a unit root in the time series for the Portuguese capital income tax is to test if γ= 0 in the following model

$$\Delta y_t = \gamma \; y_{t-1} + \sum_{i=1}^{\rho} \beta_i \Delta y_{t-i} + \varepsilon_t \,. \tag{3.28}$$

Estimating (3.28) yields

$$\Delta y_t = \underset{(0.0090)}{-\,0.0033}\, y_{t-1} + \underset{(0.1419)}{0.3806}\,\Delta y_{t-1} + \varepsilon_t \,, \qquad \text{SSR} = 0.0146 \tag{3.29}$$

[44] The empirical cumulative distribution of τ is given in Enders (2004), p. 439.

and consequently we are able to conclude that the series for capital income taxes in Portugal follows a unit root process because the *t*-statistics for γ is -0.37, which is lower (in absolute value) than the τ critical value of -1.95, at a 95 percent confidence level.

Following a procedure similar to the one just outlined, we concluded that the tax series for the Portuguese labor income tax also follows a unit root process, with a 95 percent confidence level (the statistical results are shown in Appendix C).

Finally, the Chow tests were conducted to identify structural breaks in each of the Portuguese tax series. These tests can be conducted based on two different procedures, the dummy variables test or the sum of squares test - both lead to similar *F*-statistics values. Here we adopt the latter procedure. Briefly, the methodology employs the first n_1 observations to estimate the regression equation and applies it to predict the following n_2 observations.[45] If $n_2>1$, we can use the following F-test to assess structural breaks

$$F = \frac{\dfrac{RRSS - RSS1}{n_2}}{\dfrac{RSS1}{n_1 - k - 1}}, \tag{3.30}$$

where RRSS is the residual sum of squares from the regression based on $n_{1+}\ n_2$ observations, and RSS_1 stands for the residual sum of squares from the regression based on n_1 observations. In addition, we can also use the log-likelihood ratio statistic to conduct the test for the structural breaks. This latter statistic is computed by comparing the restricted and unrestricted maximum of the log likelihood function.[46]

[45] See Maddala (2001), p. 173-5.

[46] Both use the whole sample but the unrestricted includes a dummy variable for the years of interest.

Based on this simple Chow test for structural breaks, the results suggest that the capital income tax series has potential structural breaks in 1979, 1983, 1986, 1988, 1991, 1993, 1995, 1997, and 2000 with a 95 percent confidence level according to the *F*-statistic results (probability = 0.047) and 99 percent when using the log likelihood ratio (probability = 0.000).[47] For labor income tax, the Chow test indicates probable breaks in 1980, 1983, 1986, 1989, 1992, 1995, 1998, and 2002 with a 95 percent confidence level using the *F*-statistic (probability = 0.026) and 99 percent using the log likelihood ratio (probability = 0.000). Therefore, the econometric tests provide additional support to the conjuncture of frequent changes in the Portuguese fiscal regime during the 1975-2004 period.

A similar econometric study was elaborated for the effective tax series in Spain.[48] The procedure to select the appropriate lag length (ρ) for the differenced dependent variable terms suggests the inclusion of two lags in the econometric model for the capital income tax series and one lag in the labor income tax model. The visual inspection of each income tax series, Figure 3.E (plotted using data from Table 3.C), seems to reveal that an econometric model for the capital income tax should include a drift and a trend given the declining path during the overall period, whereas the time path of the estimated labor income tax signals the presence of an upward trend from 1975 to 1986 and a downward trend during the post-1995 period, therefore suggesting that a drift and trend should be included in the econometric model.

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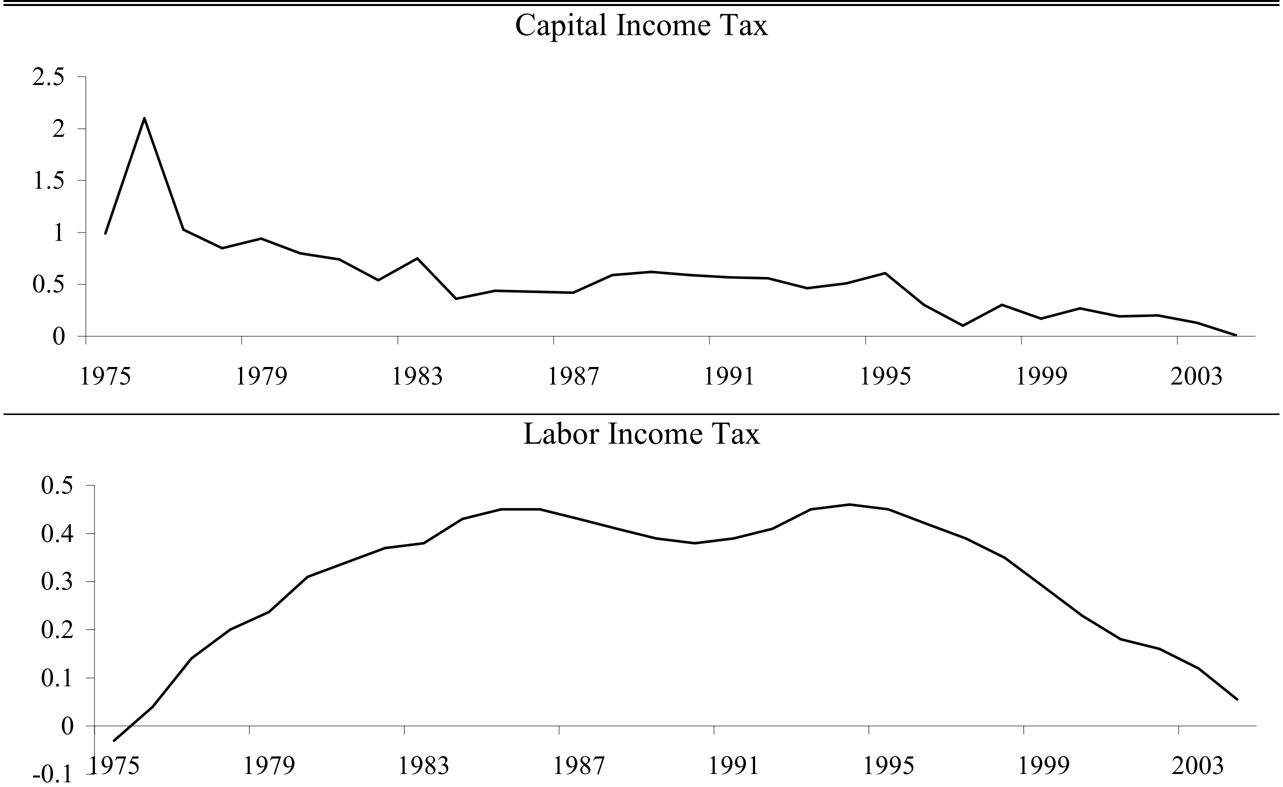
[47] Using Eviews 3.1.

[48] The detailed statistical results are shown in Appendix D.

Figure 3.E Annual Effective Income Taxes in Spain



The unit roots tests on the Spanish capital income tax reveal that this series does not follow a unit root process, whereas for the labor income tax series the methodology points to the presence of a unit root with a 95 percent confidence level. The Chow tests on the Spanish taxes signal that the capital income tax series has potential structural breaks in 1981, 1985, 1989, 1993, and 1998, with a 99 percent confidence level according to the *F*-statistic results (probability = 0.006) and the log likelihood ratio (probability = 0.000). For labor income tax, the Chow tests indicate probable breaks in 1979, 1982, 1985, 1989, 1992, 1995, 1998, and 2002 with a 95 percent confidence level using the *F*-statistic (probability = 0.035) and 99 percent using the log likelihood ratio (probability = 0.000).

In summary, based on the political and socioeconomic context, the fact that the econometric analysis suggests multiple structural breaks, and that three out of the four tax series follow unit root processes, the assumption of significant annual changes in fiscal policy during the post-1974 period appears plausible.

Unfortunately, the numerical results outlined in Table 3.C. indicate an unrealistic case of permanent labor subsidies in Portugal given that it is widely known that labor in Continental Europe is actually heavily taxed – for example, Daveri and Tabellini (2000) argue that rising unemployment in Europe during the 1965-1995 period was mainly due to high and rising tax burden on labor income. To investigate this problem further two additional scenarios were contemplated: a) the data used for the employment rate is overestimated; b) the calibration procedure underestimates the consumption preferences.

3.4.2. The Case of an Overestimated Employment Rate

The basis for this scenario is founded on the popular belief that employment rates are often overestimated in the Mediterranean countries because of an underestimation of the number of people willing to work. This problem is particularly acute during election years. The literature on this topic is scarce but it is a theme commonly discussed in the local media. Blanchard and Jimeno (1995) briefly analyze the disparities between the official and real unemployment numbers in the Iberian economies and argue that these might be correlated with the individual costs and benefits associated with registration in the unemployment centers.

This section explores the popular belief that the employment rates are actually overestimated and speculates that the discrepancy is about 20 percent of the value that the data indicates for both countries. For example, if the data set indicates a 5 percent unemployment rate, we would expect the actual number to be about 6 percent.

A new simulation contemplating our deflated employment rates implies the levels of average effective tax rates shown in Table 3.D.

Table 3.D Annual Effective Tax Rates with Overestimated Employment Rate

	Portugal		Spain	
	Capital	Labor	Capital	Labor
1975	3.000	0.086	4.500	0.175
1976	3.100	0.275	4.100	0.332
1977	0.750	0.439	3.300	0.450
1978	0.720	0.453	0.855	0.535
1979	0.580	0.449	0.835	0.552
1980	0.600	0.446	0.800	0.581
1981	0.530	0.458	0.760	0.597
1982	0.520	0.460	0.560	0.612
1983	0.530	0.395	0.775	0.622
1984	0.450	0.381	0.520	0.642
1985	0.430	0.397	0.600	0.659
1986	0.420	0.412	0.530	0.656
1987	0.390	0.407	0.500	0.647
1988	0.330	0.407	0.600	0.640
1989	0.325	0.390	0.550	0.635
1990	0.560	0.328	0.500	0.633
1991	0.580	0.290	0.510	0.631
1992	0.600	0.314	0.500	0.641
1993	0.820	0.332	0.450	0.658
1994	0.620	0.370	0.480	0.665
1995	0.660	0.380	0.485	0.657
1996	0.540	0.380	0.410	0.645
1997	0.520	0.375	0.175	0.630
1998	0.480	0.358	0.365	0.613
1999	0.460	0.350	0.275	0.586
2000	0.400	0.335	0.290	0.560
2001	0.380	0.315	0.245	0.546
2002	0.340	0.298	0.255	0.534
2003	0.320	0.283	0.195	0.516
2004	0.290	0.241	0.110	0.493

Note that all tax figures are positive in Table 3.D. The graphical demonstration of the model's fit is a replica of Figure 3.C. It is worth mentioning that the model is still unable to attain a perfect fit during the first three periods simulated.

Section 3.5 will present a comparative analysis of all annual tax series estimated for each different scenario, so we will delay the detailed discussion of the results for later. But, as an insight toward that assessment, note that the only significant consequence of assuming lower employment rates is an inflated labor income tax series since the capital tax values remain within the same range as in the baseline scenario of annual changes in fiscal policy. Graphically, this means that the curves of each estimated tax series are pretty much scaled replications of each other.

3.4.3. The Case of Underestimated Consumption Preferences

Another hypothetical scenario was built on the assumption that the levels of relative consumption preferences (γ) used in all previous simulations are actually lower than the "true" values. The calibration procedure outlined in Section 3.2.1 ascertained the level of relative preferences to be about 0.64 in each country. This last scenario investigates the conjuncture that the true γ could be around 0.8. The relative lack of empirical dynamic general equilibrium studies on the Iberian economies makes it difficult to explicitly support this claim. Nonetheless, recent figures of the European Central Bank (Rinaldi and Sanchis-Arellano, 2006) indicate a dramatic increase in the Iberian household indebtedness ratios. Rinaldi and Sanchis-Arellano (2006) show that according to quarterly data for the 1997-2004 period, the ratio of household indebtedness surged about 100 percent in Portugal and 68 percent in Spain, which by 2004 meant that the level of debt was about 100 percent of the household income in Portugal and near 80 percent in Spain. Using these figures as a proxy for relative consumption preferences, then it might be the case that the true values for both countries are actually higher than those initially calibrated in the previous simulations.

Table 3.E Annual Effective Tax Rates with Underestimated Consumption Preferences

	Portugal		Spain	
	Capital	Labor	Capital	Labor
1975	-0.530	0.521	1.600	0.540
1976	0.050	0.535	1.300	0.585
1977	0.480	0.547	1.100	0.612
1978	0.630	0.550	0.990	0.635
1979	0.500	0.540	0.870	0.654
1980	0.510	0.531	0.780	0.683
1981	0.529	0.540	0.710	0.702
1982	0.516	0.544	0.640	0.713
1983	0.500	0.465	0.670	0.724
1984	0.480	0.460	0.450	0.742
1985	0.460	0.475	0.630	0.753
1986	0.450	0.500	0.670	0.756
1987	0.420	0.477	0.460	0.747
1988	0.430	0.470	0.490	0.737
1989	0.470	0.450	0.530	0.732
1990	0.530	0.370	0.490	0.727
1991	0.570	0.300	0.470	0.727
1992	0.565	0.350	0.465	0.737
1993	0.680	0.390	0.460	0.752
1994	0.610	0.426	0.456	0.760
1995	0.700	0.450	0.540	0.750
1996	0.525	0.435	0.410	0.737
1997	0.515	0.427	0.310	0.727
1998	0.510	0.405	0.330	0.708
1999	0.490	0.386	0.270	0.684
2000	0.470	0.360	0.290	0.656
2001	0.500	0.334	0.250	0.639
2002	0.490	0.319	0.300	0.625
2003	0.470	0.310	0.200	0.607
2004	0.350	0.255	0.100	0.592

The numerical results associated with the hypothetical scenario of γ equal to 0.8 are shown above in Table 3.E. Once again, all tax series are positive (except for the Portuguese capital income tax in 1975) and the pattern remains unchanged. Moreover, the graphical illustration of the model's fit is still a replica of Figure 3.C.

3.5. The Iberian Fiscal Experiences

The numerical experiments conducted in this study produced a set of estimated series for effective tax rates on capital and labor income using one of the sophisticated tools currently available in macroeconomic analysis. Like any other economic estimates, these are ad hoc measures that should be interpreted with caution since they were computed within a framework that does not necessarily capture all the features of the real world.

In section 3.4, a set of annual effective tax series was derived based on three different simulation exercises. A so-called baseline scenario where the model was calibrated as described in section 3.2.1., a second scenario which assumed that the employment rates observed in the data were overestimated by about 20 percent, and a third scenario that imposed inflated consumption preferences and therefore γ was reset at 0.8 for both countries.

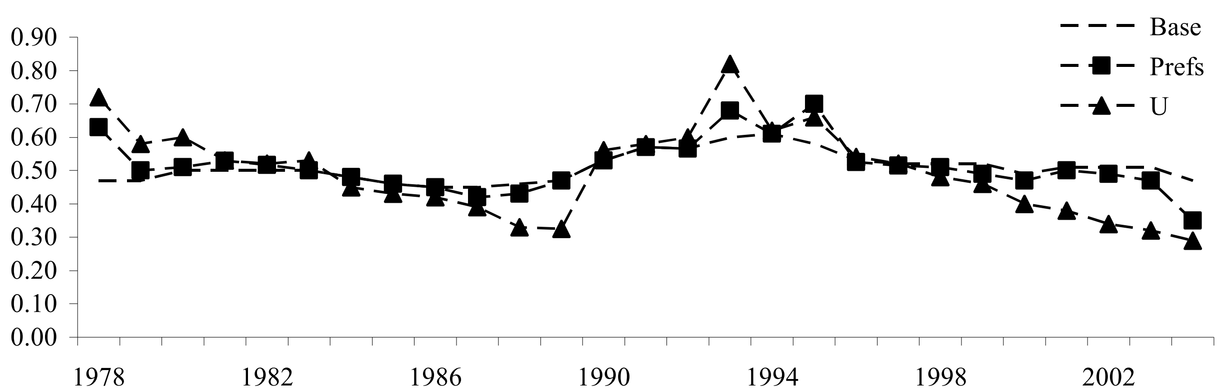
The discussion that follows focuses on expansionary and contractionary fiscal regimes rather than on the estimated levels for effective capital and labor income taxes based on the acknowledgment outlined above that the framework employed in this essay does not necessarily contemplates all aspects that characterize the Iberian economies. Therefore, the fluctuations present on each estimated tax series are probably more reliable than the estimated levels. The latter inference is in line with De Hann *et al.* (2004) who argue that, regardless of the methodology employed to estimate effective tax rates on capital and labor income, the derived series are often highly correlated overtime, though significantly different in terms of estimated levels.

3.5.1. The Portuguese Fiscal Experience

Figure 3.F summarizes the results for capital income taxes in Portugal. The plot has been confined to post-1978 data given that in the simulation results outlined in the previous section, the model took three time periods to capture the actual ratios of both factor inputs. As these initial values are considered outliers they have not been included in the graphs because otherwise the plotting scale would prevent inferring any significant differences across the estimated tax series during those periods that the model actually fits the observed capital and labor ratios.

As shown in the figure below, all the scenarios capture similar timings for expansionary and contractionary fiscal regimes on capital income despite recording different magnitudes for those changes.

Figure 3.F The Portuguese Effective Tax Series on Capital Income (all scenarios)



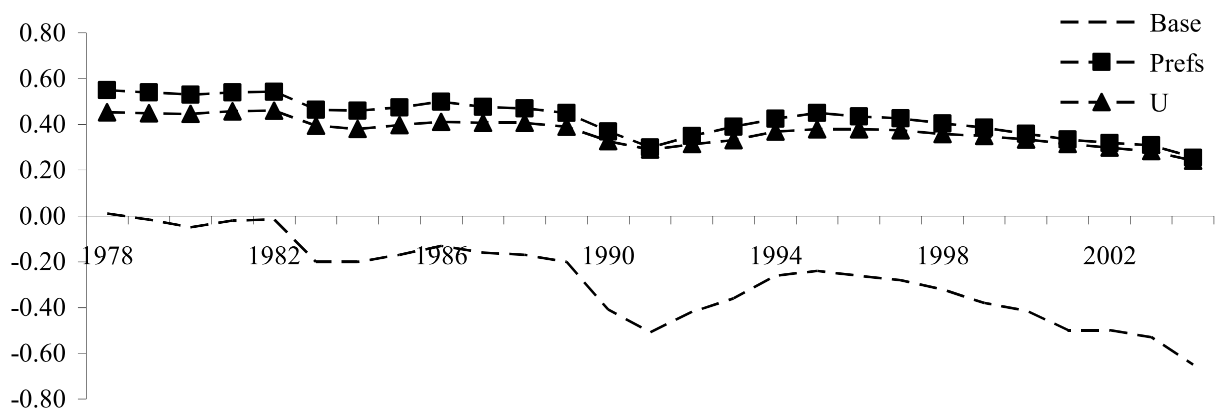
According to Figure 3.F, the average effective tax on capital income decreased from 1978 until 1987. This result is consistent with Carreira's (1984) observation that statutory tax rates in Portugal, after increasing vigorously, and frequently from 1968 to 1979, experienced a turning point by 1980 – for example, in 1979 the statutory tax rates on capital income where between 25 and 85.6 percent, depending on the income bracket, while by 1982 they were somewhat lower, ranging from 20.7 to 82.6 percent. The decline in capital income taxes continued throughout the 1980s. Martins (2000, p.279) provides data supporting that statutory corporate taxes decreased from 35 to 45 percent in 1984, to a range of 30 to 35 percent by 1988.

In the 1989-1993 period, all estimated series for capital income tax show an upward movement. This increase might be associated with the 1988 changes in the tax code, the most important tax reform in Portugal since the 1960s (Martins, 2000). Carreira (1990), reveals that in 1989 the key reference rate for corporate taxes in Portugal - the so-called IRC after 1988, which excludes other taxes paid by firms such as municipal taxes - rose to 40.1 percent, a level well above the 30 to 35 percent range mentioned by Martins (2000) for 1988.

In the simulations' results, the post-1996 era was characterized by a steady decline in the effective capital income tax. These estimates are consistent with the advent of increasing fiscal competition among the European Single Market member states, fostered by the free mobility of capital and labor. Leite and Machado (2001) point out that the IRC declined steadily between 1998 and 2004, from 34 to 30 percent. The OECD's Policy Brief of July 2008 further confirms this downward trend until the year of 2007, when the IRC reached approximately 28 percent.

We now turn the discussion to effective tax rates on labor income. As depicted in Figure 3.E, the estimates obtained by all scenarios consistently capture the same cyclical changes in the effective labor tax despite the discrepancies in levels.

Figure 3.G The Portuguese Effective Tax Series on Labor Income (all scenarios)



As previously mentioned, the hypothesis of a thirty year subsidy suggested by the baseline scenario finds no support in the literature. Consequently, during the process of reporting corroborating evidence to the estimated changes in fiscal regimes, the levels proposed by the baseline scenario will be omitted from the discussion.

According to Carreira (1984, p.441), statutory labor income taxes were in the 21.8 to 83.9 percent range in 1979. A decade later, as a result of the 1988 tax reform, the newly introduced IRS was set at 15 percent (Carreira, 1990, p.25). The estimates in this essay indicate an average effective labor income tax in the 44.9 to 54 percent range in 1979 and also suggest a decline of the labor tax by 1989, to somewhere between 39 to 45 percent.

The tendency to decrease labor taxes became more evident after adhesion to the European Single Market in 1993. Edwards and Mitchell (2008), claim that most of the resulting tax cuts were supply-side oriented and aimed at reducing the costs of productive activities, such as working and investing. Moreover, the authors also state that Portugal and Spain were among the countries that implemented the most dramatic reductions on top income tax rates between 1985 and 2007.

Given the analysis above, the suggested effective tax series for both capital and labor income in Portugal seem to do a fairly good job assessing fiscal regime changes during the post-dictatorship period. Is this also the case for the Spanish experience?

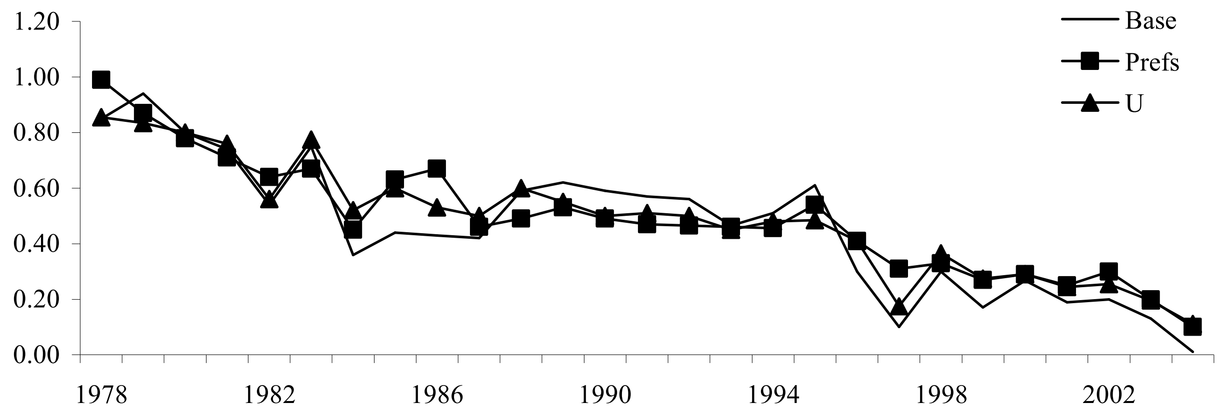
3.5.2. The Spanish Fiscal Experience

To a certain extent, the nature and timing of the changes in the Iberian fiscal regimes were quite similar, particularly those for average effective tax rates on capital income. As shown in Figure 3.H, the simulation results indicate an analogous downward trend on the capital income tax during the post-1975 period, despite the occasional clear spikes in 1983, 1985, and 1995.

Data from the OECD Taxdatabase (2008) indicates that the statutory corporate income tax rate increased slightly from 33 to 35 percent during the 1982-1986 period and that it remained at this level until 1995. Using the corporate tax as a proxy for effective tax rate on capital income, this evidence supports the relative stagnation shown in Figure 3.H for the same period. Additional corroborating evidence is found in Carey and Tchilinguirian (2000). Based on the numerical experiments of the latter authors, the average effective capital income tax was 31.4 percent during the 1986-1990 period, and 31.9 percent between 1991 and 1997.

Another noteworthy conclusion shown in Figure 3.H is that the model captures the fiscal regime change implied by the European Single Market adhesion under all scenarios. As in the Portuguese case, the OECD's Policy Brief in July 2008 indicates that the Spanish average statutory corporate income tax rate decreased between 1994 and 2007, though more modestly (from 35 to 33 percent). Nonetheless, Edwards and Mitchell (2008) confirm the continuity of this downward trend by claiming that the top statutory tax rate on capital income declined to 30 percent by 2008.

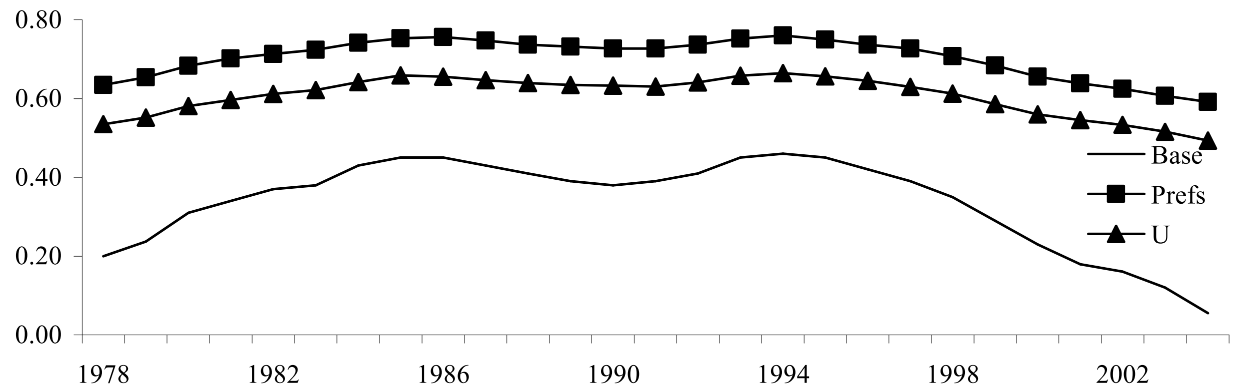
Figure 3.H The Spanish Effective Tax Series on Capital Income (all scenarios)



In relation to average effective taxes on labor income, the numerical experiments displayed in Figure 3.I indicate a steady increase in the early years of democratization. This estimated upward trend in the effective labor tax along with the relatively high unemployment benefits mentioned by Blanchard *et al.* (1995), might indeed be the justification for the steep decline observed in the employment rate until 1986 because both would create a downward pressure on the opportunity cost of leisure.

When comparing the figure below with Figure 3.E, it is clear that the shapes of the curves are quite the same since joining the European Community in 1986, indicating that the Iberian countries implemented similar policies during this period. Specifically, the plots indicate a simultaneous increase in taxes until 1994, followed by another similar period of decreasing tax rates. Hence, reinforcing the fact that embracing the European economic and political project resulted in the implementation of similar fiscal regimes, and consequently, analogous effects on the effective tax rates since then.

Figure 3.I The Spanish Effective Tax Series on Labor Income (all scenarios)



Evidence to support the path of the estimated tax series portrayed in Figure 3.I was found in the Carey and Tchilinguirian's (2000) claim that the effective tax on labor income increased between the 1980-1985 and 1986-1990 periods, moving from 24.2 to a 27.7 percent average. Therefore, confirming our estimated average levels for the labor tax during the same both periods since a cursory look at the plot reveals that the average of our estimated levels for the 1980-1985 must be necessarily lower the averaged value of our annual estimates for the 1986-1990 period.

For the decrease observed in Figure 3.I during the 1986-1990 period, we find support in Edwards and Mitchell (2008) as they endorse the claim that the labor tax, though high in relative terms comparatively to the early democratic years, might have declined between 1986 and 1990 period given that the top individual income tax rate decreased from 66 to 56 percent during this period. In relation to the 1991-1997 period, Carey and Tchilinguirian (2000) state that the average effective tax rate increased to an average of 30.4 percent. This latter claim supports, to a certain extent, the increase depicted in Figure 3.I for the 1991-1995 period.

The significant decrease estimated for the effective labor income tax during the post-1995 period is also corroborated by Edwards and Mitchell's (2008) claim that the top individual income tax decreased from 56 to 40 percent between 1995 and 2005. This latter movement in the tax rates is also supported by the two tax cuts mentioned in Appendix A, namely in 1999 and 2002, along with the increasing fiscal competition within the European Single Market.

Overall, it seems that the model's fit to the Spanish economy is satisfactory under all scenarios because it is able to capture the changes in fiscal regimes that occurred during the post-dictatorship period.

3.6. Conclusion

Because true economies are far more complicated than any economic model, some simplification has to be adopted. This is particularly true of the tax system. Empirical studies of taxes are often confined to the analysis of effective tax rates, which measure the net amount of tax levied on the activity of interest based on the underlying framework assumptions.

This essay brings additional elements to existing work, such as a set of estimates for the average annual effective tax rates on capital and labor that might have been present in the Iberian Peninsula during the 1975-2004 period. As in any economic model, the validity of the proposed tax rates depends on how accurately the framework employed reflects the complexities of the real world. Although the methodology employed here does not necessarily capture all aspects that characterize the Iberian economies, it is believed that the tax series implied by the model are as meaningful as modern macroeconomics models allow.

The main contribution of this study is the estimated changes in average effective tax rates on capital and labor income under several scenarios and the evidence that these are consistent with the changes in fiscal policy asserted in the literature for the post-dictatorship experiences of the Iberian economies. In addition, the suggested tax series can serve as a reference for more in-depth research on the Portuguese and Spanish fiscal policies and how these may have constrained or fostered economic growth.

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Appendix A - Chronology of Political and Socioeconomic Events

PORTUGAL		SPAIN		WORLDWIDE
Economic Events	*Political Events*	*Economic Events*	*Political Events*	*Events*
1953-73: Implementation of Foment Plans 1960-73: Massive emigration (15.6% of pop); GDPpc 6.9% per annum	1961: Start of the Colonial War	1958-73: Automobile production grows 22% per annum 1960-73: GDP per capita grows 7% per annum		1958: FR, IT, West Germany and Benelux establish EEC
1960: EFTA entry 1961: OECD entry 1968-79: Frequent Tax increases		1960: Highly protectionist tariffs 1961: OECD entry 1963: Law on Top Priority Industries 1964: First Development Plan		1960: EFTA established 1961: OECD established 1967: EEC, ECSC and Euratom merge into EC
1970: Full employment; Recruiting in Colonies.	1968: Americo Tomas replaces Salazar by Marcelo Caetano due to illness	1970: Preferential trade agreement with the European Common Market	1969: MATESA Scandal	1971: USA abandons Bretton Woods Agreement - floating exchange rates
1973: end of Golden years 1973-76: Inflow of Portuguese (Pop. + 8%); Lost 15% of Exports		1973-94: End of golden years; GDP per capita grows 1.4% per annum		1972: UK, IE, DK join EC 1973: Oil shock; Worldwide slowdown
1973-94: GDP per capita grows 1.9% per annum; 3rd major inflation episode	1974: Carnation Revolution; End of Colonial War. 1974-76: Six Provisional Governments		1975: Death of Franco; King *Juan Carlos I* becomes Chief of State	
1974-76:Nationalizations; rise of state monopolies 1975: EFTA $100 million Fund 1976-77: Currency crisis. IMF intervention. 1981-83: Currency crisis; IMF intervention.	1976 -78: I & II Constitutional Governments (CG) led by Soares (Socialist) 1978-81: III, IV, V and VI CGs 1981-83: VII and VIII CGs led by Balsemao (Social Democrat) 1983-85: IX CG led by Soares	1977: Tax reform – modern personal income tax; Deposit Guarantee Fund 1978-85: Banking crisis 1979: EFTA agreement 1981-83: Onset of industrial conversion – cut over-manning in troubled sectors 1982: Peseta Devaluated 1982-94: Boom in education1	1976: Law on political reform 1977: First Elections. Unified Central Democrats(UCD) win. 1979-82: I *Legislatura* (LG) led by UCD 1981: Tejero's failed *coup d'état* 1982-96: Onset of Socialist Era. II, III, IV and V LGs led by Gonzales	1979: Oil shock; EMS established 1981: Greece joins the EC
1985: EFTA exit 1986: EC entry 1989: Labor Reform - Fixed term contracts 1988: Major Tax Reform since the 1960s	1985-95: Social Democrat Era (X, XI and XII CGs led by Cavaco)	1984: Industrial Conversion Law and Labor Reform (Fixed term contracts) 1985: Unemployment peaked at 21% 1986: EC entry 1989: Spain joins EMS		1986: Favorable Oil Shock.
1989-99: Privatizations 1989-2006: Inflow of European Structural Funds 1992: Implementation of Maastricht criteria 1993-94: European Single Market 2000: Portugal is the 2nd poorest country in the EMU	1993-94: EC became EU 1995-2002: XIII and XIV CGs led by Guterres (Socialist)	1989-2006: Inflow of European Structural Funds 1992: Implementation of Maastricht criteria; 1993-94: Unemployment 20%; European Single Market 1994: Labor Reform - lower dismissal costs but stricter rules for fixed contracts 1996-2000: Privatizations generate $30 billion (about 0.9% of annual GDP)	1993-94: EC became EU 1996:VI and VII LGs led by Aznar (Popular Party - conservative)	1991: Treaty of Maastricht (signed in 1992; enforced in 1993) 1992: Crisis of the EMS; Depression in most Western Europe 1993-94: EC became EU; ESM 1995: AT, FI, SE join EU 1999: EU accounting in €
2002: € new currency	2002-04: XV CG led by Barroso (Social Democrat)	1999-2002: two tax cuts 2002: € new currency	2004: VIII LG led by Zapatero (Socialist)	2002: € currency in 12EU states 2002-06: Increasing oil prices 2004: 10 additional states join EU

Appendix B - Mathematical Appendix

Because of the unusual interpretation that the labor market situation is located at a boundary, it is easiest to think of the social planning problem as a two step problem where in the first step a representative agent makes all the allocation decisions taking prices as given and then in the second step equilibrium rental rates and wage rates are applied. To this end, the Lagrangian for this problem is

$$\ell(.) = \sum_{t=0}^{\infty} \beta^t \ln\left(c_t - B(1+\gamma)^t h_t^\eta\right) +$$

$$+\lambda_t \left[r_{kt}k_t + r_{zt}z_t + w_t h_t - c_t - k_{t+1}^{\frac{1}{\delta_k}} (A_k)^{\frac{-1}{\delta_k}} k_t^{\frac{\delta_k - 1}{\delta_k}} - z_{t+1}^{\frac{1}{\delta_z}} (A_k)^{\frac{-1}{\delta_z}} k_t^{\frac{\delta_z - 1}{\delta_z}} \right],$$

The first order conditions for t=0,1,… are

$$\frac{\partial \ell(.)}{\partial c_t} = \frac{1}{c_t - B(1+\gamma)^t h_t^\eta} - \lambda_t = 0, \tag{2.10}$$

$$\frac{\partial \ell(.)}{\partial h_t} = \frac{-B(1+\gamma)^t \eta h_t^{\eta-1}}{c_t - B(1+\gamma)^t h_t^\eta} - \lambda_t w_t = 0 \tag{2.11}$$

$$\frac{\partial \ell(.)}{\partial k_{t+1}} : -\lambda_t \left(\frac{1}{\delta_k}\right)\left(\frac{i_{kt}}{k_{t+1}}\right) + \beta\lambda_{t+1}\left[r_{kt+1} - \left(\frac{\delta_k - 1}{\delta_k}\right)\left(\frac{i_{kt+1}}{k_{t+1}}\right)\right] = 0, \tag{2.12}$$

$$\frac{\partial \ell(.)}{\partial z_{t+1}} : -\lambda_t \left(\frac{1}{\delta_z}\right)\left(\frac{i_{zt}}{z_{t+1}}\right) + \beta\lambda_{t+1}\left[r_{zt+1} - \left(\frac{\delta_z - 1}{\delta_z}\right)\left(\frac{i_{zt+1}}{z_{t+1}}\right)\right] = 0 \tag{2.13}$$

$$\frac{\partial \ell(.)}{\partial \lambda_t} : r_{kt}k_t + r_{zt}z_t + w_t h_t - c_t - i_{kt} - i_{zt} = 0. \tag{2.14}$$

Substituting in (2.4), (2.5) and (2.6) gives the social planner's first order conditions for t=0,1,… of

$$\frac{\partial \ell(.)}{\partial c_t} = \frac{1}{c_t - B(1+\gamma)^t h_t^\eta} - \lambda_t = 0\,, \tag{2.15}$$

$$\frac{\partial \ell(.)}{\partial h_t} = \frac{-B(1+\gamma)^t \eta h_t^{\eta-1}}{c_t - B(1+\gamma)^t h_t^\eta} - \lambda_t \frac{(1-\theta_k-\theta_z)y_t}{h_t} = 0 \tag{2.16}$$

$$\frac{\partial \ell(.)}{\partial k_{t+1}} : -\lambda_t\left(\frac{1}{\delta_k}\right)\left(\frac{i_{kt}}{k_{t+1}}\right) + \beta\lambda_{t+1}\left[\theta_k \frac{y_{t+1}}{k_{t+!}} - \left(\frac{\delta_k - 1}{\delta_k}\right)\left(\frac{i_{kt+1}}{k_{t+1}}\right)\right] = 0\,, \tag{2.17}$$

$$\frac{\partial \ell(.)}{\partial z_{t+1}} : -\lambda_t\left(\frac{1}{\delta_z}\right)\left(\frac{i_{zt}}{z_{t+1}}\right) + \beta\lambda_{t+1}\left[\theta_z \frac{y_{t+1}}{z_{t+!}} - \left(\frac{\delta_z - 1}{\delta_z}\right)\left(\frac{i_{zt+1}}{z_{t+1}}\right)\right] = 0 \tag{2.18}$$

$$\frac{\partial \ell(.)}{\partial \lambda_t} : y_t - c_t - i_{kt} - i_{zt} = 0\,. \tag{2.19}$$

To find the decision rules we use the method of undetermined coefficients. We guess the functional forms

$$i_{kt} = a_k y_t\,, \tag{2.20}$$

$$i_{zt} = a_z y_t\,, \tag{2.21}$$

$$\frac{1}{\lambda_t} = a_\lambda y_t\,, \tag{2.22}$$

where a_k, a_z and a_λ are constants to be determined. Substituting these into (2.17) and solving for a_k gives

$$a_k = \frac{\beta\delta_k\theta_k}{1-\beta(1-\delta_k)}\,.$$

Substituting these into (2.18) and solving for a_z gives

$$a_z = \frac{\beta\delta_z\theta_z}{1-\beta(1-\delta_z)}.$$

To find the consumption decision rule substitute (2.20) and (2.21) into (2.19) and solve for c_t to get

$$c_t = (1-a_k-a_z)y_t. \tag{2.23}$$

We can interpret $(1-a_k-a_z)$ as the marginal propensity to consume out of income. Note, this is simply the decision rule from the Solow model. To find the labor decision rule we substitute (2.15) into (2.16) and using (2.1) gives get

$$B(1+\gamma)^t\eta h_t^\eta = (1-\theta_k-\theta_z)y_t = (1-\theta_k-\theta_z)A(\pi)h_t(1+\gamma)^{(1-\theta_k-\theta_z)t}k_t^{\theta_k}z_t^{\theta_z}.$$

Now solving for h_t gives

$$h_t = \left[\frac{(1-\theta-\theta)A(\pi)k_t^{\theta_k}z_t^{\theta_z}}{B\eta(1+\gamma)^{(\theta_z+\theta_k)t}}\right]^{\frac{1}{\eta-1}}.$$

Finally, we need to verify that our guess was correct by verifying that a_λ is a constant. To do this, substitute (2.15) into (2.16) to get

$$B(1+\gamma)^t\eta h_t^\eta = (1-\theta_k-\theta_z)y_t. \tag{2.24}$$

Next, substitute (2.22) into (2.15) get

$$c_t - B(1+\gamma)^t h_t^\eta = a_\lambda y_t.$$

Now substituting in (2.23) and (2.24) and solving for a_λ gives

$$a_\lambda = (1-a_k-a_z) - \frac{1-\theta_k-\theta_z}{\eta},$$

which is a constant and thus confirms our guess.

Appendix C - Stata Code and Results for the Portuguese Tax Series

Using Stata (version 10.0) and the Portuguese tax series for capital income displayed in Table 3.C, we have programmed the code below and obtained the following results:

```
. gen klag1=taxak[_n-1]
(1 missing value generated)

. gen d_taxak = taxak[_n] - taxak[_n-1]
(1 missing value generated)

. gen d_taxaklag1 = d_taxak[_n-1]
(2 missing values generated)

. gen d_taxaklag2 = d_taxak[_n-2]
(3 missing values generated)

. gen d_taxaklag3 = d_taxak[_n-3]
(4 missing values generated)

. gen d_taxaklag4 = d_taxak[_n-4]
(5 missing values generated)

. gen d_taxaklag5 = d_taxak[_n-5]
(6 missing values generated)

. gen d_taxaklag6 = d_taxak[_n-6]
(7 missing values generated)

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3 d_taxaklag4 d_taxaklag5 d_taxaklag6

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  7,    15) =    1.41
       Model |   .00556756     7  .000795366           Prob > F      =  0.2707
    Residual |   .00844331    15  .000562887           R-squared     =  0.3974
-------------+------------------------------           Adj R-squared =  0.1161
       Total |   .01401087    22  .000636858           Root MSE      =  .02373

------------------------------------------------------------------------------
      d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        klag1 |  -.2640385    .161518    -1.63   0.123     -.608306     .080229
  d_taxaklag1 |    .393755   .2545972     1.55   0.143    -.1489061    .9364161
  d_taxaklag2 |   .1637982   .2597306     0.63   0.538    -.3898045     .717401
  d_taxaklag3 |   .0631868   .2646678     0.24   0.815    -.5009394     .627313
  d_taxaklag4 |   .3363426   .2737645     1.23   0.238    -.2471726    .9198577
  d_taxaklag5 |  -.2877445   .2779455    -1.04   0.317    -.8801713    .3046823
  d_taxaklag6 |  -.0121483   .2002474    -0.06   0.952    -.4389655    .4146689
        _cons |   .1352105   .0827244     1.63   0.123    -.0411123    .3115333
------------------------------------------------------------------------------
```

```
. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3 d_taxaklag4 d_taxaklag5

      Source |       SS       df       MS              Number of obs =      24
-------------+------------------------------           F(  6,    17) =    1.87
       Model |  .005565133     6  .000927522           Prob > F      =  0.1455
    Residual |  .008447367    17  .000496904           R-squared     =  0.3972
-------------+------------------------------           Adj R-squared =  0.1844
       Total |    .0140125    23  .000609239           Root MSE      =  .02229

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.2591411   .1362918    -1.90   0.074    -.5466918    .0284095
 d_taxaklag1 |   .3945169   .2146675     1.84   0.084     -.058392    .8474257
 d_taxaklag2 |   .1632046   .2432102     0.67   0.511     -.349924    .6763333
 d_taxaklag3 |   .0581849   .2396139     0.24   0.811    -.4473562    .5637261
 d_taxaklag4 |   .3362264   .2369712     1.42   0.174    -.1637392    .8361919
 d_taxaklag5 |  -.3053957   .1727639    -1.77   0.095    -.6698957    .0591042
       _cons |    .132627   .0696381     1.90   0.074    -.0142966    .2795506
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3 d_taxaklag4

      Source |       SS       df       MS              Number of obs =      25
-------------+------------------------------           F(  5,    19) =    1.88
       Model |  .004944788     5  .000988958           Prob > F      =  0.1458
    Residual |  .010005212    19   .00052659           R-squared     =  0.3308
-------------+------------------------------           Adj R-squared =  0.1546
       Total |      .01495    24  .000622917           Root MSE      =  .02295

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------

       klag1 |  -.2760625    .121744    -2.27   0.035    -.5308755   -.0212495
 d_taxaklag1 |   .4276933   .2200912     1.94   0.067     -.032963    .8883495
 d_taxaklag2 |   .0691991   .2442383     0.28   0.780    -.4419976    .5803958
 d_taxaklag3 |   .1861736   .2190308     0.85   0.406     -.272263    .6446103
 d_taxaklag4 |   .1045242   .1661463     0.63   0.537     -.243224    .4522724
       _cons |   .1392091   .0621358     2.24   0.037     .0091573    .2692608
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3

      Source |       SS       df       MS              Number of obs =      26
-------------+------------------------------           F(  4,    21) =    2.06
       Model |  .004211113     4  .001052778           Prob > F      =  0.1227
    Residual |  .010738887    21  .000511376           R-squared     =  0.2817
-------------+------------------------------           Adj R-squared =  0.1449
       Total |      .01495    25     .000598           Root MSE      =  .02261

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.2162455   .1083195    -2.00   0.059    -.4415084    .0090173
 d_taxaklag1 |   .4835035   .2101344     2.30   0.032     .0465052    .9205019
 d_taxaklag2 |  -.0610501    .214198    -0.29   0.778    -.5064993     .384399
 d_taxaklag3 |   .1500358   .1571235     0.95   0.350    -.1767203    .4767919
       _cons |   .1089093   .0552718     1.97   0.062    -.0060347    .2238534
------------------------------------------------------------------------------
```

```
. reg d_taxak klag1 d_taxaklag1 d_taxaklag2

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  3,    23) =    1.72
       Model |  .002758974     3  .000919658           Prob > F      =  0.1905
    Residual |  .012287322    23  .000534231           R-squared     =  0.1834
-------------+------------------------------           Adj R-squared =  0.0768
       Total |  .015046296    26  .000578704           Root MSE      =  .02311

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1629179   .1046848    -1.56   0.133    -.3794749    .0536391
 d_taxaklag1 |    .365787   .2032894     1.80   0.085    -.0547491    .7863231
 d_taxaklag2 |  -.1168732   .1579395    -0.74   0.467     -.443596    .2098496
       _cons |   .0822737   .0533611     1.54   0.137    -.0281123    .1926596
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 /* significant at 95% conf level*/

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =    5.81
       Model |  .005889305     2  .002944653           Prob > F      =  0.0085
    Residual |  .012671409    25  .000506856           R-squared     =  0.3173
-------------+------------------------------           Adj R-squared =  0.2627
       Total |  .018560714    27  .000687434           Root MSE      =  .02251

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1857107   .0940983    -1.97   0.060    -.3795098    .0080884
 d_taxaklag1 |   .3444867    .136146     2.53   0.018     .0640886    .6248847
       _cons |   .0933411   .0479495     1.95   0.063    -.0054127     .192095
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 obs /* Unrestricted model */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  3,    24) =    3.73
       Model |  .005901257     3  .001967086           Prob > F      =  0.0248
    Residual |  .012659457    24  .000527477           R-squared     =  0.3179
-------------+------------------------------           Adj R-squared =  0.2327
       Total |  .018560714    27  .000687434           Root MSE      =  .02297

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1940501   .1108331    -1.75   0.093    -.4227983    .0346981
 d_taxaklag1 |   .3524685   .1486658     2.37   0.026     .0456373    .6592997
         obs |   .0001003   .0006663     0.15   0.882    -.0012748    .0014754
       _cons |   .0958512   .0516792     1.85   0.076    -.0108095    .2025118
------------------------------------------------------------------------------

. reg d_taxak d_taxaklag1 /* Restricted model */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  1,    26) =    6.95
       Model |  .003915087     1  .003915087           Prob > F      =  0.0139
    Residual |  .014645628    26  .000563293           R-squared     =  0.2109
-------------+------------------------------           Adj R-squared =  0.1806
       Total |  .018560714    27  .000687434           Root MSE      =  .02373


------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 d_taxaklag1 |   .3758053   .1425475     2.64   0.014     .0827948    .6688158
       _cons |  -.0008986   .0045994    -0.20   0.847    -.0103528    .0085556
------------------------------------------------------------------------------
```

```
. reg d_taxak klag1 d_taxaklag1 /* New unrestricted */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =    5.81
       Model |  .005889305     2  .002944653           Prob > F      =  0.0085
    Residual |  .012671409    25  .000506856           R-squared     =  0.3173
-------------+------------------------------           Adj R-squared =  0.2627
       Total |  .018560714    27  .000687434           Root MSE      =  .02251

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1857107   .0940983    -1.97   0.060    -.3795098    .0080884
 d_taxaklag1 |   .3444867    .136146     2.53   0.018     .0640886    .6248847
       _cons |   .0933411   .0479495     1.95   0.063    -.0054127     .192095
------------------------------------------------------------------------------

. reg d_taxak d_taxaklag1, nocon /* New restricted */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  1,    27) =    7.33
       Model |  .003982871     1  .003982871           Prob > F      =  0.0116
    Residual |   .01466713    27  .000543227           R-squared     =  0.2136
-------------+------------------------------           Adj R-squared =  0.1844
       Total |      .01865    28  .000666071           Root MSE      =  .02331

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 d_taxaklag1 |   .3696399   .1365122     2.71   0.012       .08954    .6497398
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1, nocon

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    26) =    3.62
       Model |  .004057877     2  .002028939           Prob > F      =  0.0412
    Residual |  .014592123    26  .000561235           R-squared     =  0.2176
-------------+------------------------------           Adj R-squared =  0.1574
       Total |      .01865    28  .000666071           Root MSE      =  .02369

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.0032937   .0090095    -0.37   0.718     -.021813    .0152257
 d_taxaklag1 |   .3805519   .1419307     2.68   0.013     .0888092    .6722947
------------------------------------------------------------------------------
```

Using Stata (version 10.0) and the Portuguese tax series for labor income displayed in Table 3.C, we have programmed the code below and obtained the following results:

```
. gen llag1=taxal[_n-1]
(1 missing value generated)

. gen d_taxal = taxal[_n] - taxal[_n-1]
(1 missing value generated)

. gen d_taxallag1 = d_taxal[_n-1]
(2 missing values generated)

. gen d_taxallag2 = d_taxal[_n-2]
(3 missing values generated)

. gen d_taxallag3 = d_taxal[_n-3]
(4 missing values generated)

. gen d_taxallag4 = d_taxal[_n-4]
(5 missing values generated)

. gen d_taxallag5 = d_taxal[_n-5]
(6 missing values generated)

. gen d_taxallag6 = d_taxal[_n-6]
(7 missing values generated)

. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3 d_taxallag4 d_taxallag5 d_taxallag6

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  7,    15) =    0.74
       Model |  .032742861     7  .004677552           Prob > F      =  0.6415
    Residual |  .094600619    15  .006306708           R-squared     =  0.2571
-------------+------------------------------           Adj R-squared = -0.0896
       Total |   .12734348    22   .00578834           Root MSE      =  .07941

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0182977   .1401439    -0.13   0.898    -.3170073    .2804119
 d_taxallag1 |    .216048   .2804512     0.77   0.453    -.3817196    .8138156
 d_taxallag2 |  -.3763882   .2784373    -1.35   0.196    -.9698633    .2170869
 d_taxallag3 |  -.0170997   .2826192    -0.06   0.953    -.6194884    .5852889
 d_taxallag4 |  -.2771602   .2840836    -0.98   0.345    -.8826702    .3283497
 d_taxallag5 |  -.1603486   .2714066    -0.59   0.563     -.738838    .4181408
 d_taxallag6 |  -.1447434   .2590037    -0.56   0.585    -.6967968      .40731
       _cons |  -.0446606   .0378391    -1.18   0.256    -.1253127    .0359916
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3 d_taxallag4 d_taxallag5

      Source |       SS       df       MS              Number of obs =      24
-------------+------------------------------           F(  6,    17) =    0.68
       Model |  .025380463     6  .004230077           Prob > F      =  0.6650
    Residual |  .105119538    17  .006183502           R-squared     =  0.1945
-------------+------------------------------           Adj R-squared = -0.0898
       Total |  .130500002    23  .005673913           Root MSE      =  .07864

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0025538   .1308991    -0.02   0.985    -.2787268    .2736191
 d_taxallag1 |    .260083   .2680611     0.97   0.346    -.3054766    .8256425
 d_taxallag2 |  -.3542635   .2637814    -1.34   0.197    -.9107936    .2022666
 d_taxallag3 |   .0329195    .276766     0.12   0.907    -.5510058    .6168448
 d_taxallag4 |  -.2260995   .2623185    -0.86   0.401    -.7795432    .3273442
 d_taxallag5 |  -.1101541   .2522788    -0.44   0.668    -.6424157    .4221076
       _cons |  -.0314472   .0349892    -0.90   0.381    -.1052679    .0423735
------------------------------------------------------------------------------
```

```
. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3 d_taxallag4

      Source |       SS       df       MS              Number of obs =      25
-------------+------------------------------           F(  5,    19) =    0.82
       Model |  .023060182     5  .004612036           Prob > F      =  0.5537
    Residual |   .10751758    19   .00565882           R-squared     =  0.1766
-------------+------------------------------           Adj R-squared = -0.0401
       Total |  .130577762    24   .00544074           Root MSE      =  .07523

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0098872   .1160158    -0.09   0.933    -.2527111    .2329366
 d_taxallag1 |   .2945779   .2420895     1.22   0.239    -.2121212     .801277
 d_taxallag2 |  -.3319949   .2499909    -1.33   0.200    -.8552318    .1912421
 d_taxallag3 |   .0721565   .2480475     0.29   0.774    -.4470128    .5913258
 d_taxallag4 |  -.2241825   .2351611    -0.95   0.352    -.7163803    .2680154
       _cons |  -.0291482   .0312104    -0.93   0.362    -.0944722    .0361759
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3

      Source |       SS       df       MS              Number of obs =      26
-------------+------------------------------           F(  4,    21) =    0.83
       Model |   .01780931     4  .004452328           Prob > F      =  0.5216
    Residual |  .112768845    21  .005369945           R-squared     =  0.1364
-------------+------------------------------           Adj R-squared = -0.0281
       Total |  .130578155    25  .005223126           Root MSE      =  .07328

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0441053   .1049737    -0.42   0.679      -.26241    .1741995
 d_taxallag1 |   .3365945   .2310806     1.46   0.160    -.1439639    .8171528
 d_taxallag2 |  -.2610369   .2322683    -1.12   0.274    -.7440653    .2219916
 d_taxallag3 |   .0273535   .2279105     0.12   0.906    -.4466123    .5013193
       _cons |  -.0341887   .0282752    -1.21   0.240    -.0929903    .0246128
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 d_taxallag2

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  3,    23) =    1.04
       Model |  .015872724     3  .005290908           Prob > F      =  0.3924
    Residual |  .116688907    23  .005073431           R-squared     =  0.1197
-------------+------------------------------           Adj R-squared =  0.0049
       Total |  .132561631    26  .005098524           Root MSE      =  .07123

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0272543   .0926978    -0.29   0.771    -.2190144    .1645057
 d_taxallag1 |   .3372613   .2125824     1.59   0.126    -.1024989    .7770216
 d_taxallag2 |  -.2110905   .2146559    -0.98   0.336      -.65514     .232959
       _cons |  -.0271454   .0256281    -1.06   0.301    -.0801612    .0258705
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =    1.39
       Model |   .01364945     2  .006824725           Prob > F      =  0.2679
    Residual |  .122825408    25  .004913016           R-squared     =  0.1000
-------------+------------------------------           Adj R-squared =  0.0280
       Total |  .136474858    27  .005054624           Root MSE      =  .07009

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0579975   .0832506    -0.70   0.492    -.2294553    .1134602
 d_taxallag1 |   .3271157   .1970997     1.66   0.109    -.0788188    .7330502
       _cons |  -.0311207   .0234976    -1.32   0.197    -.0795149    .0172736
------------------------------------------------------------------------------
```

```
. reg d_taxal llag1 obs /* Unrestricted model */

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  2,    26) =    4.29
       Model |  .038023039     2   .01901152           Prob > F      =  0.0245
    Residual |  .115129652    26  .004428064           R-squared     =  0.2483
-------------+------------------------------           Adj R-squared =  0.1904
       Total |  .153152691    28  .005469739           Root MSE      =  .06654

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.3592031   .1435736    -2.50   0.019     -.654323   -.0640833
         obs |  -.0083685   .0028558    -2.93   0.007    -.0142388   -.0024982
       _cons |   .0312119   .0270986     1.15   0.260    -.0244901    .0869138
------------------------------------------------------------------------------

. reg d_taxal /* Restricted model */

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  0,    28) =    0.00
       Model |           0     0           .           Prob > F      =       .
    Residual |  .153152691    28  .005469739           R-squared     =  0.0000
-------------+------------------------------           Adj R-squared =  0.0000
       Total |  .153152691    28  .005469739           Root MSE      =  .07396

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       _cons |  -.0168966   .0137336    -1.23   0.229    -.0450285    .0112354
------------------------------------------------------------------------------

. reg d_taxal llag1 /* New unrestricted */

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  1,    27) =    0.00
       Model |  6.2493e-07     1  6.2493e-07           Prob > F      =  0.9917
    Residual |  .153152066    27  .005672299           R-squared     =  0.0000
-------------+------------------------------           Adj R-squared = -0.0370
       Total |  .153152691    28  .005469739           Root MSE      =  .07531

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |   .0008821   .0840372     0.01   0.992     -.171548    .1733121
       _cons |  -.0166859   .0244626    -0.68   0.501    -.0668789    .0335072
------------------------------------------------------------------------------

. reg d_taxal, nocon /* New restricted */

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  0,    29) =    0.00
       Model |           0     0           .           Prob > F      =       .
    Residual |     .161432    29  .005566621           R-squared     =  0.0000
-------------+------------------------------           Adj R-squared =  0.0000
       Total |     .161432    29  .005566621           Root MSE      =  .07461

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
------------------------------------------------------------------------------
```

```
. reg d_taxal llag1, nocon

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  1,    28) =    1.01
       Model |  .005640849     1  .005640849           Prob > F      =  0.3226
    Residual |  .155791151    28   .00556397           R-squared     =  0.0349
-------------+------------------------------           Adj R-squared =  0.0005
       Total |     .161432    29  .005566621           Root MSE      =  .07459

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |   .0479118   .0475842     1.01   0.323      -.04956    .1453836
------------------------------------------------------------------------------
```

Appendix D - Stata Code and Results for the Spanish Tax Series

Using Stata (version 10.0) and the Spanish tax series for capital income displayed in Table 3.C, we have programmed the code below and obtained the following results:

```
. gen klag1=taxak[_n-1]
(1 missing value generated)

. gen d_taxak = taxak[_n] - taxak[_n-1]
(1 missing value generated)

. gen d_taxaklag1 = d_taxak[_n-1]
(2 missing values generated)

. gen d_taxaklag2 = d_taxak[_n-2]
(3 missing values generated)

. gen d_taxaklag3 = d_taxak[_n-3]
(4 missing values generated)

. gen d_taxaklag4 = d_taxak[_n-4]
(5 missing values generated)

. gen d_taxaklag5 = d_taxak[_n-5]
(6 missing values generated)

. gen d_taxaklag6 = d_taxak[_n-6]
(7 missing values generated)

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3 d_taxaklag4 d_taxaklag5 d_taxaklag6

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  7,    15) =    1.05
       Model |  .163921404     7  .023417343           Prob > F      =  0.4412
    Residual |  .335697019    15  .022379801           R-squared     =  0.3281
-------------+------------------------------           Adj R-squared =  0.0145
       Total |  .499618424    22  .022709928           Root MSE      =   .1496

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1753642   .1920402    -0.91   0.376    -.5846881    .2339598
 d_taxaklag1 |  -.3363841   .2718885    -1.24   0.235    -.9159008    .2431326
 d_taxaklag2 |  -.0353507    .275713    -0.13   0.900     -.623019    .5523177
 d_taxaklag3 |   .0886668   .2671881     0.33   0.745    -.4808312    .6581648
 d_taxaklag4 |   -.027351    .240194    -0.11   0.911    -.5393125    .4846105
 d_taxaklag5 |  -.0865958   .1686252    -0.51   0.615    -.4460118    .2728203
 d_taxaklag6 |  -.1658343   .1184192    -1.40   0.182    -.4182389    .0865703
       _cons |   .0218392   .0934072     0.23   0.818    -.1772536     .220932
------------------------------------------------------------------------------
```

```
. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3 d_taxaklag4 d_taxaklag5

      Source |       SS       df       MS              Number of obs =      24
-------------+------------------------------           F(  6,    17) =    0.90
       Model |  .120720472     6  .020120079           Prob > F      =  0.5167
    Residual |  .379663351    17  .022333138           R-squared     =  0.2413
-------------+------------------------------           Adj R-squared = -0.0265
       Total |  .500383822    23  .021755818           Root MSE      =  .14944

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1459113    .175643    -0.83   0.418    -.5164856     .224663
 d_taxaklag1 |  -.4086249   .2568795    -1.59   0.130    -.9505932    .1333435
 d_taxaklag2 |  -.1037689   .2653162    -0.39   0.701    -.6635372    .4559995
 d_taxaklag3 |   .0431461   .2396954     0.18   0.859    -.4625669    .5488592
 d_taxaklag4 |   .0662589   .1676011     0.40   0.698    -.2873486    .4198664
 d_taxaklag5 |   .0607884   .1173731     0.52   0.611    -.1868473     .308424
       _cons |   .0238861   .0859968     0.28   0.785    -.1575513    .2053235
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3 d_taxaklag4

      Source |       SS       df       MS              Number of obs =      25
-------------+------------------------------           F(  5,    19) =    1.24
       Model |  .125727893     5  .025145579           Prob > F      =  0.3300
    Residual |  .385664093    19   .02029811           R-squared     =  0.2459
-------------+------------------------------           Adj R-squared =  0.0474
       Total |  .511391986    24  .021307999           Root MSE      =  .14247

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1593357   .1509256    -1.06   0.304    -.4752267    .1565552
 d_taxaklag1 |  -.3896066   .2364605    -1.65   0.116    -.8845241    .1053108
 d_taxaklag2 |  -.0884011   .2274021    -0.39   0.702    -.5643592    .3875569
 d_taxaklag3 |   .0090088    .159503     0.06   0.956    -.3248347    .3428523
 d_taxaklag4 |   .0124218   .1116517     0.11   0.913     -.221268    .2461115
       _cons |   .0235798   .0749792     0.31   0.757    -.1333534     .180513
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 d_taxaklag3

      Source |       SS       df       MS              Number of obs =      26
-------------+------------------------------           F(  4,    21) =    1.91
       Model |  .140772492     4  .035193123           Prob > F      =  0.1456
    Residual |  .386177026    21  .018389382           R-squared     =  0.2671
-------------+------------------------------           Adj R-squared =  0.1276
       Total |  .526949518    25  .021077981           Root MSE      =  .13561

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |   -.156462   .1294054    -1.21   0.240    -.4255751    .1126512
 d_taxaklag1 |  -.3988164   .1969508    -2.02   0.056    -.8083979    .0107652
 d_taxaklag2 |  -.1122916   .1489177    -0.75   0.459     -.421983    .1973998
 d_taxaklag3 |   .0034669   .1060327     0.03   0.974    -.2170402    .2239739
       _cons |   .0206916   .0660128     0.31   0.757    -.1165896    .1579728
------------------------------------------------------------------------------
```

```
. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 /* significant at 90% conf level*/

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  3,    23) =    2.58
       Model |  .137907637     3  .045969212           Prob > F      =  0.0780
    Residual |  .409481965    23  .017803564           R-squared     =  0.2519
-------------+------------------------------           Adj R-squared =  0.1544
       Total |  .547389601    26  .021053446           Root MSE      =  .13343

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |   -.228566   .1076964    -2.12   0.045    -.4513529   -.0057791
 d_taxaklag1 |  -.2532328    .135046    -1.88   0.074    -.5325967    .0261311
 d_taxaklag2 |  -.1786235    .097047    -1.84   0.079    -.3793805    .0221336
       _cons |   .0526223   .0586509     0.90   0.379    -.0687062    .1739509
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 obs /* Unrestricted model */

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  4,    22) =    3.26
       Model |  .203837357     4  .050959339           Prob > F      =  0.0303
    Residual |  .343552245    22  .015616011           R-squared     =  0.3724
-------------+------------------------------           Adj R-squared =  0.2583
       Total |  .547389601    26  .021053446           Root MSE      =  .12496

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.5716621   .1950773    -2.93   0.008    -.9762277   -.1670965
 d_taxaklag1 |  -.1404131   .1378817    -1.02   0.320    -.4263622    .1455361
 d_taxaklag2 |  -.1070384   .0973379    -1.10   0.283    -.3089048     .094828
         obs |   -.013294   .0064699    -2.05   0.052    -.0267118    .0001238
       _cons |   .4601134   .2057847     2.24   0.036      .033342    .8868849
------------------------------------------------------------------------------

. reg d_taxak d_taxaklag1 d_taxaklag2 /* Restricted model */

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  2,    24) =    1.41
       Model |  .057716175     2  .028858087           Prob > F      =  0.2626
    Residual |  .489673427    24  .020403059           R-squared     =  0.1054
-------------+------------------------------           Adj R-squared =  0.0309
       Total |  .547389601    26  .021053446           Root MSE      =  .14284

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 d_taxaklag1 |  -.1920224   .1412338    -1.36   0.187    -.4835147    .0994698
 d_taxaklag2 |  -.1662664   .1037035    -1.60   0.122    -.3802998    .0477671
       _cons |  -.0565791   .0301352    -1.88   0.073    -.1187751     .005617
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2 /* New unrestricted */

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  3,    23) =    2.58
       Model |  .137907637     3  .045969212           Prob > F      =  0.0780
    Residual |  .409481965    23  .017803564           R-squared     =  0.2519
-------------+------------------------------           Adj R-squared =  0.1544
       Total |  .547389601    26  .021053446           Root MSE      =  .13343

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |   -.228566   .1076964    -2.12   0.045    -.4513529   -.0057791
 d_taxaklag1 |  -.2532328    .135046    -1.88   0.074    -.5325967    .0261311
 d_taxaklag2 |  -.1786235    .097047    -1.84   0.079    -.3793805    .0221336
       _cons |   .0526223   .0586509     0.90   0.379    -.0687062    .1739509
------------------------------------------------------------------------------
```

```
. reg d_taxak d_taxaklag1 d_taxaklag2, nocon /* New restricted */

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  2,    25) =    0.54
       Model |  .024177146     2  .012088573           Prob > F      =  0.5904
    Residual |  .561594825    25  .022463793           R-squared     =  0.0413
-------------+------------------------------           Adj R-squared = -0.0354
       Total |  .585771972    27  .021695258           Root MSE      =  .14988

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 d_taxaklag1 |  -.0855224   .1357168    -0.63   0.534    -.3650363    .1939915
 d_taxaklag2 |  -.1071991   .1036865    -1.03   0.311    -.3207453    .1063472
------------------------------------------------------------------------------

. reg d_taxak klag1 d_taxaklag1 d_taxaklag2, nocon

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  3,    24) =    3.06
       Model |  .161958287     3  .053986096           Prob > F      =  0.0477
    Residual |  .423813684    24  .017658904           R-squared     =  0.2765
-------------+------------------------------           Adj R-squared =  0.1860
       Total |  .585771972    27  .021695258           Root MSE      =  .13289

------------------------------------------------------------------------------
     d_taxak |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       klag1 |  -.1437965   .0514796    -2.79   0.010    -.2500451   -.0375478
 d_taxaklag1 |  -.2533493   .1344962    -1.88   0.072    -.5309357    .0242371
 d_taxaklag2 |  -.1866958   .0962357    -1.94   0.064    -.3853165    .0119248
------------------------------------------------------------------------------
```

Using Stata (version 10.0) and the Spanish tax series for labor income displayed in Table 3.C, we have programmed the code below and obtained the following results:

```
. gen llag1=taxal[_n-1]
(1 missing value generated)

. gen d_taxal = taxal[_n] - taxal[_n-1]
(1 missing value generated)

. gen d_taxallag1 = d_taxal[_n-1]
(2 missing values generated)

. gen d_taxallag2 = d_taxal[_n-2]
(3 missing values generated)

. gen d_taxallag3 = d_taxal[_n-3]
(4 missing values generated)

. gen d_taxallag4 = d_taxal[_n-4]
(5 missing values generated)

. gen d_taxallag5 = d_taxal[_n-5]
(6 missing values generated)

. gen d_taxallag6 = d_taxal[_n-6]
(7 missing values generated)

. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3 d_taxallag4 d_taxallag5 d_taxallag6

      Source |       SS       df       MS              Number of obs =      23
-------------+------------------------------           F(  7,    15) =    6.66
       Model |  .017624074     7  .002517725           Prob > F      =  0.0011
    Residual |  .005669403    15   .00037796           R-squared     =  0.7566
-------------+------------------------------           Adj R-squared =  0.6430
       Total |  .023293477    22  .001058794           Root MSE      =  .01944

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0153266   .0652565    -0.23   0.817    -.1544175    .1237642
 d_taxallag1 |   1.097158   .2507144     4.38   0.001     .5627729    1.631543
 d_taxallag2 |  -.1818663   .2709754    -0.67   0.512    -.7594367    .3957041
 d_taxallag3 |  -.4115737   .2666079    -1.54   0.143    -.9798349    .1566876
 d_taxallag4 |   .6089423   .2845773     2.14   0.049     .0023802    1.215504
 d_taxallag5 |  -.2227388   .2365954    -0.94   0.361      -.72703    .2815524
 d_taxallag6 |   .0808106   .1935787     0.42   0.682    -.3317927    .4934139
       _cons |  -.0000405   .0249038    -0.00   0.999    -.0531218    .0530407
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3 d_taxallag4 d_taxallag5

      Source |       SS       df       MS              Number of obs =      24
-------------+------------------------------           F(  6,    17) =    7.10
       Model |  .017882795     6  .002980466           Prob > F      =  0.0006
    Residual |  .007132828    17  .000419578           R-squared     =  0.7149
-------------+------------------------------           Adj R-squared =  0.6142
       Total |  .025015624    23  .001087636           Root MSE      =  .02048

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |   .0483342   .0575378     0.84   0.413    -.0730599    .1697283
 d_taxallag1 |   .7981378   .2096548     3.81   0.001     .3558048    1.240471
 d_taxallag2 |   .0681079   .2521833     0.27   0.790    -.4639523    .6001681
 d_taxallag3 |  -.4369272   .2804839    -1.56   0.138    -1.028696    .1548421
 d_taxallag4 |   .2972713   .2381788     1.25   0.229     -.205242    .7997846
 d_taxallag5 |  -.0380006   .1983246    -0.19   0.850    -.4564289    .3804277
       _cons |  -.0251394    .021151    -1.19   0.251     -.069764    .0194852
------------------------------------------------------------------------------
```

```
. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3 d_taxallag4

      Source |       SS       df       MS              Number of obs =      25
-------------+------------------------------           F(  5,    19) =    8.19
       Model |  .021676572     5  .004335314           Prob > F      =  0.0003
    Residual |  .010052466    19  .000529077           R-squared     =  0.6832
-------------+------------------------------           Adj R-squared =  0.5998
       Total |  .031729038    24  .001322043           Root MSE      =    .023

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0365576   .0534485    -0.68   0.502    -.1484267    .0753115
 d_taxallag1 |   .7072243    .231484     3.06   0.007     .2227228    1.191726
 d_taxallag2 |    .111992   .2812483     0.40   0.695    -.4766675    .7006514
 d_taxallag3 |  -.0634263   .2654335    -0.24   0.814    -.6189851    .4921325
 d_taxallag4 |    .167892   .2148096     0.78   0.444    -.2817097    .6174937
       _cons |   .0064835   .0193343     0.34   0.741    -.0339836    .0469507
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 d_taxallag2 d_taxallag3

      Source |       SS       df       MS              Number of obs =      26
-------------+------------------------------           F(  4,    21) =   11.31
       Model |  .022954981     4  .005738745           Prob > F      =  0.0000
    Residual |  .010659364    21  .000507589           R-squared     =  0.6829
-------------+------------------------------           Adj R-squared =  0.6225
       Total |  .033614345    25  .001344574           Root MSE      =  .02253

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0155311    .046803    -0.33   0.743    -.1128632    .0818011
 d_taxallag1 |   .7171052   .2260321     3.17   0.005     .2470456    1.187165
 d_taxallag2 |   .0450974   .2490101     0.18   0.858    -.4727475    .5629422
 d_taxallag3 |    .081543   .2043323     0.40   0.694    -.3433892    .5064753
       _cons |  -.0004699   .0167548    -0.03   0.978    -.0353134    .0343735
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 d_taxallag2

      Source |       SS       df       MS              Number of obs =      27
-------------+------------------------------           F(  3,    23) =   18.85
       Model |  .026838898     3  .008946299           Prob > F      =  0.0000
    Residual |  .010916508    23  .000474631           R-squared     =  0.7109
-------------+------------------------------           Adj R-squared =  0.6731
       Total |  .037755406    26  .001452131           Root MSE      =  .02179

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0003291   .0402064    -0.01   0.994    -.0835024    .0828441
 d_taxallag1 |   .6746641   .1953296     3.45   0.002      .270594    1.078734
 d_taxallag2 |   .1241542    .191168     0.65   0.522    -.2713068    .5196152
       _cons |  -.0059085   .0142681    -0.41   0.683    -.0354244    .0236074
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 /* significant at 99%*/

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =   33.80
       Model |  .035052322     2  .017526161           Prob > F      =  0.0000
    Residual |  .012962641    25  .000518506           R-squared     =  0.7300
-------------+------------------------------           Adj R-squared =  0.7084
       Total |  .048014963    27  .001778332           Root MSE      =  .02277

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0330311   .0369682    -0.89   0.380    -.1091687    .0431064
 d_taxallag1 |   .8376721   .1050226     7.98   0.000     .6213741     1.05397
       _cons |   .0069685   .0130415     0.53   0.598    -.0198909    .0338279
------------------------------------------------------------------------------
```

```
. reg d_taxal llag1 d_taxallag1 obs /* Unrestricted model */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  3,    24) =   30.86
       Model |  .038130189     3  .012710063           Prob > F      =  0.0000
    Residual |  .009884775    24  .000411866           R-squared     =  0.7941
-------------+------------------------------           Adj R-squared =  0.7684
       Total |  .048014963    27  .001778332           Root MSE      =  .02029

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0437677   .0331813    -1.32   0.200    -.1122505    .0247152
 d_taxallag1 |   .4269552   .1770152     2.41   0.024     .0616139    .7922966
         obs |   -.002458   .0008992    -2.73   0.012    -.0043138   -.0006022
       _cons |   .0532758   .0205438     2.59   0.016     .0108754    .0956762
------------------------------------------------------------------------------

. reg d_taxal d_taxallag1 /* Restricted model */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  1,    26) =   67.33
       Model |  .034638377     1  .034638377           Prob > F      =  0.0000
    Residual |  .013376587    26  .000514484           R-squared     =  0.7214
-------------+------------------------------           Adj R-squared =  0.7107
       Total |  .048014963    27  .001778332           Root MSE      =  .02268

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 d_taxallag1 |   .8504255   .1036438     8.21   0.000     .6373825    1.063468
       _cons |  -.0040201   .0043224    -0.93   0.361    -.0129049    .0048646
------------------------------------------------------------------------------

. reg d_taxal llag1 d_taxallag1 /* New unrestricted */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =   33.80
       Model |  .035052322     2  .017526161           Prob > F      =  0.0000
    Residual |  .012962641    25  .000518506           R-squared     =  0.7300
-------------+------------------------------           Adj R-squared =  0.7084
       Total |  .048014963    27  .001778332           Root MSE      =  .02277

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0330311   .0369682    -0.89   0.380    -.1091687    .0431064
 d_taxallag1 |   .8376721   .1050226     7.98   0.000     .6213741     1.05397
       _cons |   .0069685   .0130415     0.53   0.598    -.0198909    .0338279
------------------------------------------------------------------------------

. reg d_taxal d_taxallag1, nocon /* New restricted */

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  1,    27) =   66.81
       Model |  .034201358     1  .034201358           Prob > F      =  0.0000
    Residual |  .013821642    27  .000511913           R-squared     =  0.7122
-------------+------------------------------           Adj R-squared =  0.7015
       Total |  .048022999    28  .001715107           Root MSE      =  .02263

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 d_taxallag1 |   .8380426    .102528     8.17   0.000     .6276726    1.048413
------------------------------------------------------------------------------
```

```
. reg d_taxal llag1 d_taxallag1, nocon

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    26) =   34.62
       Model |  .034912317     2  .017456159           Prob > F      =  0.0000
    Residual |  .013110682    26  .000504257           R-squared     =  0.7270
-------------+------------------------------           Adj R-squared =  0.7060
       Total |  .048022999    28  .001715107           Root MSE      =  .02246

------------------------------------------------------------------------------
     d_taxal |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       llag1 |  -.0144032     .01213    -1.19   0.246    -.0393368    .0105305
 d_taxallag1 |   .8472406   .1020529     8.30   0.000      .637468    1.057013
------------------------------------------------------------------------------
```