EC2B1 Coursework Submission Form

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EC2B1 Macroeconomics II

Group Project on Economic Growth

Spain's Growth Puzzle:

From TFP-Led Boom to Labor-Driven Expansion (1950-2019)

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Abstract

This paper explores Spain's economic growth from 1950 to 2019 through the growth accounting methodology and theoretical growth frameworks and analyzes the contributions of capital accumulation, labour input, and total factor productivity (TFP) to GDP growth, identifying three distinct phases: "Golden Age" (1950-1975), stagnation (1976-1985), and moderate growth (1986-2019). The analysis reveals that Spain's economic growth aligns with Solow model initially, while the later period follows the Romer model. As for growth accounting and labour productivity, findings indicate that in 1950-1975, Spain's economy was driven by TFP, while later growth (1986–2019) relied more on capital deepening and labour input.

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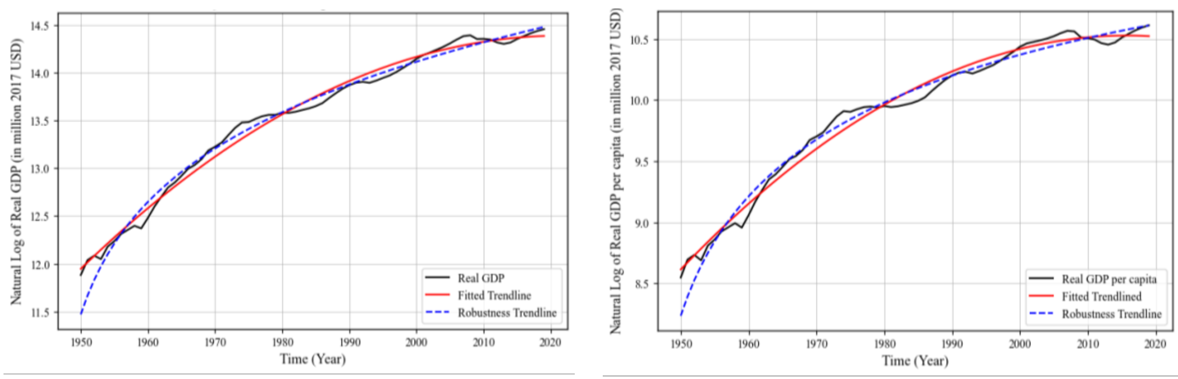
1. Introduction

As a developed country, Spain is the world's 14th largest by nominal GDP and the 6th largest in Europe (Carreras et al., 2021). Studying Spain's historical growth patterns and drivers that have shaped its long-term growth has profound significance on policymaking, comparing growth models with other economies, and predicting the country's future growth potential.

This study examines the long-term growth trend of Spain from 1950 to 2019. Using real GDP and ln (GDP) as dependent variables, each regressed on t, t^2, and both together and get 6 regressions. The same applies to real GDP per capita. According to observation and the value of mean squared error, the quadratic model of natural log of GDP (GDP per capita) provides the best fit, the estimated time trends are visualized in *Figure 1.*

In *Figure 1*, Spain's long-run trends in real GDP and real GDP per capita show an upward trend with diminishing growth rate over the periods, regardless of fluctuations (black line in the graph below). To stabilize the variance and reduce skewness of long-term economic data, we use the natural logarithm model to fit the trendline (red line) and use levels for robustness check (blue line).

Figure 1: Spain's long-term trend of real GDP and GDP per capita from 1950 to 2019



In the 1950s, Spain just recovered from the Spanish Civil War and experienced international isolation due to Franco's authoritarian regime, resulting in a largely agrarian and stagnated economy (McVeigh, 1999). Since 1959, Spain experienced a 'Spanish Miracle', a period of rapid economic growth. With GDP expanding at an average annual rate of 5.3%, the country's GDP per capita had risen to approximately 7 times its 1960 level by 1974 (De la Escosura & Sánchez-Alonso, 2020). This is because of the rapid industrialization and implementation of economic liberalization policies. In the mid-1970s, Franco's death led to Spain's political instability and the transition to democracy. In 1973, the oil crisis also caused the economic stagnation in Spain and the "Spanish Miracle" came to an end subsequently (Fernández-Villaverde & Ohanianz, 2009). In 1986, Spain's accession to the European Economic Community (EEC) marked a turning point, opening the door to greater economic integration and foreign investment. The country experienced strong economic growth in the late 1980s and 1990s, driven by sectors such as tourism, construction, and service industry. Therefore, the whole 70-year period will be divided into three distinct sub-periods: Golden Age (1950-1975), Stagnation (1976-1985) and Moderate Growth (1986-2019).

2. Methodology: Production Function and Growth Accounting

Assuming the production function follows the Cobb-Douglas form:

$$Y = K^{\alpha}(AL')^{1-\alpha}, 0 < \alpha < 1 \quad (1)$$

where Y is the total output (real GDP), A represents technology or total factor productivity (TFP), K represents capital, L' represents effective labour, and the constant α is the capital share of income. The effective labour input is calculated by multiplying the number of persons engaged (in millions) by the human capital index, which allows us to account for the impact of both the human capital's quantity and quality on economic growth (Mankiw et al., 1992).

According to *Equation (1)*, economic growth can be decomposed into three contributions:

$$\text{Capital accumulation contribution: } \alpha * \frac{\Delta K}{K} \quad (2)$$

$$\text{Labour input contribution: } (1-\alpha) * \frac{\Delta L'}{L'} \quad (3)$$

$$\text{Technological progress (TFP) contribution: } (1-\alpha) * \frac{\Delta A}{A} \quad (4)$$

Given the *Equation (2) (3) (4),* aggregate growth accounting during this 70-year period can be calculated. Assuming the value of α equals to 0.3, which is broadly consistent with national income accounts data for developed countries (Hall & Jones, 1999), it can be found that the capital accumulation contribution is approximately 31.9% labour input contribution is approximately 27.2%, and the technological progress is approximately 40.9%. This means that in Spain's long-run development, the main driver of GDP changes is the total factor of productivity.

To capture significant shifts in economic contribution over time, we divide 70 years of economic data from 1950 to 2019 into seven decade-long segments and calculate the contributions respectively. This allows us to identify key trends and structural changes, therefore exploring the underlying drivers of Spain's economic growth.

Table 1: Decadal economic contribution findings

	K contribution	**L contribution**	**A contribution**
1950-1959	26.56%	14.27%	59.18%
1960-1969	28.94%	12.44%	58.62%
1970-1979	44.06%	6.52%	49.42%
1980-1989	30.06%	41.54%	28.40%
1990-1999	34.49%	59.08%	6.43%
2000-2009	44.54%	76.36%	-20.89%
2010-2019	23.79%	59.77%	16.43%

As shown in *Table 1,* technological innovation and productivity improvement (TFP) were the main driving forces of economic growth before the 1990s. Technological innovation enables companies and industries to use resources more efficiently, and the economy shifted from a stage dominated by labour-intensive or capital-intensive industries to new industries driven by knowledge, innovation, and research & development (R&D).

Since the 1980s, the main driver of economic growth has shifted from technology to labour. This change reflected population growth and the increasing role of labour-intensive industries, such as manufacturing and construction, in driving economic growth.

It is worth mentioning that since a relatively short time interval was used, some short-term fluctuations in capital, labour, and total factor productivity may lead to negative contributions (see the data in 2000-2009 in *Table 1*).

Based on the observations of key transformations in growth contributions above, along with major economic transformations between 1950 and 2019, the period can be devided into three subperiods: Golden Age (1950-1975), Stagnation (1976-1985), Moderate Growth (1986-2019). Table 2 and Table 3 illustrate a shift in Spain's economic growth pattern, transitioning from TFP driven to labour driven around the mid-1980s.

Table 2: GDP, TFP, Capital, Labour growth rates in 3 subperiods

Subperiod	GDP Growth[1]	TFP Growth	Capital Growth	Labour Growth
1950-1975	6.16%	5.05%	5.96%	1.20%
1976-1985	1.34%	1.52%	2.66%	-0.75%
1986-2019	2.34%	0.02%	2.56%	2.24%

Table 3: Growth accounting contributions in 3 subperiods

Subperiod	A Contribution	K Contribution	L Contribution
1950-1975	57.36%	29.04%	13.60%
1976-1985	79.31%	59.64%	-38.95%
1986-2019	0.50%	32.71%	66.79%

Growth accounting

1950-1975 (Golden Age): Spain's productivity grow rapidly during this period, with an average annual GDP growth rate of 6.16%. This fast growth was primarily driven by TFP improvements with a contribution of 57.36%. Meanwhile, Spain transitioned from an agricultural economy to an industrial

[1] Average annual growth rate, calculated as the log difference of the variable, divided by the length of the period.

economy, undergoing industrialization and modernization under Franco's economic liberation policies (Prados & Sanz, 1996). These structural changes significantly brought up labour productivity.

1976-1985 (Stagnation): Following Franco's death in 1975, Spain faced economic stagnation, with GDP growth slowing to 1.34% annually. It was primarily due to political turbulence, economic restructuring, and an external shock of the oil crisis from 1973 to 1979 (Prados & Rosés, 2021). The unemployment rate surged to 20%, which resulted in negative labour growth and a shrinking contribution of labour contribution to GDP growth. In this period, the negative labour contribution can be treated as a result of short-term business cycle fluctuations, which cannot be separated from long-term fundamental shifts in Spain's economic growth by growth accounting.

1986-2019 (Moderate Growth): After Spain joined EEC in 1986, its GDP growth recovered to an average of 2.34% per year. Labour became the major contributor to GDP growth. This may be driven by policy changes that encourage labour force participation. For example, Spain's first immigration law, Organic Law 7/1985, facilitated foreign labour inflows (Pinyol-Jiménez, 2023). The foreign labour inflow compensated for the decline in Spain's native working-age population (Fuentes & Callejo, 2011) and filled labour shortages.

3. TFP versus Labour Productivity

In economics, productivity measures how efficiently inputs are used to produce output (S. C. B. O., 2024). At the macroeconomic level, it is typically assessed in two ways: total factor productivity (TFP) and labor productivity (Sargent & Rodriguez, 2001). Specifically, total factor productivity (TFP) is the portion of output that cannot be directly attributed to inputs used in production, like capital and labour (Comin & Diego, 2008). In contrast, labor productivity measures output per worker or per hour worked, focusing specifically on labor efficiency (S. C. B. O., 2024).

3.1. Theoretical analysis of TFP versus labour productivity

To see the relationship between TFP and labour productivity:

Step 1. Using the Cobb-Douglas production function:

$$Y = K^{\alpha}(A * hc * L)^{1-\alpha}, \quad 0 < \alpha < 1 \quad (5)$$

Step 2. Dividing *Equation (5)* by the number of persons working (L):

$$\frac{Y}{L} = \frac{A^{1-\alpha} * K^{\alpha} * hc^{1-\alpha}}{L^{\alpha}} \quad (6)$$

Step 3. Calculating labour productivity by *Equation (6)* by the definition GDP (output) per worker:

$$LP = A^{1-\alpha} * k^{\alpha} hc^{1-\alpha} \quad (7)$$

where LP is labour productivity and k is capital per capita.

Step 4. Taking the partial derivative of *Equation (7)* with respect to TFP to see the theoretical relationship of TFP and labour productivity:

$$\frac{\partial LP}{\partial A} = 1 - \alpha, \quad 0 < \alpha < 1 \quad (8)$$

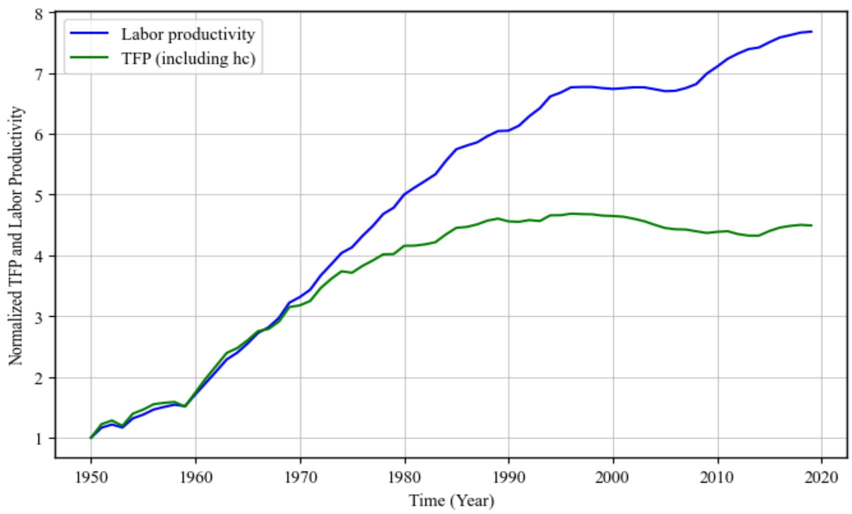
Equation (7) shows that TFP is an important factor in labour productivity, and in theory, there is necessarily a positive relationship between them since the first-order condition in *Equation (8)* is positive, holding k and hc constant.

However, in the short term, there is not necessarily a positive relationship between TFP and labour productivity. According to *Equation (7)*, if economic growth depends on capital deepening (i.e., k increases), labor productivity rises while TFP remains unchanged or declines, assuming human capital (hchchc) remains constant. Similarly, as indicated by *Equation (6)*, a decrease in the labor force (L), such as due to rising unemployment, may increase labor productivity (Y/L) even when TFP (A) declines.

3.2. Analysis of TFP and Labour Productivity in Spain from 1950 to 2019

As shown in *Figure 2*, total factor productivity and labour productivity in Spain exhibited a positive relationship[2] from 1950 to 2019 with a general upward trend, which suggests that Spanish productivity has generally been increasing for the past 70 years, except for the years when the economy was stagnant.

Figure 2: TFP and labour productivity series (normalized with 1950 as the benchmark)



To show the growth rate of labour productivity[3], take the natural logarithm on both sides of *Equation (7),* then get *Equation (9)* and visualize it in *Figure 3*.

$$g(LP) = g(k) + (1 - \alpha)g(A) + (1 - \alpha)g(hc) \quad (9)$$

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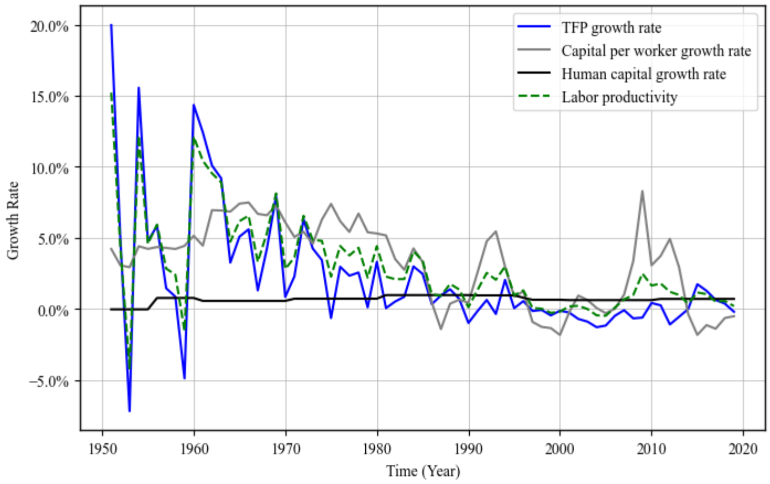
[2] We tested the relationship by calculating the correlation coefficient and obtained a value of 0.9492. While this only captures the linear relationship, we believe it is sufficient to demonstrate the positive correlation between the two factors.

[3] Take the natural logarithm (*ln*) of both sides of equation (6) and take difference to derive the labour productivity growth rate function (7).

Figure 3: Growth of labour productivity and its factors



1950-1985: According to Kohli (2004), productivity growth is typically driven by capital deepening, technological progress, and human capital accumulation. From 1950 to 1985[4], labor productivity and total factor productivity (TFP) grew at nearly the same rate, indicating that TFP was the primary driver of labor productivity growth, complemented by capital deepening. However, human capital saw minimal growth during this period and contributed little to labor productivity improvements. Particularly, both TFP and labour productivity have increased sharply since 1960, largely due to Spain's 1959 Stabilisation and Liberalisation Plan under Franco's regime. This plan opened the country to international organisations and committed to gradual liberalization, attracting foreign technical assistance that boosted TFP and foreign capital inflows that contributed to capital (Prados et al., 2011).

1986-2008: The growth rate of labour productivity was significantly higher than that of TFP during this interval, while TFP growth slowed down and even began to decline (as shown in *Figure 2* and *Figure 3*). Capital deepening played a greater role in labor productivity growth, as evidenced in *Figure 3*, where human capital growth remained around 0%, and the differences[5] between labor productivity and TFP growth rate became apparent. Additionally, labor productivity growth[6] closely followed the trend of capital per worker growth, indicating a strong influence of capital per worker growth.

Researchers are still looking for reasons for the slowdown in TFP growth in Spain after 1985: Firms' low spending on research and development as well as low investment in intangible capital hampers TFP (Corrado et al., 2013). Reallocation of resources into sectors with limited innovation (and productivity) potential, especially residential real estate, which accounts for two-thirds of the country's total capital stock (Díaz & Franjo, 2016).

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[4]As shown in *Figure 2*, they moved in parallel, and *Figure 3* indicates that their growth rates were nearly identical.

[5]They were no longer nearly identical as they were before 1985 in *Figure 3*.

[6]The curve of labour productivity growth was biased towards the curve of capital per worker growth.

2009-2019: After 2008, labour productivity and TFP in Spain fluctuated with the economic cycle such as the financial crisis and its subsequent recovery.

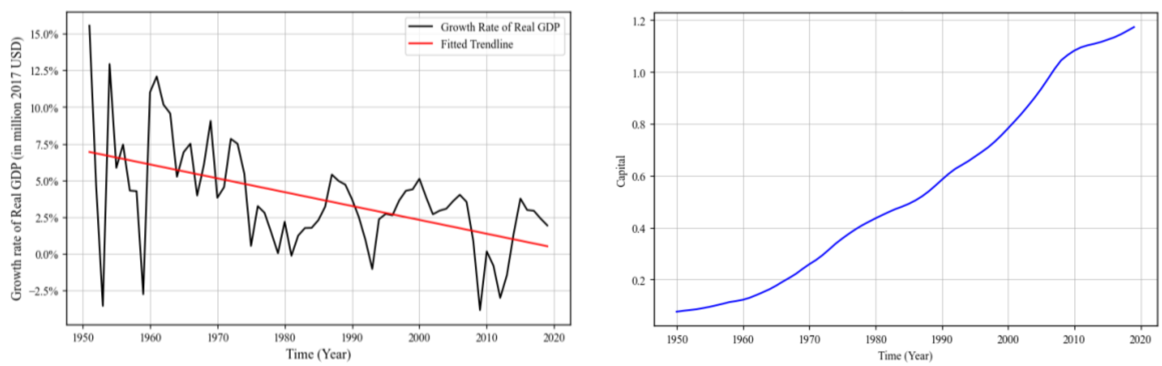
Overall, labour productivity and TFP diverged in Spain from 1950 to 2019. The growth of labour productivity was driven by TFP growth, capital deepening, and human capital (Kohli, 2004), TFP growth (i.e. Technology improvement) was the main driver of labour productivity growth during the first 35 years (1950-1985). After 1985, TFP growth slowed down, and capital deepening had a greater impact on labour productivity growth. As a result, the gap between labour productivity and TFP continued to widen, leading to a diverged long-term pattern.

4. Application of the Solow and Romer Growth Models

4.1. GDP Growth Analysis Using the Solow Model (1950–2019)

According to *Figure 1*, Spain's GDP for the whole period maintains an upward growth trend and gradually converges to a steady state, which can be explained by the Solow model generally.

Figure 4: Growth rate of real GDP (left) and capital (right)



Based on *Figure 4,* while the capital increase (right), the fitted line of growth rate of real GDP (left) shows a downward trend, indicating the diminishing marginal returns to capital as the economy developed. In the early stage of capital accumulation when the capital stock is low, the Solow model's prediction suggests that the marginal returns to investment are higher, and the economy grows faster. As the economy developed, the marginal returns to capital accumulation decreased, leading to a slowdown in the growth rate of the economy, which was in line with the assumption of the Solow model.

However, the Solow model has limited explanatory power, especially for the short-term shocks in the real Spanish economy. For instance, the fluctuations during the 1970s led by external shocks such as the oil crisis and regime change after Franco's death (McVeigh, 1999) cannot be explained by the Solow model. Also, the Solow model is unable to endogenize the impact of the financial system such as the global financial crisis and the property bubble in 2008 (Ferreiro & Serrano, 2012).

4.2. Subperiod Analysis: Solow (1950–1975) and Romer (1986–2009)

In this section, the Solow model[7] (Solow, 1956) and the Romer model[8] (Romer, 1986) were applied to analyze Spain's productivity growth patterns during two subperiods: 1950–1975 and 1986–2009.

$$\ln GDP_t = \beta_0 + \beta_1 t + \varepsilon_t \quad (10)$$

$$\ln GDP_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \varepsilon_t \quad (11)$$

Based on the regression model in *Equation (10)* and *Equation (11)*, following Romer's methodology (Romer, 1986), empirical analyses for the two subperiods were conducted separately. Using $\ln GDP_t$ as dependent variables, each regressed on t, t^2 for the two subperiods, providing the best fit among all 6 regressions, with the estimated time trends are visualized in *Figure 5*. The regression coefficient estimates are presented in *Table 3* for greater precision, while *Table 4* shows the significant test results, with the null hypothesis assuming a nonpositive trend.

Figure 5: Trend of productivity in subperiods

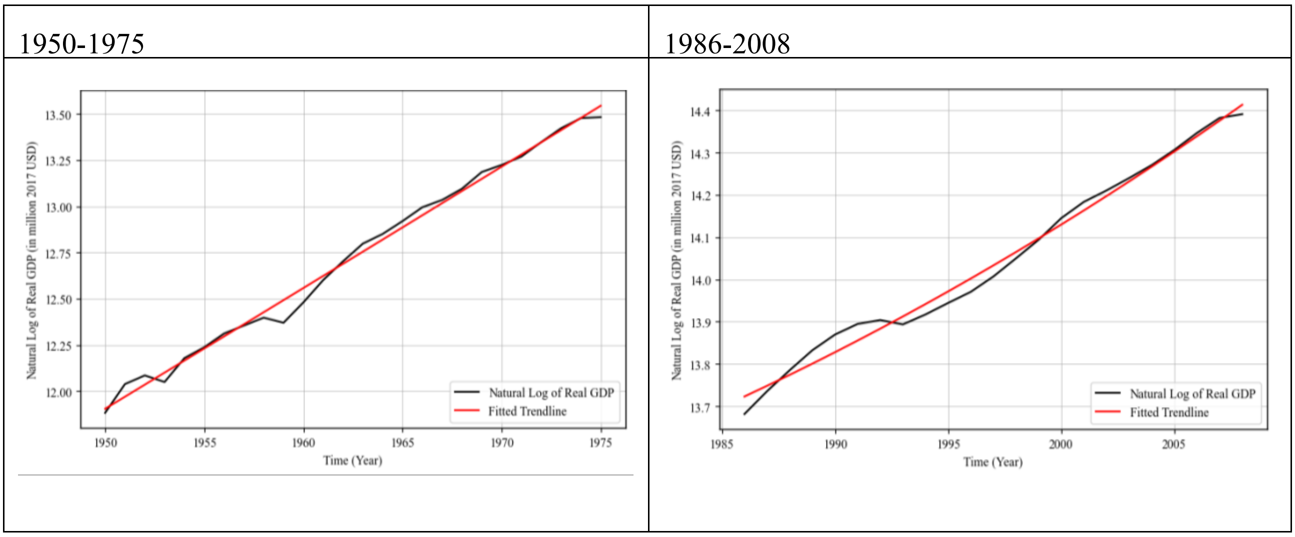


Table 4: Coefficients of regressions in subperiods

Intervals	**β₀**	**β₁**	**β₂**
1950-1975	11.8389	0.0652	0.00001657
1986-2009	13.1939	0.0036	0.00028928

[7] The Solow growth model is based on four central assumptions. First, the level of technology is exogenously determined. Second, the production function exhibits constant returns to scale. Third, the marginal product of capital is positive but diminishing. Fourth, the economy is closed.

[8] Romer's endogenous growth model has 3 main assumptions. First, Knowledge is inherently non-rival in its use and thus its creation and diffusion most likely leads to spillovers and increasing returns. Second, positive population growth will endogenously generate increase in TFP and break DRS. Third, production function exhibits increasing marginal productivity and global increasing returns to scale in the long run.

Table 5: Regression results of ln(GDP) on time variables for 1950-1975 and 1986-2008

	(1)	(2)	(3)	(4)
	Subperiod 1 (1950-1975)		Subperiod 2 (1986-2009)	
Variables	ln (GDP)	ln (GDP)	ln (GDP)	ln (GDP)
t^2		0.000		0.000**
		(0.000)		(0.000)
t	0.066***	0.065***	0.031***	0.004
	(0.001)	(0.005)	(0.001)	(0.012)
Constant	11.837***	11.839***	12.540***	13.194***
	(0.018)	(0.028)	(0.040)	(0.294)
Observations	26	26	23	23
R-squared	0.993	0.993	0.985	0.988
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

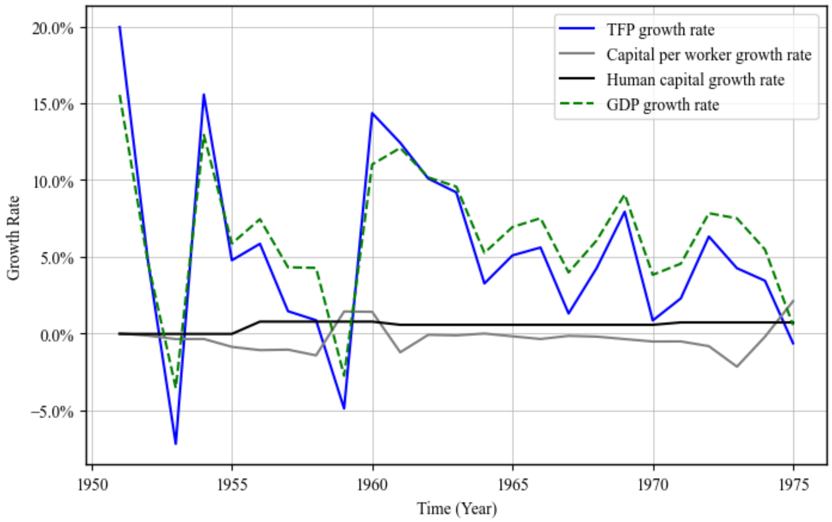
4.3. Applying the Solow Model to the interval 1950-1975

The growth rate of real GDP in Spain increased from 1950 to 1975 as shown in *Figure 5 (left)*. Despite the plot evidence, estimated values for β_1 in *Equation 10 and Equation 11* are 0.066 and 0.065 respectively, which are both positive and significant at a 1% confidence level. This suggests that Spain's productivity grew at an average annual rate of around 6.6% during this period. Additionally, the estimated coefficient of t^2 (0.00001506) is positive but not statistically significant. This means we cannot reject the null hypothesis (β_2= 0), implying that GDP growth followed a nearly linear trend over time.

This increasing growth rate with an annual rate of 8.6% (Prados & Sanz, 1996) during 1950-1975, shows that Spain experienced rapid capital accumulation, which could be reasonably explained by Solow model. During this period, Spain's economy functioned almost like a closed system, given the autarkic policies implemented from 1950 to 1959 (McVeigh, 1999). After 1959, the economy reformed with the Stabilization Plan (Hidalgo et al., 2010; Hidalgo & Molero, 2009), leading to controlled liberalization, while it remained one of the most closed capitalist economies in Western Europe (McVeigh, 1999; Prados & Sanz, 1996). Moreover, Spain saw a strong influx of external technology

(Hidalgo et al., 2010), especially importing advanced technology from the U.S. and EU in the chemical and machinery sectors, thus the TFP can be considered exogenous. Under these assumptions, we analyse real Spain GDP growth rate in *Figure 6*. The real GDP growth rate remained relatively stable overall despite some fluctuations, closely following the trend of TFP growth. This pattern is consistent with the Solow model, which states that GDP growth is primarily driven by TFP growth under steady state in the long run, i.e., $g_y = g_A$.

Figure 6: Growth rate of TFP, k, hc, GDP (1950-1975)



Additionally, *Figure 7* shows an upward trend in capital and output per effective worker, which corresponds to the overall increase in the saving rate (*Figure 8*) during this period. This can be explained by Solow model in *Equation (12)*:

$$\Delta k = sy - \delta k \quad (12)$$

Given all the savings are used to fund investment, a higher saving rate (s) can increase investment per labour (sy), accumulating the capital per effective labour (k) and output per effective labour (y). Therefore, the permanent increase in saving rate can result in higher steady-state per capita output.

Figure 7: Trend of capital per worker, output per worker

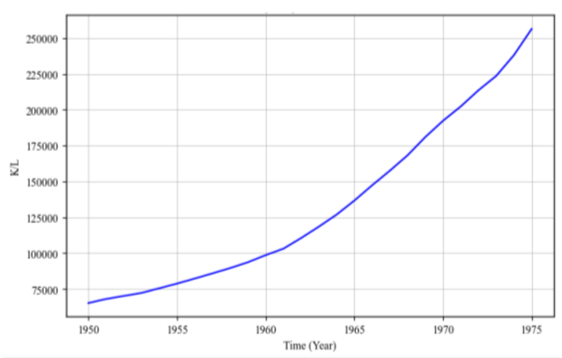
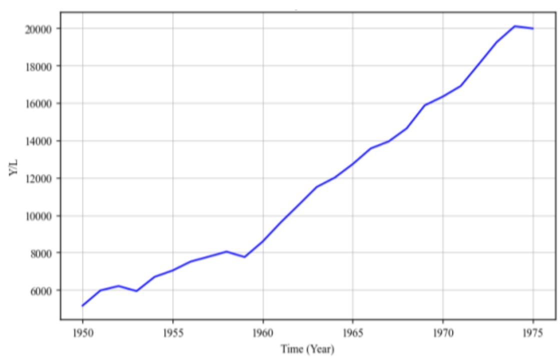
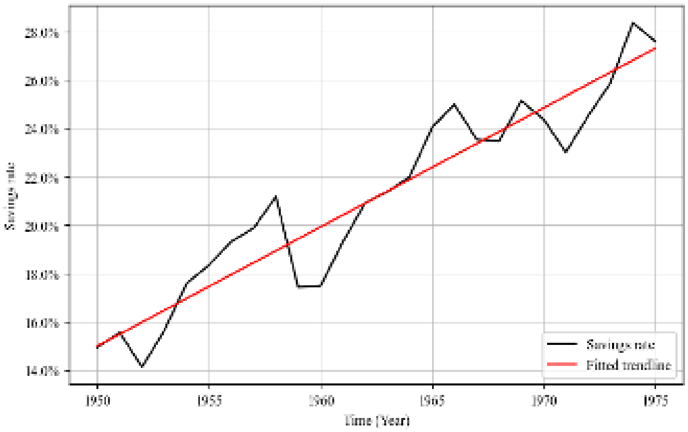
Capital per worker	Output per worker
	

Figure 8: Trend of saving rates



4.4. Applying Romer model the interval 1986-2008

For the interval 1986-2008, *Figure 5* (right) captures the consistently increasing growth pattern of Spain's real GDP. Moreover, the regression results in *Table 4* confirm that β_1 and β_2 are nonnegative, suggesting that the GDP grew at an increasing rate from 1986 to 2008. *Table 5* further supports this finding, as the estimate of *t* in Model 1 (column 3) is 0.031, which is statistically significant at the 1% level in a one-sided test and null hypothesis of that a nonpositive trend in the growth rate can be rejected. However, β_1 is estimated as insignificant as 0.0036 (column 4 of *Table 5*) when t^2 is included, which should be treated with caution. On the other side, the estimated coefficient of t^2 is 0.000289 which is positively significant at a 1% confidence level, indicating a convex curve of the GDP growth and thus providing evidence for the Romer model.

This increasing growth trend from 1986 to 2008 is in line with the Romer model, which assumes increasing marginal productivity in the production function (Romer, 1986). From a historical perspective, labour played a key role in economic growth (McVeigh, 1999; Prados & Sanz, 1996), as immigration reforms led to a significant rise in the labour force after Spain joined the EEC in 1986 (De La Escosura, 2007; Corujo, 2014). The Romer model assumes a fixed proportion between R&D labour and total labour. Therefore, as Spain's total labour force grew, R&D labour should have increased proportionally—supporting the model's prediction that R&D labor was a key driver of GDP growth during this period. However, most immigrants entering Spain were low-wage workers on short-term contracts in real world (Wölfl & Mora-Sanguinetti, 2011; Prados & Sanz, 1996). This suggests that the actual composition of the labour force may not have fully followed Romer's assumptions. As for TFP, real R&D expenditure in Spain increased by 140% between 1991 and 2001, according to OECD data (2003) (Busom, 2010), which is a key driver of productivity growth.

Word count: 2940

Reference

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