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Fundación de Estudios de Economía Aplicada

Eppur si Muove! Spain: Growing without a Model*

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Abstract

The purpose of this article is to analyze the growth of the Spanish economy since the advent of democracy until today. In the first part, the specificities of the growth model are analysed, showing that the empirical evidence is not consistent with the conclusions of the standard growth models (i.e. neoclassical growth model with exogenous TFP). More precisely, in the last 30 years Spain has experienced two long growth cycles which, far from being balanced, have shown major differences in the path of the relevant aggregated ratios. While the first cycle (1978-1993) showed a relatively small increase in employment and a considerable rise in productivity, the second cycle (1994-08) proved exactly the opposite: a spectacular increase in employment and a small gain in productivity. In the second part we develop a dynamic general equilibrium model of technology adoption dynamic à la Boldrin and Levine (2002), trying to account qualitatively for the main Spanish growth facts. We show that the characteristics of the labor market in Spain, with a dual system that protects permanent workers at the expense of temporary ones and an inefficient collective wage bargaining system have played a very relevant role in explaining the growth patterns of the last 30 years.

Resumen

El objetivo de este artículo es analizar el proceso de crecimiento de la economía española desde los orígenes de la Democracia hasta nuestros días. En la primera parte analizamos las peculiaridades del modelo de crecimiento y vemos como la evidencia empírica no es consistente con las predicciones de los modelos de crecimiento estándar (i.e. modelo de crecimiento neoclásico con TFP exógena). En concreto, en los últimos 30 años España ha presentado dos largos ciclos de crecimiento que lejos de estar equilibrados han presentado grandes oscilaciones en todos los ratios relevantes. Así, el primer ciclo (1978-93) se caracterizó por un incremento relativamente pequeño del empleo y un considerable aumento de la productividad, mientras que el segundo ciclo (1994-08) presento justo las características opuestas: espectacular avance del empleo y escaso avance de la productividad. En la segunda parte del artículo, desarrollamos en un modelo de equilibrio general con adopción tecnológica a la Boldrin y Levine (2002) y tratamos de replicar cualitativamente los principales hechos estilizados. Demostramos que las características del mercado de trabajo en España, con un sistema dual que protege a los trabajadores indefinidos a costa de los temporales y una negociación colectiva ineficiente, han jugado un papel muy relevante a la hora de explicar el patrón de crecimiento de los últimos 30 años.

Contents

1 Introduction

Through the lenses of a couple of neoclassical dynamic general equilibrium models we try making sense of the Spanish growth experience since its transition to democracy, in the middle 1970s. To do this we use mostly data for the last thirty years but sometimes go back to the "Franco's era" to either stress some dramatic difference or learn something about long run trends and features of the Spanish economy.

Our conclusion is that, maybe, "España es diferente" from what standard theory predicts, but not by much. While it is true that the Spanish growth experience is inconsistent with the predictions of the most established models of economic growth, it is also true that the Spanish growth process can be rationalized by a "not so strange" dynamic general equilibrium model of technology adoption once three historical and institutional characteristics of Spain are taken into due account.

i) Spain was all along, and still is today, far from the technological frontier: hence we are studying the dynamics of a catching-up process.

ii) Right after the transition Spain adopted a very rigid and non-competitive labor market that was partially reformed in the 1980s and then again in the 1990s. It has turned not into a competitive market, but into a dual one, with protected tenured workers on one side, and completely disenfranchised temporary workers on the other.

iii) During the last decade or so, Spain has witnessed a dramatic inflow of cheap migrant labor that increased its labor force of about 25%.

Taking these peculiarities into account, we believe to have learned something useful along three dimensions. First, about how the actual Spanish growth experience has taken place, and about which theories are consistent with it. Second, about the kind of growth patterns neoclassical growth models can capture. Third, about which policies may be useful in the current situation, and in the near future. We will elaborate on each of these themes in due course.

The paper is organized as follows. We start with a description of the aggregate time series and we highlight a number of puzzles, or questions. Next we use a standard, neoclassical growth model with exogenous TFP, competitive markets and a Cobb-Douglas technology to perform a growth accounting exercise and explain why the puzzles identified in the historical analysis are indeed puzzling in the light of established economic theory. After this, we sketch a different theoretical model and outline how it can account for the Spanish growth facts, at least qualitatively. Finally, in the last section, we wrap up our analysis and briefly discuss some of its policy implications. We include a data Appendix at the end of the paper.

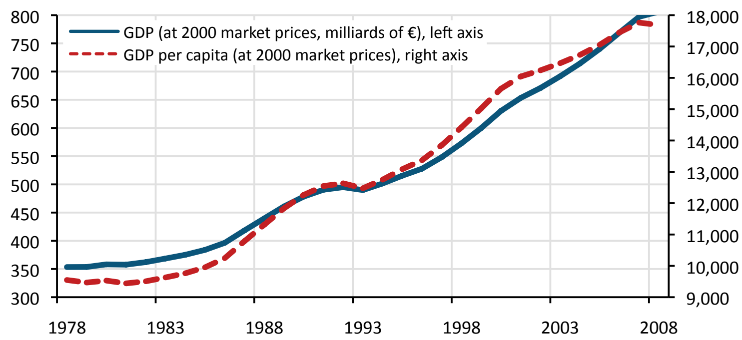
2 A Look at the Spanish National Accounts

2.1 Gross Domestic Product

Here is Spanish GDP from the beginning of democracy, thirty years ago, to today, expressed in the market prices of the year 2000. First things first: Spain grew. Over the last three decades, Spanish GDP grew by 128%, which corresponds to an average annual growth rate of 2.4 percent, and Spanish per-capita GDP grew by 84 percent, which corresponds to a 1.7 percent average annual growth rate, pretty close to Ed Prescott's magical 2% number. In Figure 1 we represent both time series.

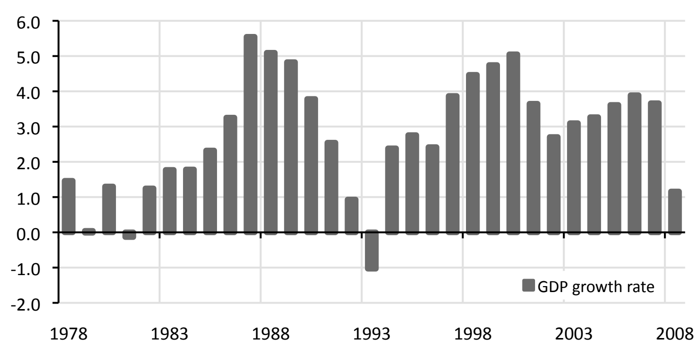
In Figure 2 we represent the growth rates of Spanish GDP. Two very long "growth cycles" stand out. The first cycle started roughly at the time of Spain's admission into the European Union in 1985, or perhaps

Figure 1: GDP and GDP per Capita (2000 constant market prices)



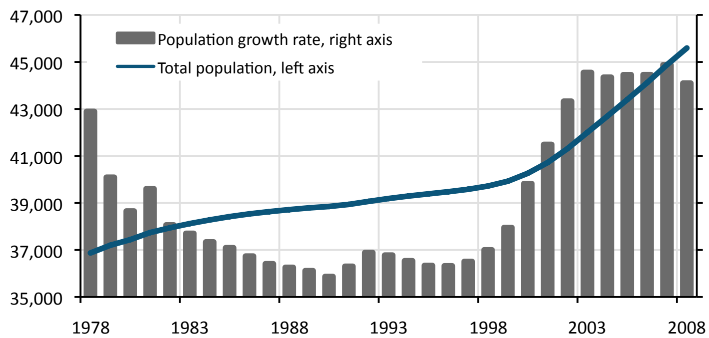
slightly before that, and it ended abruptly in 1992-93. The second cycle started in 1994-95 and it ended even more abruptly in 2007-08, as we all know. Had we gone back further in time, as far back as the available set of consistent time series allows us, we would have found a third, even longer, growth cycle that started in 1959-60 and lasted until 1973-74. It was followed by almost a decade of economic stagnation. Two full cycles in about thirty years, and each one of them about 15 years long, are clearly not the matter of "standard" business cycle theory. At least, this is certainly not the frequency at which business cycle analysis is carried out, and business cycle models are written, calibrated, and simulated. Because of this, we look at growth models for guidance and we ask whether they can account for the Spanish experience in one way or another. We also ask whether they can help us to understand it, and to make informed guesses about the times to come.

Figure 2: GDP growth rate (2000 constant market prices)



Per capita income has traveled roughly along the same waves, even if the last one —which seems bigger than the previous one in the aggregate data — is in fact smaller when measured in per capita terms. It so happens that after about thirty years of very slow growth, Spanish population grew at a remarkable pace during the last ten years from 39M to 45M people (see Figure 3 and Table A.1 in the Appendix). This implies that the growth rate of per capita income has been about 1.5 percentage points lower than the aggregate growth rate.

Figure 3: Spanish Population annual growth rate



2.2 Expenditure

While they do not really add much to the information contained in Figure 1, it is worth looking at the evolution over time of the various components of Spanish GDP. Consumption is first (see Figure A.1) and it reveals nothing we would not already know or expect: it displays two growth cycles, but less pronounced than those in GDP, as elementary economic theory predicts. Government consumption grows remarkably faster than private consumption and it is also quite pro-cyclical. The diligent reader may want to make a note of the latter, as a number of models, frequently adopted to either interpret the data or provide prescriptions for policy, predict or advocate government spending to be counter-cyclical. In Spain, at least, it certainly has not been.

Again, as elementary economic theory predicts, investment fluctuates more than GDP. In fact, as Figure A.2 shows, the growth rate of Gross Capital not only went negative twice already in Spain (the third time is still taking place and it is only barely hinted at in the available data) but it also displays, especially in the equipment component, three cycles, as the slowdown of 2001 was substantial.

Finally, because the National Income Accounting of Spanish expenditure is not complete without a look at the external sector, but also because Spain is a small and progressively *much more* open economy[1], we should take a look at imports and exports, and the trade deficit, also reported in the Data Appendix (Figures A.5 and A.6). Again, we find the two long cycles with, again, the inflection around 2001 and the dramatic growth of which we are all aware, especially in imports, during the last seven years.

2.3 Production

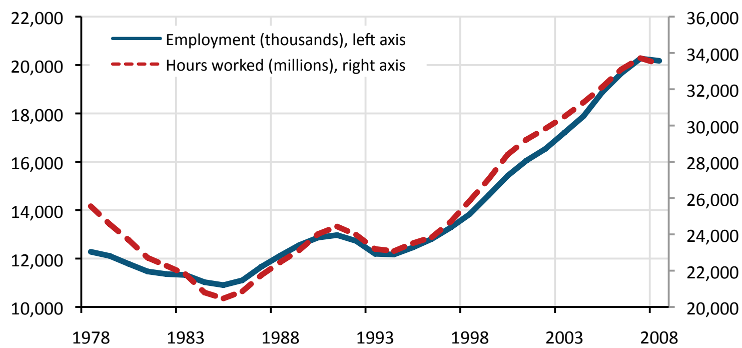
We use a production function $F_t(K_t, L_t, ...)$ to summarize the link between inputs and outputs. Value added is the result of "mixing" and operating together labor and capital, under varying technological conditions.

2.3.1 Employment

Let us start from the aggregate employment numbers, reported in Figure 4. Here comes the first surprise: the two cycles, so visibly similar in the output and demand data, are still visible but they are less similar here (see also Figure A.7 where we report the employment growth rates). During the first growth cycle

[1] Spain has an openness ratio, $(X + M)/GNP$, of 0.7 which is bigger than Great Britain, France, or Italy.

Figure 4: Employment and Labor Hours



employment grew, but not a lot: by about 1.2 million workers in absolute terms from trough to peak, which corresponds to about 10% of its initial value. During the second growth cycle, employment grew much more in both absolute and relative terms: by about 8 million workers and 66%. Therefore, while total output grew at very similar annual rates during the two growth waves (see Table A.1) employment did not.

Maybe a reconciliation can be found in the behavior of total labor hours, which are the product of hours per worker and the number of workers. But (see Figure A.8) the answer is not there either: hours per worker have been declining, albeit not steadily, since 1978. Hence, as we can see in Figure 4 total hours worked have behaved almost like the number of workers: they increased by about 11% during the first growth wave and by about 40% during the second wave.

From a long run perspective, and focusing on the number of workers, there was an almost *de facto* stagnation between 1976 and 1994, followed by a spectacular growth of about 86 percent from trough to peak between 1994 and early 2008, when employment started to decline again. In more detail: the Spanish economy destroyed about 1.8 million jobs between 1976 and 1984. It slowly recovered them, only to remain stuck at a total employment figure of about 13 million workers until 1993, when it lost about 1 million workers in roughly two years. To put it differently, in the fifteen years that preceded the 1993-94 recession, the growth rates of total employment remained between 0.5 and 0.9 percent per year, to result in a total increase of about 1.4 million jobs in 13 years (1980 to 1993). Then, during the 14 years between 1994 and 2008, the Spanish economy created more than five times that number of jobs!

Figures A.7-A.17, in the Data Appendix, document additional facts about the Spanish labor market. While it is true that, after 1992, the employment of women more than doubled and grew, in percentage terms, a lot more than the employment of men, in absolute terms the increases were about equal: 4 million extra employed males and 4.3 million extra employed females. Hence, Spain's "new" employment was tremendously egalitarian amongst the sexes while the most recent data suggests that the "new" unemployment is not. Because most of the labor adjustment, approximately 55 percent, has taken place in the construction sector, males are being fired an order of magnitude faster than females (see Figure A.10 and A.11).

Figure A.12 also shows that the expansion that just ended was not all "bricks and mortar". Employment in the services sector roughly doubled during the same period, from 7.2 million in the second quarter of 1994 to 13.9 million in the third quarter of 2008. This means that most of the extraordinary growth in employment took place in the service sector[2]: about 6.5 million went into services, 1.7 million went into construction and 1.8 million went into industry. Figure A.13 shows how this increase was split, 55-45, between Spanish nationals and immigrants. The following table summarizes our main findings about the two growth cycles.

[2]Real state services, during the last expansion, represented less than 1% of total employment in services.

Table 1: Changes in the Labor Market during the two Growth Waves

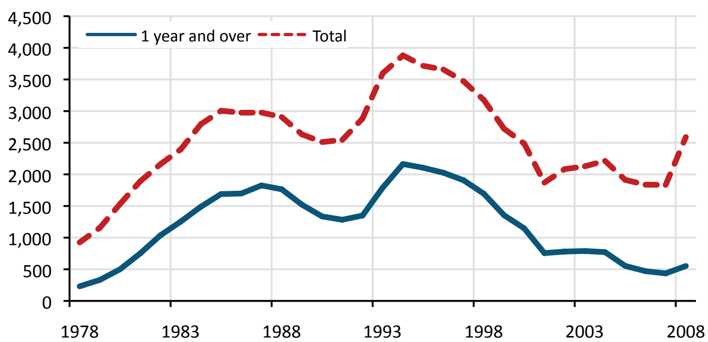
	ΔL^a	$\Delta L\%^b$	$\Delta(L/N_1)^c$	$\Delta(L/N_2)^d$	ΔH^e
1984–1993	1,172.9	10.6%	2.4%	–0.1%	11.5%
1994–2008	8,006.0	65.9%	18.7%	14.3%	44.7%

[a]Growth in employment (thousands); [b]Growth in employment (%); [c]Growth in Employment per person in the 16–64 age group (%). [d]Growth in Employment per person over 16 (%); [e]Growth in labor hours (%).

2.3.2 Unemployment

While "unemployment" is, for many known reasons, a poorly defined concept, we analyze its reported values next to help us zoom-in on our first "puzzle".

Figure 5: Unemployed (LFS) and more than 1 year unemployed



Beginning with the crisis of 1974-75, a "stock" of about 2.5-3.5 million "unemployed" people was created, in a process that lasted more than ten years and peaked around 1985. That "stock" of unemployment remained there for about 10-15 years and, even during the very best years of the latter expansion, between 2002 and 2006, there were still 2 million officially unemployed people in Spain! During the 1975-2000 period, the stock of working age people grew at a moderate rate of about 0,8% per year and scholarization grew tremendously[3] still, as Figure 5 shows, the stock of people unemployed for more than a year dropped below 1.5 million only in 2000. After that date, and in spite of a much higher growth rate of the working age population, which runs at around 1.7% between 2001 and 2008, the number of long term unemployed drops below 0.5 million.

Summing up: the two growth cycles differ in their duration but, most importantly, they differ in their impact upon employment and unemployment. The first growth wave, between 1985 and 1993, was a somewhat "jobless" expansion that lead to a very small reduction of the Spanish unemployment rate. The second growth wave, between 1995 and 2007, lead to a very large increase in employment and to a substantial drop in the measured unemployment rate. Therefore, we ask:

Question No. 1 *What, if anything, happened to the Spanish labor market in the late 1980s or early 1990s that may help us understand the large differences in the behavior of employment between the two growth waves?*

Question No. 2 *If the change was not in the labor market, where was it?*

[3]In 1978, 77 percent of the working age population had either primary or lower levels of education, while, in 2008, 50 percent of the working population had secondary education or higher.

2.3.3 Productive Capacity

To assess how productive capacity evolved over time we look at the movements of the capital/output ratio, K/Y, reported in Figure 6 and Figure 7 at 2000 prices. Our data, in this case, reach back to the 1960s. We observe that during the great expansion that ended around 1973, the K/Y ratio dropped dramatically, suggesting either very large productivity gains or a "wearing out" of productive capacity due to an investment rate lower than what a sustainable growth process would require. After 1974, K/Y starts growing again and it does so in a cyclical fashion. Obvious to some as this may be, it is hardly consistent with the predictions of standard growth models, be they of the endogenous or exogenous variety.

Figure 6: The Growth Rates of the Capital-Output Ratio and GDP

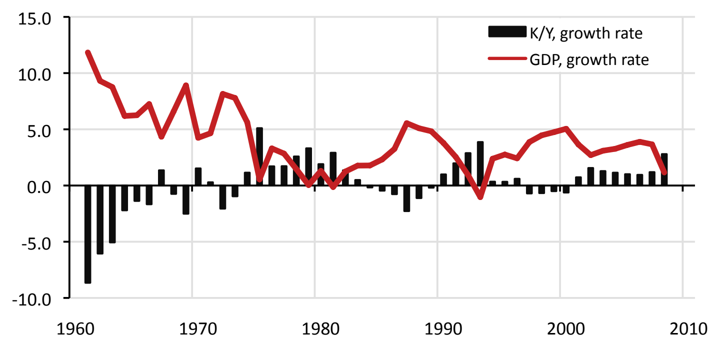


Table 2: The Correlations of the Growth Rates of Output, Labor, K/Y, and K/L

	Period 1961–2008				Period 1961–1975				Period 1976–2008			
	ΔY	$\Delta(K/Y)$	$\Delta(K/L)$	ΔL	ΔY	$\Delta(K/Y)$	$\Delta(K/L)$	ΔL	ΔY	$\Delta(K/Y)$	$\Delta(K/L)$	ΔL
ΔY	1.00				1.00				1.00			
$\Delta(K/Y)$	–0.89	1.00			–0.95	1.00			–0.81	1.00		
$\Delta(K/L)$	–0.20	0.36	1.00		–0.73	0.87	1.00		–0.85	0.80	1.00	
ΔL	0.35	–0.27	–0.87	1.00	0.47	–0.35	–0.43	1.00	0.89	–0.65	–0.95	1.00

Data reported in the Appendix (Figures A.18-A.21) confirm both of these findings: the recession of 1973-74, and the long stagnation following it, define a shift in the statistical relation between capital and output. In the earlier period, capital is growing faster than labor (hence K/L is increasing) but a lot slower than output (hence K/Y is decreasing); this is consistent with the standard growth model, positing that growth in Total Factor Productivity accounts for the difference between the growth in output and the growth in K and L. Figures 8 and 9, below, seems to confirm this interpretation. The two ratios comove but their growth rates are of different magnitudes; the difference is accounted for by a positive TFP growth rate. After, roughly, 1974-75, the growth rates of K/L and K/Y become similar, (see Figure 7), implying that TFP growth has essentially halted. Again, recall that standard growth models predict K/Y should be roughly constant and K/L procyclical, at least as long as growth is driven by labour-augmenting technological progress. Hence we ask:

Question No. 3. *Where did TFP growth go and what got rid of it?*

Figure 7: The Capital-Output and Capital-Labor Ratios

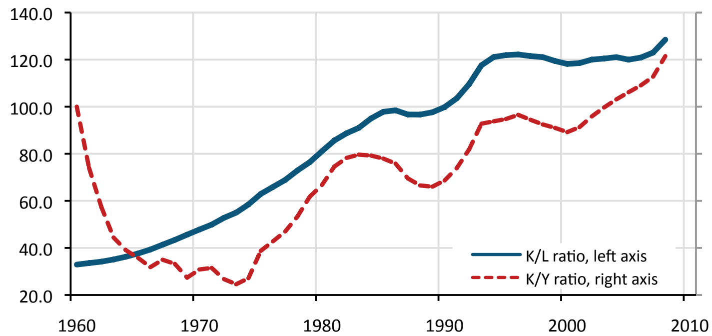
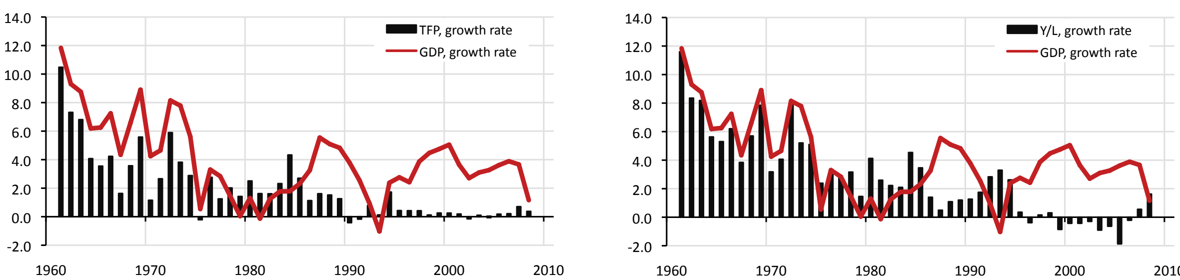


Figure 8: The Growth Rates of Total Factor Productivity, Y/L, and GDP



2.3.4 Productivity

Next, in Figure 8, we show the growth rates of two standard measures of aggregate productivity: labor productivity (Y/L) and total factor productivity (TFP). The message is clear: during the last thirty years, productivity growth in Spain was countercyclical. Both measures of productivity increased during recessions and periods of slow growth, while decreasing when output and employment grew at above average rates.

Once again, it was not always like this: the correlation between productivity and growth was the "usual" one before 1975 and it changed after that (see Table 3). For example, the correlation between the growth rates of output and output per worker changed from 0.95, between 1961 and 1975, to –0.60, between 1976 and 2008. The change in the correlation between the growth rates of output and TFP —from 0.95 to –0.25— is similarly striking. Such radical changes cannot be reconciled with the predictions of any of the readily-available off-the-shelves models. Nor can they be attributed to some kind or another of a "business cycle" shock, because the first pattern lasted for almost twenty years and the second one has been with us for more than thirty years now. The ongoing recession, which has brought about a remarkable jump in labor productivity, reinforces the puzzle.

This leads to reformulate Question 3 as follows:

Question No. 4. *Why did productivity growth become negligible and countercyclical after 1975?*

Figure 9: TFP Growth Rate and K/Y

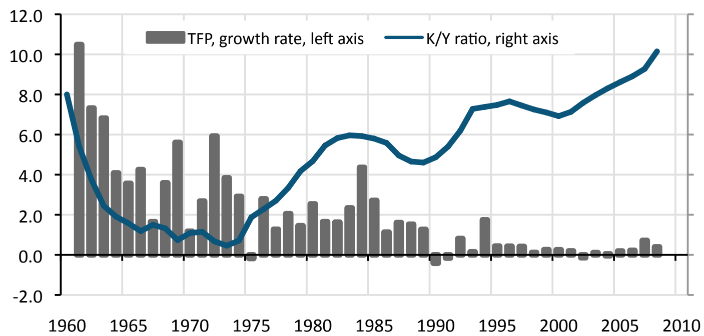


Table 3: The Correlations of the Growth Rates of Output, TFP, and Y/L

	Period 1961–2008				Period 1961–1975				Period 1976–2008			
	ΔY	ΔTFP	Δ(Y/L)	Δ(Y/H)	ΔY	ΔTFP	Δ(Y/L)	Δ(Y/H)	ΔY	ΔTFP	Δ(Y/L)	Δ(Y/H)
ΔY	1.00				1.00				1.00			
ΔTFP	0.74	1.00			0.95	1.00			–0.25	1.00		
Δ(Y/L)	0.62	0.92	1.00		0.95	0.99	1.00		–0.60	0.74	1.00	
Δ(Y/H)	0.53	0.94	0.94	1.00	0.93	0.98	0.99	1.00	–0.59	0.90	0.84	1.00

2.4 Changes in the Spanish Labor Market

The two main reforms of the Spanish labour market took place in 1984 and 1994. The 1984 labour reform completely liberalized term contracts, which started to be used extensively after that date. This created, *de facto,* a dual labor market*:* jobs that existed before the reform remained "protected", and jobs created after the reform could fall into either of the two separate worlds, permanent jobs and term jobs. As it should be expected, term contracts grew slowly at the beginning, and then spread across the economy like wildfire. By the early 1990s, one third of Spanish workers had a liberalized term contracts (see Figure A.17).

The 1994 reform was more far-reaching. It allowed private employment agencies to operate freely, and it substantially altered the *Estatuto de los Trabajadores*, weakening many of the previous employment protection rules. It also introduced additional flexibility in firing costs and in the collective bargaining process, allowing for a large variety of "opt-out" clauses that could be used by companies subject to one form or another of "economic distress". Finally, the 1994 reform also reduced the generosity of the unemployment insurance program. It was completed in 1997 with the introduction of a new contract called the *Contrato de Fomento a la Contratación Indefinida*, which lowered severance pay albeit in a controversial way: the new contract did not apply to workers in the 30-44 age group who had been unemployed for less than a year, thereby consolidating the dual nature of the Spanish labor market. A further reform took place in 2002, leading to a minor reduction in firing costs.

2.5 Factor Prices and Factor Shares

2.5.1 Cyclical Labor Shares

Figures 10 and 11 report factor shares, and their growth rates, together with the growth rates of output. Quite visibly, Spanish factor shares follow a cyclical pattern until the last expansion, after which the cyclicality switches sign (our hunch, though, is that when the data for the current recession will become available, the cyclicality, as described below, will become apparent again). This overall cyclical nature is confirmed by the sample correlations, reported in Table 4. These regular oscillations contradict the standard model and beg for an explanation.

Figure 10: Capital Share and GDP

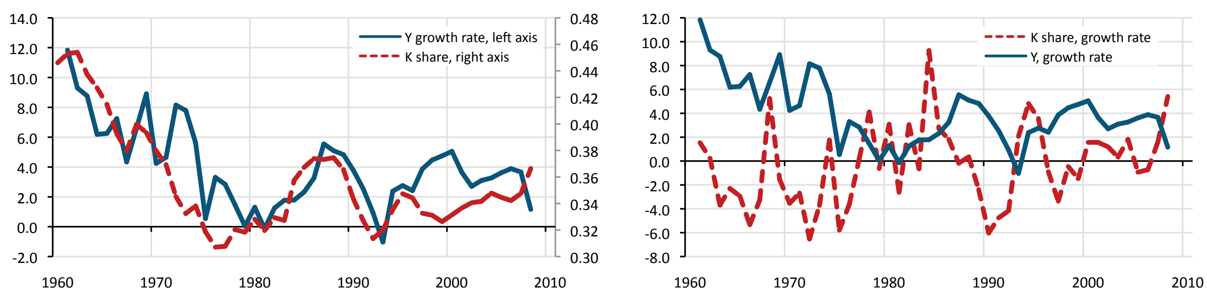


Figure 11: Labour Share and GDP

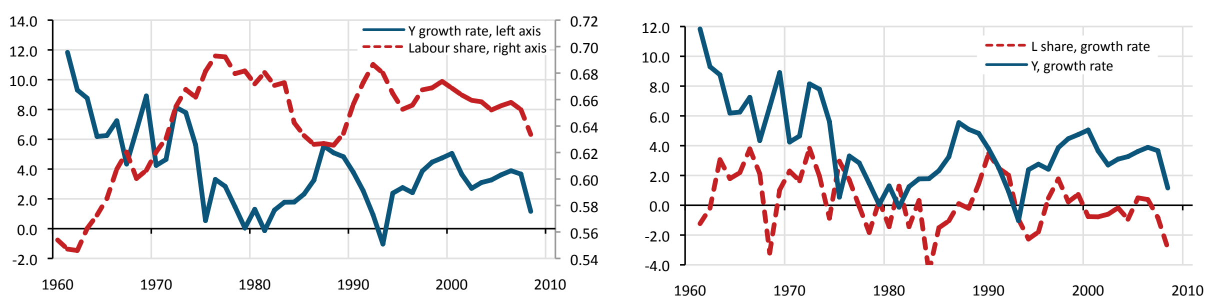


Table 4: Correlations between the Growth Rate of Output and the Factor Shares

Period 1961-2008

	ΔY	L share	K share
ΔY	1.00		
L share	-0.75	1.00	
K share	0.75	-1.00	1.00
	ΔY	Δ(L share)	Δ(K share)
ΔY	1.00		
Δ(L share)	0.27	1.00	
Δ(K share)	-0.25	-0.99	1.00

Period 1961-1975

	ΔY	L share	K share
ΔY	1.00		
L share	-0.63	1.00	
K share	0.63	-1.00	1.00
	ΔY	Δ(L share)	Δ(K share)
ΔY	1.00		
Δ(L share)	-0.28	1.00	
Δ(K share)	0.32	-0.98	1.00

Period 1976-1995

	ΔY	L share	K share
ΔY	1.00		
L share	-0.65	1.00	
K share	0.65	-1.00	1.00
	ΔY	Δ(L share)	Δ(K share)
ΔY	1.00		
Δ(L share)	0.21	1.00	
Δ(K share)	-0.20	-1.00	1.00

Period 1995-2008

	ΔY	L share	K share
ΔY	1.00		
L share	0.87	1.00	
K share	-0.87	-1.00	1.00
	ΔY	Δ(L share)	Δ(K share)
ΔY	1.00		
Δ(L share)	0.57	1.00	
Δ(K share)	-0.56	-1.00	1.00

2.5.2 Correlation between real wages and labor productivity

Figure 12 and Table 5 confirm that, at least at the most basic level, the Spanish labor market behaves "normally": on average, real wages grow when labor productivity grows and viceversa. Still, a particular "anomaly" emerges when one looks at the relation between employment, labor productivity and real wages. Before 1975, variations in real wages are essentially uncorrelated with variations in employment, while the correlation becomes strongly negative after that year. A low correlation between the aggregate real wage and employment is also a feature of the US data at business cycle frequency, and it coincides with the prediction of a standard RBC model when labor contracts are present or labor supply is highly elastic (Danthine and Donaldson, 1990, Boldrin and Horvath 1995). A negative correlation, though, such as the one visible in Spain since 1975 could obtain only absent any form of technological progress as firms, facing decreasing marginal productivity of labor, travel along their static demand curve for labor. Secondly, but this fact we already know from earlier on, while before 1975 the correlation between employment and labor productivity is weak but positive, after that year it is quite negative. Notice, again, that most standard models (in which employment is basically determined by labor productivity) predict that the correlation should be positive and strongly so. Hence, post 1975, Spain becomes an "anomalous growth country": as employment grows, productivity and real wages do not grow or even decrease.

Figure 12: Real Wages and Y/L Growth Rate

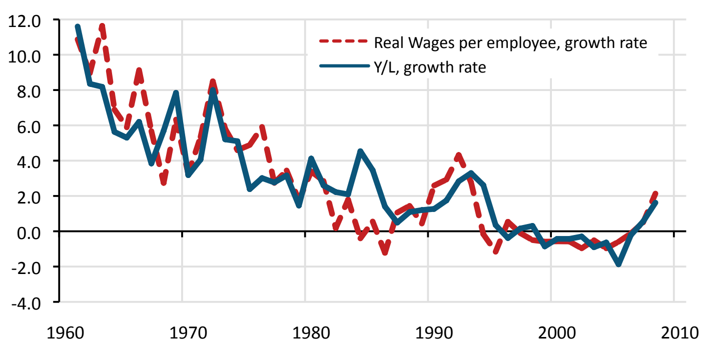


Table 5: Correlations between Real Wages and Productivity (Y/L) (1961-2008)

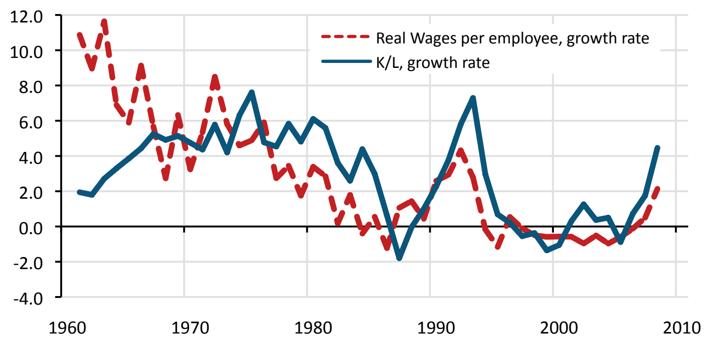
	Period 1961–2008			Period 1961–1975			Period 1975–2008		
	ΔW	ΔY/L	ΔL	ΔW	ΔY/L	ΔL	ΔW	ΔY/L	ΔL
ΔW	1.00			1.00			1.00		
ΔY/L	0.88	1.00		0.78	1.00		0.63	1.00	
ΔL	-0.39	-0.52	1.00	-0.03	0.15	1.00	-0.59	-0.90	1.00

2.5.3 Co-movements between the K/Y Ratio, Factor Prices, and Factor Shares

Figure 13 shows that the K/L ratio reacts quite strongly to factor prices: they comove. The comovements are negative until 1975 (when the real wage grows less than on average the K/L ratio grows more than on average) and positive after that. This induces yet another puzzle: we have noted that, until 1975 and among most dimensions, aggregate variables behave in a way that is similar to what a standard growth model would predict. The same model predicts that when the K/L ratio increases labor productivity and real wages increase, and this seems not to have been the case. Viceversa, after 1975, when Spanish aggregate quantities contradict the standard growth model along most dimension, this particular correlations gets on line and real wages grow together with the K/L ratio. More headhaches to come, in other words.

Finally, we note that, during both subperiods, employment grows when the labor share decreases even if the correlation is weak. Because we know that employment and real wages are negatively correlated in Spain, this simply means that (relative to output growth) employment does not grow enough to make up for the drop in wages, hence labor share decreases.

Figure 13: Real Wages and Capital per Labour Growth Rates



2.6 Summing up

We sum up our long data analysis with a list of Facts.

1. Spanish growth was neither steady nor balanced: it came in two big and long waves and it brought about wide oscillations in all standard ratios.
2. While before 1975 the aggregate Spanish variables had behaved - with the significant exception of the relation between K/L intensity and real wages - as standard growth models predict, this was no longer the case after 1975.
3. The extent of the change can be seen by comparing the correlations reported in Table 6 (Periods 1961-1975 and 1976-1994). A large fraction of the entries do not just change in magnitude but in sign.
4. The first growth cycle came with a relatively small increase in employment and a sizeable increase in productivity. The opposite during the second: extremely weak productivity growth and historically high employment growth.
5. The K/L and K/Y ratios are neither constant nor monotone.
6. The long-run slow down in productivity growth is dramatic: productivity grows strongly until 1975, slows down but remain positive between then and 1995, after which it all but disappears. Moreover, productivity growth, which before 1975 was procyclical, now becomes either a- or counter-cyclical.
7. Factor shares are far from constant: their variations are large, and systematically and strongly correlated to output growth.
8. Real wages and labor productivity are positively correlated. Nevertheless, while before 1975 employment and real wages are positively, if weakly correlated, they become negatively correlated after that. in particular after 1995 (-0.68) and after 2000 (-0.82).

Table 6: Cross-correlations

Period 1961-2008

	ΔY	$\Delta K/L$	ΔW	ΔL	$\Delta Y/L$	ΔTFP	L share	Δ(L share)
ΔY	1.00							
$\Delta K/$L	-0.20	1.00						
ΔW	0.60	0.51	1.00					
ΔL	0.35	-0.87	-0.39	1.00				
$\Delta Y/L$	0.62	0.54	0.88	-0.52	1.00			
ΔTFP	0.74	0.25	0.79	-0.30	0.92	1.00		
L share	-0.74	0.11	-0.56	-0.06	-0.63	-0.71	1.00	
Δ(L share)	0.27	0.12	0.49	0.11	0.15	0.05	-0.05	1.00

Period 1961-1975

	ΔY	$\Delta K/L$	ΔW	ΔL	$\Delta Y/L$	ΔTFP	L share	Δ(L share)
ΔY	1.00							
$\Delta K/L$	-0.73	1.00						
ΔW	0.68	-0.62	1.00					
ΔL	0.47	-0.43	-0.03	1.00				
$\Delta Y/L$	0.94	-0.66	0.78	0.15	1.00			
ΔTFP	0.95	-0.74	0.79	0.21	0.99	1.00		
L share	-0.63	0.88	-0.55	-0.17	-0.64	-0.68	1.00	
Δ(L share)	-0.28	0.21	0.26	-0.13	-0.27	-0.27	0.29	1.00

Period 1976-1994

Variables	ΔY	$\Delta K/L$	ΔW	ΔL	$\Delta Y/L$	ΔTFP	L share	Δ(L share)
ΔY	1.00							
$\Delta K/L$	-0.86	1.00						
ΔW	-0.23	0.55	1.00					
ΔL	0.94	-0.92	-0.26	1.00				
$\Delta Y/L$	-0.57	0.75	0.22	-0.82	1.00			
ΔTFP	-0.03	0.06	-0.17	-0.26	0.57	1.00		
L share	-0.65	0.81	0.72	-0.62	0.38	-0.13	1.00	
Δ(L share)	0.21	-0.10	0.53	0.37	-0.55	-0.68	0.24	1.00

Period 1995-2008

Variables	ΔY	$\Delta K/L$	ΔW	ΔL	$\Delta Y/L$	ΔTFP	L share	Δ(L share)
ΔY	1.00							
$\Delta K/L$	-0.81	1.00						
ΔW	-0.53	0.70	1.00					
ΔL	0.88	-0.92	-0.68	1.00				
$\Delta Y/L$	-0.44	0.74	0.63	-0.82	1.00			
ΔTFP	-0.09	0.22	0.53	-0.30	0.46	1.00		
L share	0.87	-0.87	-0.61	0.80	-0.47	-0.25	1.00	
Δ(L share)	0.57	-0.74	-0.31	0.65	-0.54	-0.09	0.71	1.00

3 The Standard Growth Model Does Not Work

In order to assess the extent to which the standard neoclassical model of long run growth fits or does not fit the Spanish experience, we will carry out a growth accounting exercise following Kehoe and Prescott (2002). We use a standard Cobb-Douglas aggregate production function of the form

$$Y_t = A_t K_t^{\theta} L_t^{1-\theta} \tag{1}$$

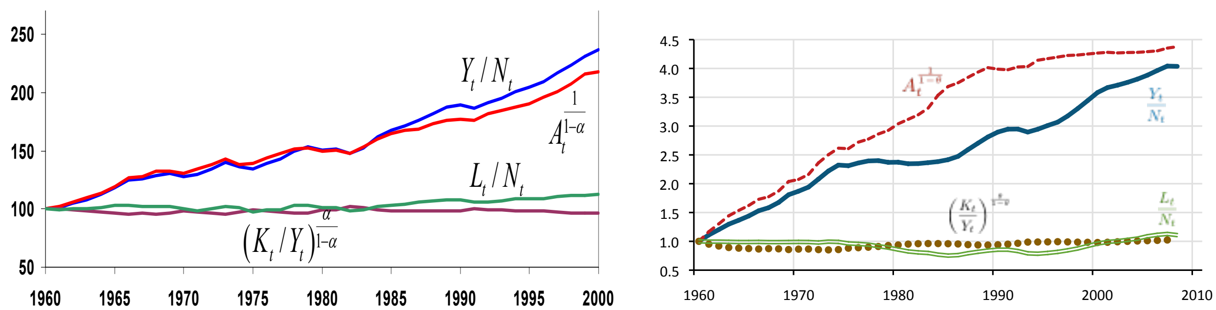
where Y_t denotes output, A_t total factor productivity and K_t and L_t the capital and labor inputs.

We decompose output per working-age person as follows:

$$\frac{Y_t}{N_t} = A_t^{1/(1-\theta)} \left(\frac{K_t}{Y_t}\right)^{\theta/(1-\theta)} \left(\frac{L_t}{N_t}\right) \tag{2}$$

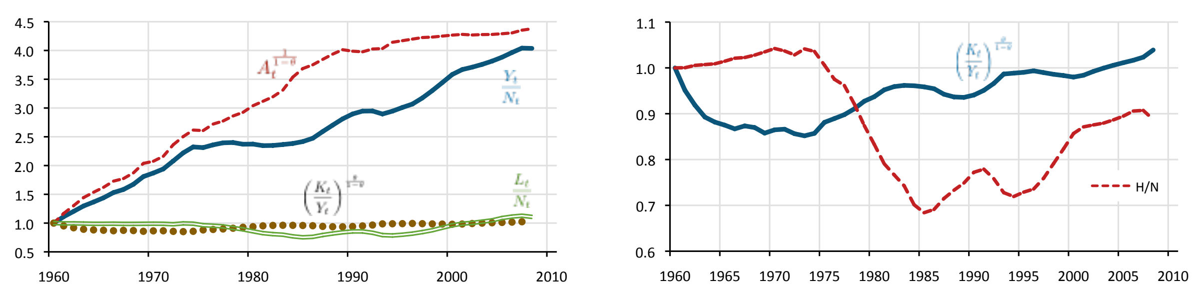
where N_t denotes the number of working-age people. Along a balanced growth path the capital-output ratio and hours worked per working-age person are constant over time. Therefore output per working-age person should grow at the same rate as total factor productivity. We report the results of this growth accounting exercise for the United States and for Spain in Figure 14 and for Spain in the first panel of Figure 15.

Figure 14: Growth Accounting for the USA and for Spain



Clearly the United States is pretty much on a balanced growth path during the entire period considered, while Spain departs form its balanced growth path sometime around 1975. After this year, Spanish output per working age person grows slower than TFP until about 1986, then it speeds up recovering some of the lost ground and, eventually, catching up with TFP in 2007.

Figure 15: Growth Accounting for Spain



Combining the two panels of this figure, one can see how these differing tendencies result from the combination of non-monotone movements in TFP and hours worked. During the first twenty years (1975-1994) the employment rate and hours worked per employed person decrease, while TFP growth remains positive, albeit lower than before. This leads Y/N to fall substantially behind TFP. After 1995, though, TFP growth comes almost to a halt, while employment growth accelerates again so that output per working age person overtakes total factor productivity in 2007, which is the last year for which we have reliable data. The oscillations in the K/Y ratio, also reported in the second panel, we have already noted earlier and cannot be accounted for by the model. Notice, again, that after 1975 the shape of the hours per working-age person series is almost a mirror image of the capital-output ratio series.

3.1 Which Kind of Model May Work?

The standard model, based on smooth capital-labor substitution and a continuous process of TFP growth, has no way of accounting for the many anomalies we have observed. Models based on externalities have even fewer chances: not only because they lack an explicit treatment of employment and, many times, even of capital accumulation but because, in particular, their long run predictions are identical to those of the standard neoclassical model. In particular, they predict constant shares, a constant or declining (due to increasing returns) K/Y ratio, labor productivity growing with employment, and so on.

To at least begin capturing the anomalies identified in our empirical analysis, we need a model where

A. There is growth, but it does not come at a constant pace. An endogenous growth model in which growth is cyclical.

B. Growth in output and employment brings about a sharp increase in labor cost and labor share in the first wave, none of that in the second. Recessions bring about the opposite movement. This requires a model where changing labor market conditions affect labor productivity growth and wage growth.

C. Technological change may slow down and come to a halt endogenously. When there is technological change, labor productivity and wages grow, when it stops they also stop growing.

E. Technological change comes around when labor is scarce and expensive, much less or not at all when labor is cheap and abundant.

4 A Variant of the Neoclassical Growth Model

We illustrate here our basic analytical framework under the assumptions of a representative agent, complete markets, and two aggregate firms producing capital and consuption goods respectively. There is no doubt that neither the representative agent nor complete markets were sitting around Spain during the last thirty years, or before for that matter. Similarly, reducing everything to a couple of representative firms producing two aggregate goods, consumption and capital, may trivialize many aspects of Spanish economic development. Still, these simplifications should allow us to focus on the main forces at work and illustrate in what sense a modified neoclassical model can help our understanding of the Spanish growth experience. More general versions of this model can found in Boldrin (2009) and Boldrin and Peralta Alva (2010), while its original version is in Boldrin and Levine (2002).

4.1 Preferences

There is a continuum of identical agents, whose preferences are represented by

$$\max \sum_{t=0}^{\infty} \delta^t \left[u(C_t) + v(1 - L_t) \right].$$

The utility functions $u(C_t)$ and $v(1-L_t)$ are monotone increasing, strictly concave, continuously differentiable and real valued.

4.2 Technology

Production takes places in two different sectors, $s = a, b$, both composed of homogeneous firms. Description of the two sectors follow.

Firms in the first sector use their *active technologies* to produce *aggregate consumption*, C_t, through labor, L, and productive capacity, Π, according to a neoclassical production function $G(\Pi, L)$. In each period, starting with a given productive capacity, they hire labor in a competitive market, produce and sell output, and purchase the investment goods determining future productive capacity. This is done in two ways: by augmenting the capital stock embodying already active technologies, or by *restructuring*, i.e. adopting a not-yet-active technology, embodied in a new capital stock. Once a firm introduces a new technology[4] we label the latter as *active* . Because Spain is a relatively small country operating inside the world technology frontier, we abstract from the problem of invention and innovation: new, more advanced technologies are already available out there. To restructure themselves, firms only need to purchase the capital goods embodying the new techniques and pay the additional adoption costs.

Firms in the second sector also use labor and productive capacity to produce *aggregate investment*, I_t, again according to a neoclassical production function $H(\Pi, L)$. Apart for labels, everything works as in the consumption sector.

The total endowment of leisure/labor time is fixed at one in all periods. There are as many capital goods, K_t^j, as there are technologies, $j = 0, 1, 2, ...$ Abstracting from the time dimension, there are three homogeneous goods (consumption, investment and labor) and a countable infinity of technology-specific capital goods. The current value prices are denoted, respectively, by $\{p_t^a\}_{t=0}^{\infty}$ for the (dated) consumption good, $\left\{p_t^b\right\}_{t=0}^{\infty}$ for the (dated) investment good, $\{w_t\}_{t=0}^{\infty}$ for the (dated) labor, and $\left\{q_t^j\right\}_{t,j=0}^{\infty}$ for the (dated and technology-specific) capital goods. Set $p_0^a = 1$ as the numeraire.

4.2.1 Consumption Sector

Production Firms have access to a countable number of technologies, indexed by the superscript $j = 0, 1, ...$ We say that a technology j is *active* in period t if $K_t^j > 0$, i.e. the (representative) firm making up this sector owns a positive amount of capital stock of type j. Denote with $J_t = \{\underline{j}_t, ..., \overline{j}_t\}$ the set of all technologies that are active at time t. Think of the technologies as plants, each one exhibiting constant returns to scale.

Using plant $j \in J_t$, the representative firm obtains output

$$Y^j = \min\{K^j, \alpha^j L^j\},$$

where K^j and L^j are capital and labor, and α^j is a labor productivity parameter. Aggregating over plants we get

$$Y = \sum_{j \in J_t} Y^j,$$

Define the markeatable output of sector a as

$$C = A\,(Y)^{\theta}\,,$$

[4]Or capital good, as the latter embodies the former: the two terms are synonymous. With "productive capacity" we refer, instead, to the aggregation of all existing capital goods-technologies.

where A is a sector-specific productivity parameter, while $\theta \in (0,1)$ captures the decreasing returns induced by limited span of control at the firm level. It is important to notice that C is marketable, while neither Y^j nor Y are.[5]

Labor productivity is explained next. Assume that each technology j comes with an average labor productivity parameter α^j, where $\alpha > 1$ and j is an exponent. Hence, technological progress is, on average, labor-saving because $\alpha^j > \alpha^{j-1}$. The choice of technologies is endogenous, and carried out at the firm level: each firm knows α^j when adopting technology j.

At the beginning of period t, due to past investment decisions, the representative firm owns a vector of capital stocks $K_t = \{K_t^{\underline{j}_t}, ..., K_t^{\overline{j}_t}\}$, with $\underline{j}_t \leq \overline{j}_t$. This allows the definition of *potential productive capacity*

$$\Pi_t = A\left[\sum_{j \in J_t} K_t^j\right]^\theta,$$

and *potential employment*

$$\Lambda_t = \sum_{j \in J_t} \frac{K_t^j}{\alpha_t^j},$$

in period t.

Finally, let $\varphi_t^j \in [0,1]$ denote the *degree of capacity utilization* for technology j in period t,

$$\varphi_t^j = \frac{\alpha_t^j L_t^j}{K_t^j}.$$

Marginal productivity of labor at the plant level is

$$\frac{\partial Y_t^j}{\partial L_t^j} = \alpha_t^j, \ for \ \varphi_t^j < 1, \ and \ zero \ otherwise.$$

Because total output of the consumption good is

$$C_t = A\left[\sum_{j \in J_t} \alpha^j L^j\right]^\theta,$$

the marginal productivity of a unit of labor in the consumption sector, when applied to plant j, is

$$\frac{\partial C_t}{\partial L_t^j} = \theta A \alpha_t^j \left[\sum_{j \in J_t} (\alpha_t^j L^j)\right]^{\theta - 1}, \ for \ \varphi_t^j < 1, \ and \ zero \ otherwise.$$

Expansion of Productive Capacity A firm, starting period t with productive capacity equal to $K_t = \{K_t^{\underline{j}_t}, ..., K_t^{\overline{j}_t}\}$ and scrapping the amounts $S_t = \{S_t^{\underline{j}_t}, ..., S_t^{\overline{j}_t}\}$, is left, if it does not carry out any investment, with a productive capacity of $(1-\mu)K_t - S_t$, where the latter should be read as vector notation. Output of the investment sector is homogeneous but specializes once applied to a specific technology. Let I_t^j be the amount of investment goods allocated to active technology $j \in J_t$. We set

$$K_{t+1}^j = (1-\mu)K_t^j + I_t^j - S_t^j.$$

[5]Returns are therefore decreasing in capital and labor at the representative firm (sector) but not at the plant level. The parameters A and θ summarize firm-specific factors, reconciling the model with constant return to scale in the full list of productive factors.

Let $I_t = \sum_{j \in J_t} I_t^j$, and notice that this addition is meanigful because new machines are identical before being applied to a technology. We assume that investment/scrapping decisions are made at the end of the period, i.e. after production has been carried out. Because $\alpha > 1$, in this simple version the only active technology with positive gross investment will be the *best available technology* $\overline{j}_t$.[6]

We define the *marginal technology* $\widehat{j}_t$, in period t, as the lowest indexed technology for which $L_t^j > 0$. Notice that $\widehat{j}_t \geq \underline{j}_t$, possibly with strict inequality in the stochastic case. At the end of a period a firm may also purchase investment goods in order to restructure itself, i.e. introduce the *new technology* $\overline{j}_t + 1$. Let D_t be the total amount allocated to this purpose, we assume that

$$K_{t+1}^{\overline{j}_t+1} = (\zeta)^{\overline{j}_t+1} \cdot D_t,$$

with $\zeta < 1/\alpha$, i.e. it is costlier to introduce a new technology than to accumulate any among the old ones. This implies that restructuring does not take place automatically: new technologies are introduced along an equilibrium path only when their labor saving effect is strong enough, i.e. the cost of labor is high enough to justify the additional cost, as discussed below.

4.2.2 Investment Sector

Production The structure of the second sector parallels that of the first. Again, let $J_t = \{\underline{j}_t, ..., \overline{j}_t\}$ be the set of all technologies that are active at time t for the representative firm in this sector. Using technology $j \in J_t$, a firm obtains output

$$Y^{\cdot j} = \min\{K^j, \beta^j L^j\},$$

where β^j is the labor productivity parameter, and the rest of the notation is as before. From a theoretical perspective, both $\alpha > \beta > 1$ and $1 < \alpha < \beta$ are admissible; the data from the last few decades seem to suggest the second is the realistic case.

Potential productive capacity is

$$\Pi_t = B \left[\sum_{j \in J_t} K_t^j \right]^\theta.$$

and *potential employment* is

$$\Lambda_t = \sum_{j \in J_t} \frac{K_t^j}{\beta_t^j}.$$

The rest is defined in analogy with the first sector; in particular, *marginal productivity of labor* is

$$\frac{\partial Y_t^j}{\partial L_t^j} = \beta_t^j, \ \textit{for } \varphi_t^j < 1, \textit{ and zero otherwise},$$

and total output is

$$Y_t = \sum_{j \in J_t} Y^{\cdot j} = B \left[\sum_{j \in J_t} \beta_t^j L_t^j \right]^\theta = I_t + D_t,$$

where I_t and D_t are obtained by aggregating across firms' demand in both sectors.

[6] In the stochastic version, a technology is the best available only in an expected value sense, and positive investment in active technologies other than the best one is an equilibrium outcome when shocks have some degree of persistence.

Expansion of Productive Capacity The law of motion of the sectoral capital stock is

$$K_{t+1}^j = (1-\mu)K_t^j + I_t^j - S_t^j.$$

The *best available* and the *marginal technology* are also defined identically to those for firms in the consumption sector, and a *new technology* may be obtained according to

$$K_{t+1}^{\bar{j}_t+1} = (\zeta)^{\bar{j}_t+1} \cdot D_t.$$

The indeces $j = 0, 1, ...$ refer to the same technologies in the two sector, which allows for machines scrapped in one sector to be traded economy-wide.

4.3 Equilibrium Notion

The notion of equilibrium is standard. In each period, given productive capacity, firms maximize their market value by hiring labor and selling their output in competitive markets. Given initial wealth, the representative agent supplies labor, receives factor payments, and makes intertemporal consumption-saving decisions. Next, firms maximize their expected value by investing in either active or new technologies for next period.

4.3.1 Firms' and Households' Problem

Starting from an initial wealth of $K_0 = (K_{0,a}, K_{0,b})$, the representative agent maximizes the intertemporal expected utility under the usual sequence of budget constraints in which consumption outlays plus the acquisition of the new capital stocks are financed by the value of the old capital stock, period's profits and period's labor income.

Firms in either sector begin each period with capacity K_t^s and labor productivity σ_t, where, from here onward, $\sigma = \alpha$ when $s = a$ and $\sigma = \beta$ when $s = b$; by analogy we will also use S in place of either A or B, hoping this is not confused with the scrapping term S_t^j that is always technology and period specific. The problem of the firm consists, first, of maximizing period's profits by choosing the current level of capacity utilization, and, second, of maximizing its market value by choosing tomorrow's productive capacity.

For $s = a, b$, the firm's static optimization problem is

$$\max_{\{L_t^j\}} \pi_t^s = p_t^s S \left[\sum_{j \in J_t} \sigma_t^j L_t^j \right]^\theta - w_t \sum_{j \in J_t} L_t^j,$$

$$\textit{subject to} : \sigma_t^j L_t^j \leq K_t^j.$$

The intertemporal optimization problem is, in each separate sector,

$$\max_{\{K_{t+1}^j\}} V_{t+1} = \sum_{j \in J_{t+1}} \left[q_{t+1}^j K_{t+1}^j - p_t^b [I_t^j + D_t^j] + q_t^j S_t^j \right]$$

subject to

$$K_{t+1}^j = (1-\mu)K_t^j + I_t^j - S_t^j, j \in J_t$$

and

$$K_{t+1}^j = (\zeta)^j \cdot D_t^j, j \in \{J_{t+1} \setminus J_t\}.$$

4.3.2 Market Clearing

Sectoral output corresponds, respectively, to aggregate consumption and aggregate investment. In the baseline model we assume that capital goods are technology specific, hence, the laws of motion given above are enough, together with the definition of potential productive capacity, to characterize market clearing in the markets for machines. Equilibrium in the market for consumption amounts to say that total consumption demand from the households equals the output of that sector.

Aggregate labor demand is $L_t = L_t^a + L_t^b \leq 1$, where

$$L_t^s = \sum_{j \in J_t} \frac{\varphi_t^j K_t^j}{\sigma_t^j}, \ s = a, b, \quad \sigma = \alpha, \beta.$$

5 Equilibrium Properties

We proceed to illustrate the dynamic behavior of the main economic aggregates in the competitive equilibrium. The cyclical dynamics of the innovation and growth process, and the special role that the cost of labor plays in determining the time and nature of innovations, is most clearly seen by focusing on the profit maximizing behavior of firms.

5.1 Employment and Factor Payments

Given productive capacity $K_t = \{K_t^{\underline{j}}, ..., K_t^{\overline{j}_t}\}$, price of output p_t^s, and wage rate w_t, the representative firm sets

$$\begin{aligned} 0 &< L_t^j \leq \frac{K_t^j}{\sigma_t^j} \ , \ if \ \theta S \sigma^j \left[\sum_{j \in J_t} \sigma^j L^j \right]^{\theta - 1} \geq \frac{w_t}{p_t^s} \\ L_t^j &= 0, \ otherwise. \end{aligned}$$

Labor supply, L_t, follows from the usual static first order condition equating the marginal disutility of labor to the real wage rate w_t/p_t^a times the period marginal utility of consumption. Labor market clearing, from earlier on, requires

$$L_t = \sum_{s=a,b} \left[\sum_{j \in J_t} \frac{\varphi_t^j K_{t,s}^j}{\sigma_t^j} \right].$$

This set of conditions implies that, for each sector and each period, there exists a *marginal plant* $\widehat{j}_t^s$ for which $0 < \varphi_t^{s,j} \leq 1$. In fact, it is easy to see that, for each sector s ,

$$L_{t,s}^j = \frac{K_{t,s}^j}{\sigma_t^j} \ , \ i.e. \ \varphi_t^{s,j} = 1,$$

will hold at all plants at which the marginal productivity of labor is larger than w_t/p_t^s, where s is the sector where the firm operates. This implies, because the installed capacity of each plant is finite and the functions involved are continuous, that there will exist a plant $\widehat{j}$ such that

$$\varphi_t^{s,j} = L_{t,s}^j = 0, \ at \ all \ plants \ j < \widehat{j}.$$

Notice that, in principle, one may have $\widehat{j}$ =min$_j$ $\{J_t\}$ =min$_j\{\underline{j}_t, ..., \overline{j}_t\}$ and $\varphi_t^{s,j} = 1$, for all technologies and all firms in both sectors. This will be the case when labor supply is especially abundant, hence cheap, relatively to installed capacity. More generally we have that in each period $t = 0, 1, 2, ...$, and for each sector $s = a, b$, there exists a marginal plant, $\widehat{j}$ such that

$$\theta S \sigma_t^{\widehat{j}} \left[\sum_{j \in J_t} \sigma_t^j L_{t,s}^j \right]^{\theta - 1} = \frac{w_t}{p_t^s}.$$

For all other plants $j \in J_t$, for which $L_t^{s,j} > 0$, the following hold

$$\theta S \sigma_t^j \left[\sum_{j \in J_t} \sigma_t^j L_{t,s}^j \right]^{\theta - 1} > \frac{w_t}{p_t^s} \ , \ and \ \varphi_t^j = 1.$$

instead.

This proposition reminds us that there is "exploitation of labor" also in standard neoclassical models of production. Within each firm, almost all workers (i.e. everyone but the marginal worker at the marginal plant) are "exploited" in the sense that they are being paid a wage smaller then their marginal productivity. The (sum total) of the difference between labor productivity and wages, over all the workers employed in a sector, is equal to the gross operating surplus in that sector, which is gross capital income.

5.2 Equilibrium Price Relations

The time t price of new machines is common to all firms and technologies: it equals the price of output, p_t^b, of the investment sector. The same is true for the price, p_t^a, of consumption, which is proportional to its discounted marginal utility for the representative consumer, $\delta^t u'(C_t)$. The latter is derived from standard first order conditions for the maximization of consumer's utility, which set the (discounted) marginal utility of consumption, at each future date, equal to the present value price of consumption at that same date. Because there is no aggregate uncertainty in this model, the consumers set their consumption levels in each future period in order to fulfill such proportionality, where the proportionality factor is given by the representative agent marginal utility of wealth; the reader is referred to Boldrin and Levine (2002) for a more complete derivation.

Installed capital is "technology-specific" (in other words, the model is "putty-clay"), hence each existing machine has its own price, q_t^j. We assume that machines are technology - but not sector - specific: in each period any firm can sell any amount of its installed capital stock to other firms, which is what the scrapping terms S_t^j are supposed to remind us of in the equation for the law of motion of K_{t+1}^j above. Here we look at the equilibrium relations among these prices (recall these are present value prices), as determined by the profit's maximization activity of each firm.

As long as $I_t^j > 0$, the cost of investing in machine j today must equal the (expected) market value of the machine tomorrow

$$q_{t+1}^j = p_t^b \ , \ if \ I_t^j > 0, \ and$$

$$q_{t+1}^j < p_t^b, \ if \ I_t^j = 0,$$

meaning that Tobin Q is always less or equal to one in this model. Therefore, investment can be simultaneously positive for more than one technology as long as the price of machines adjust accordingly and the non-negativity constraint $q_{t+1}^j \geq 0$ is satisfied. Because $\alpha > 1$ and $\beta > 1$ hold, under certainty we have $I_t^j = 0$ for all $j = 1, ..., \widehat{j}_t - 1$, and $I_t^{\widehat{j}_t} \geq 0$.

Next, assume a new machine is introduced, i.e. $D_t > 0$. Because the innovation technology is $K_{t+1}^{\bar{j}_t+1} = (\zeta)^{\bar{j}_t+1} \cdot D_t$, zero profit implies

$$q_{t+1}^{\bar{j}_t+1} = \frac{p_t^b}{(\zeta)^{\bar{j}_t+1}}.$$

This implies that, for $D_t > 0$ and $I_t^{\widehat{j}_t} > 0$ to hold simultaneously, the following must also be true

$$(\zeta)^{\bar{j}_t+1} q_{t+1}^{\bar{j}_t+1} = q_{t+1}^{\bar{j}_t}.$$

5.3 Investment and Production Decisions

Because new technologies are more efficient than old ones, in the absence of productivity shocks investment concentrates, in each sector, only on the most recently adopted technology. The model, therefore, predicts that growth takes place according to the following pattern. Within each sector capital is scrapped away from older technologies and shifted toward most recent ones in each period, together with all the new investment goods. When this process is completed, if there is no additional innovation, all labor is employed in the most productive type of capital. At this point income can increase only by two means: either an increase in the labor supply decreases the real wage, making additional investment in the old technologies worth the while, or a new technology is adopted, when the price of labor is high enough.

The latter is more easily seen in a stationary labor environment, where the process of capital accumulation leads to both an increase in the productivity and cost of labor and to a reduction of profits large enough to make it profitable to invest in new, labor saving, technologies. Notice that, on impact, the adoption of a new technology leads to a reductioni in employment as fewer workers are needed, in the new plants, to produce the same amount of output. After this, recessive, adoption period has passed the growth process starts again moving the economy toward a new, temporary, steady state with higher productivity and consumption levels.

From this reasoning it follows that employment is procyclical, as it grows with productive capacity, but its growth rate depends on how quickly real wages grow. When real wages grow quickly with labor demand, as in the Spanish first expansion, employment does not grow much and new technologies that save on labor are adopted quickly and often. This leads to growth in per capita output and in productivity, but not to much growth in employment. When machines are measured properly, this also leads to an increase in the K/L ratio. When real wages do not grow fast, then employment grows a lot but labor productivity and TFP do not as new technologies are not adopted or are adopted much more slowly.

To better clarify the inner working of the model, we use a very simplified case in which returns to scale are allowed to be constant (i.e., $\theta = 1$). This implies that profit maximization at the firm's level is equivalent to the zero profits condition - there is no "managerial" factor anymore, hence all rents accrue to the owner of the capital stocks.

In this simplified world, production in each sector and technology is $Y^{s,j} = \min\{K^{s,j}, \sigma^j L^{s,j}\}$, and zero profits for technology j gives

$$p_t^s = q_t^j + \frac{w_t}{\sigma^j}$$

for $j = \widehat{j}_t, ..., \bar{j}_t$. Because of utility mazimization, we also have

$$p_t^a = \delta^t u'(C_t).$$

When two technologies are used to produce the same good during the same period, the prices of their capital goods must adjust to yield zero profits, hence:

$$q_t^j = \left[p_t^s - \frac{w_t}{\sigma^j}\right] > \left[p_t^s - \frac{w_t}{\sigma^{j-1}}\right] = q_t^{j-1}$$

holds for $j = \widehat{j}_t, ..., \bar{j}_t$. Clearly, for some $j \in \{\underline{j}_t, ..., \bar{j}_t\}$ we will have $\sigma^j p_t^s < w_t$, for either $s = a$, $s = b$, or both. In the first two cases technology j is not used in sector a (b) during period t, while in the third $q_t^j = 0$, and it is not used in either sector. When this takes place in the deterministic model the technology is scrapped (in fact, abandoned) and it never returns. In formulas, technology j will be scrapped from sector s as soon as

$$w_t \geq \sigma^j p_t^s.$$

From the zero profit condition for technology $\bar{j}_t$ in period t we conclude that, *when* $I_t^{\bar{j}_t} > 0$

$$q_{t+1}^{\bar{j}_t} = q_t^{\bar{j}_t} + \frac{w_t}{\beta^{\bar{j}_t}},$$

which gives the first order process followed by the prices of the best installed machines.

While this may not be completely apparent, this analysis implies that, as accumulation of the newest technology proceeds, labor is eventually shifted away from old technologies and toward the newest one. Because labor supply is limited and the marginal utility of leisure increasing with employment (or the bargaining power of unions strenghtened) the wage rate must eventually increase and profits, which had been growing initially, decrease. Because the technologies have fixed coefficients, this leads to the, respectively, procyclical and countercyclical movements of the capital and labor shares in value added.

5.3.1 Conditions for adoption of new technologies

Because only $I_t^{\bar{j}_t} > 0$, it suffices to compare the cost and benefits from investment in the best available technology $\bar{j}_t$ with those from investment in the new technology $\bar{j}_t + 1$. The latter is more profitable than the former if, for both $\sigma = \alpha$ and $\sigma = \beta$,

$$\frac{w_{t+1}}{p_t^b} > \frac{\sigma^{\bar{j}_t^s+1}}{\sigma - 1} \frac{1 - (\zeta)^{\bar{j}_t^s+1}}{(\zeta)^{\bar{j}_t^s+1}}.$$

This inequality already provides us with the general intuition: it is convenient to innovate when labor becomes (better, is expected to become) "expensive enough". If we make the simplifying assumption that $\zeta = 1 - \varepsilon$ (for ε vanishingly small: recall that in general we assume that ζ is smaller than 1) the previous inequality simplifies into

$$\frac{w_{t+1}}{p_t^b} > \left(\frac{\sigma}{\zeta}\right)^{\bar{j}_t^s+1} \frac{1 - (1 - \varepsilon)^{\bar{j}_t^s+1}}{\sigma - 1}$$

Notice what the latter implies: only when labor becomes expensive enough new technologies are adopted at the intensive margin. As long as labor remains cheap, accumulation continues at the extensive margin: more units of old capital are added, employment grows, output grows, but productivity and wages remain constant. In this world, it is the increasing cost of labor that brings about recessions and a decrease in the share of income going to labor. In fact, it is after or in the middle of recessions that labor-saving technologies are adopted, i.e. when employment is at or near its cyclical peak and wages are high. To the extent that this process of innovation and labor dismissal takes place in most firms simultaneously this leads to a sudden drop in employment, a reduction of wages and a subsequent increase in profitability. The drop in employment and wages coincides with a drop in the growth rate of output as capacity is scrapped and additional resources are used to adopt new technologies.

6 Which Facts We Can and Which We Cannot Explain

In light of this model, we submit here our interpretation of the main features of the Spanish growth process.

1. Growth came from adoption of new technologies until 1975 and during the first growth wave of democratic Spain; it has come mostly from the expansion of old capacity after 1994.
2. In 1975: the Spanish labor market changed. Wages became rigid downward and no longer responded to changes in employment/unemployment levels. This made it expensive to grow on the extensive margin, which kept employment low and created incentives for the adoption of labor saving technologies.
3. The first growth cycle came to its end because of a rapidly growing cost of labor: labor supply was mostly unionized and the productivity gains were more than compensated by a raising cost of labor.
4. During the following growth cycle a large, un-unionized, labor supply became progressively available as term contracts became widespread and immigrants arrived plentiful after 2000. This prevented the cost of labor from growing with employment, as it had done in the past. Hence employment grew but salaries did not as innovation slowed down. Spanish firms made profits by hiring cheap labor absent productivity gains.
5. Until 1994, productivity growth comes around as long as raising labour costs motivate the adoption of more efficient producton techniques. After 1994 Spanish labor becomes "cheaper" at the margin, hence productivity stagnates in a number of sectors. Sectorial analysis, not reported, shows that there are productivity gains in those sectors that are open to international competition and in which immigrant or cheap labor cannot be used, while in those sectors that were either not open to international competition or in which cheap labor could be used, or both, labor productivity and TFP stagnated.
6. Factor shares oscillate as in the data, this is a prediction of the model. The quantitative effect depends on how "rigid" labor supply is and how quickly an increase in employment turns into an increase in real wages. In particular - after 1995 and, even more, after 2000 - when labor supply is no longer binding at the going wage, the labor share does not increase and even slightly declines in spite of a fast growing employment.
7. Real wages and labor productivity are positively correlated in the model, at least in the long-run. The magnitude of the correlation, though, is determined by the rigidity of labor supply, which may increase wages faster or slower than productivity.

6.1 Policy Implications

The policy implications that follow from our analysis are extremely simple, albeit dramatic. A properly functioning, competitive, homogeneous and flexible labor market is essential to engender and sustain a balanced growth process in which both employment and labor productivity grow together.

Altering the proper functioning of the labor market - by unionizing it completely, making labor supply extremely rigid and wages irresponsive to productivity and market's conditions - leads to stagnation and low employment growth. On the other hand, a dual labor market composed by a super-protected portion of unionized workers and a completely unprotected portion of young and immigrant workers may lead to growth in employment but does not lead to either the adoption of new technologies or to an increase in the productivity of labor. The latter is particularly true when the existing labor market legislation is such that employers have an incentive to fire the unprotected employees after about three years of employment, thereby making any investment in firm-specific skills and human capital unprofitable.

Our analysis also suggests that, while immigration may be and certainly is a good thing from a general economic point of view, unregulated immigration that brings in only cheap and unskilled labor may be damaging. In this case labor supply tends to create its own demand, by providing incentives to invest in old and unproductive technologies, which are made profitable by the abundance of cheap, if unproductive, labor.

Widespread technology adoption and the increase in labor productivity cannot be legislated or imposed by government interventions: they are the outcome of thousands of small and decentralized entrepreneurial decisions. Labor market policies can and should create the conditions for such decisions to be undertaken in the least distorted form. As the adoption of new methods of production responds to economic incentives and to the cost of labor in particular, making the latter either artificially expensive or abnormally cheap will lead either to too little employment or too little productivity growth.

A sustainable model of economic development for Spain requires a substantive labor market reform.

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A. Data Appendix

Table A.1: GDP, GDP per capita and Population

	GDP (2000 constant market prices)	GDP growth rate	Population	Population growth rate	GDP per capita (2000 constant prices)	GDP per capita growth rate
1978	353416		36873		9548	
1979	353564	0.04	37201	0.89	9467	-0.84
1980	358162	1.3	37439	0.64	9530	0.66
1981	357684	-0.13	37741	0.81	9441	-0.93
1982	362142	1.25	37943	0.54	9508	0.71
1983	368557	1.77	38122	0.47	9630	1.29
1984	375129	1.78	38279	0.41	9762	1.37
1985	383837	2.32	38419	0.37	9952	1.95
1986	396327	3.25	38536	0.3	10245	2.94
1987	418311	5.55	38631	0.25	10787	5.29
1988	439621	5.09	38716	0.22	11311	4.86
1989	460844	4.83	38791	0.2	11834	4.62
1990	478279	3.78	38850	0.15	12263	3.63
1991	490443	2.54	38939	0.23	12546	2.31
1992	495006	0.93	39068	0.33	12634	0.7
1993	489901	-1.03	39189	0.31	12476	-1.25
1994	501575	2.38	39295	0.27	12751	2.2
1995	515405	2.76	39387	0.23	13085	2.62
1996	527862	2.42	39478	0.23	13371	2.18
1997	548284	3.87	39582	0.26	13851	3.6
1998	572782	4.47	39721	0.35	14420	4.1
1999	599966	4.75	39926	0.52	15026	4.21
2000	630263	5.05	40263	0.84	15653	4.17
2001	653255	3.65	40720	1.14	16042	2.48
2002	670920	2.7	41314	1.46	16240	1.23
2003	691695	3.1	42005	1.67	16467	1.4
2004	714291	3.27	42692	1.64	16731	1.6
2005	740108	3.61	43398	1.65	17054	1.93
2006	768890	3.89	44116	1.66	17448	2.31
2007	797052	3.66	44879	1.73	17762	1.8
2008	806288	1.16	45593	1.59	17684	-0.44

Table A.2: Spain: Population

	Total Population	(%)	Working Population (15-64)					
			Total	(%)	Female	%	Male	%
1979	37201	0.9	23312	1.3	11771	1.2	11541	1.4
1980	37439	0.6	23590	1.2	11898	1.1	11692	1.3
1981	37741	0.8	23866	1.2	12024	1.1	11842	1.3
1982	37943	0.5	24133	1.1	12145	1.0	11988	1.2
1983	38122	0.5	24392	1.1	12263	1.0	12129	1.2
1984	38279	0.4	24637	1.0	12375	0.9	12262	1.1
1985	38419	0.4	24865	0.9	12481	0.9	12384	1.0
1986	38536	0.3	25076	0.8	12579	0.8	12497	0.9
1987	38631	0.2	25273	0.8	12672	0.7	12601	0.8
1988	38716	0.2	25466	0.8	12763	0.7	12703	0.8
1989	38791	0.2	25659	0.8	12855	0.7	12804	0.8
1990	38850	0.2	25849	0.7	12946	0.7	12903	0.8
1991	38939	0.2	26058	0.8	13046	0.8	13012	0.8
1992	39068	0.3	26281	0.9	13151	0.8	13130	0.9
1993	39189	0.3	26482	0.8	13246	0.7	13236	0.8
1994	39295	0.3	26658	0.7	13327	0.6	13331	0.7
1995	39387	0.2	26807	0.6	13395	0.5	13412	0.6
1996	39478	0.2	26930	0.5	13451	0.4	13479	0.5
1997	39582	0.3	27037	0.4	13500	0.4	13537	0.4
1998	39721	0.4	27151	0.4	13553	0.4	13598	0.5
1999	39926	0.5	27297	0.5	13622	0.5	13675	0.6
2000	40263	0.8	27540	0.9	13732	0.8	13808	1.0
2001	40720	1.1	27877	1.2	13883	1.1	13994	1.3
2002	41314	1.5	28312	1.6	14081	1.4	14231	1.7
2003	42005	1.7	28811	1.8	14311	1.6	14500	1.9
2004	42692	1.6	29310	1.7	14540	1.6	14770	1.9
2005	43398	1.7	29839	1.8	14776	1.6	15063	2.0
2006	44116	1.7	30318	1.6	14992	1.5	15326	1.7
2007	44879	1.7	30873	1.8	15241	1.7	15632	2.0
2008	45593	1.6	31321	1.5	15466	1.5	15855	1.4

Figures

National Accounts

Figure A.1. Consumption

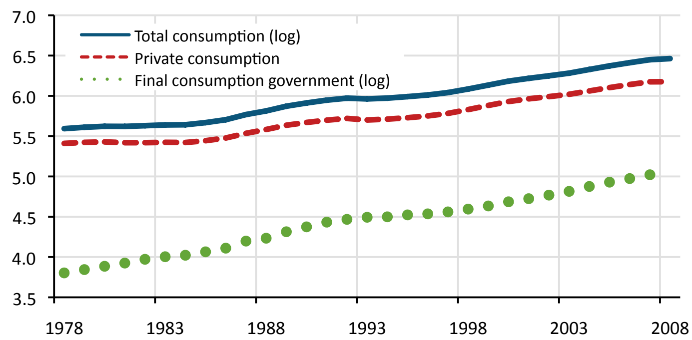


Figure A.2. Gross Capital Formation

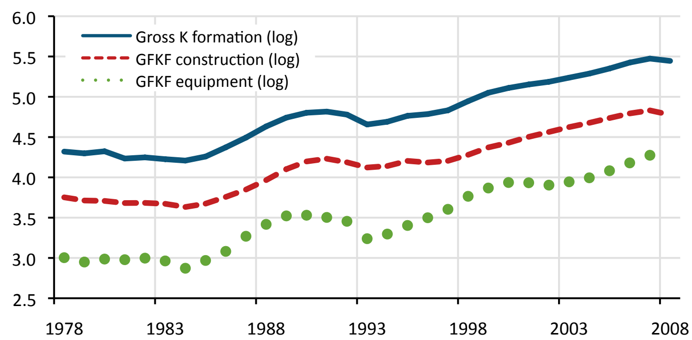


Figure A.3. Public Investment

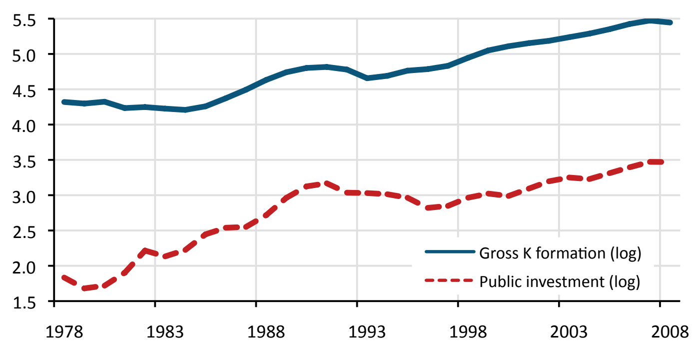


Figure A.4. Public Deficit and Public debt

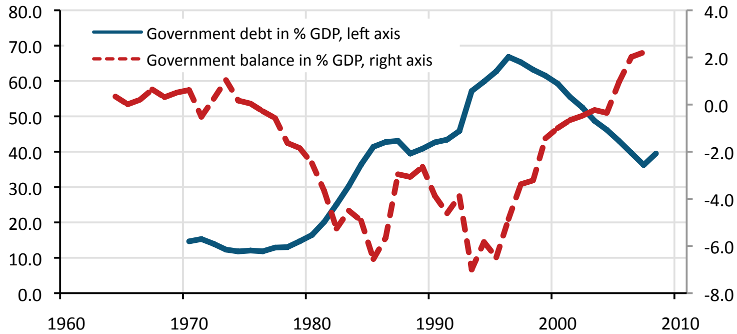


Figure A.5. Exports and Imports

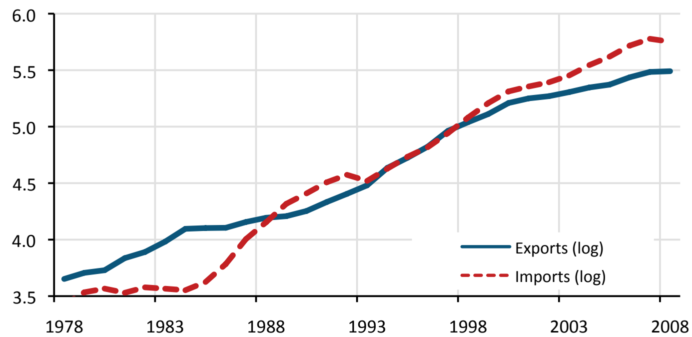
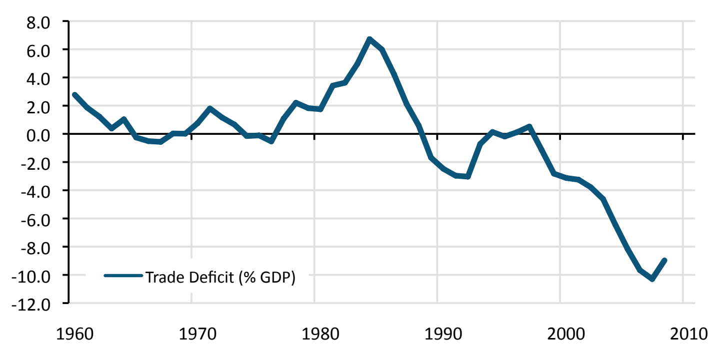


Figure A.6. Trade Deficit (%GDP)



Labor Market

Figure A.7. Employment Growth Rate (LFS)

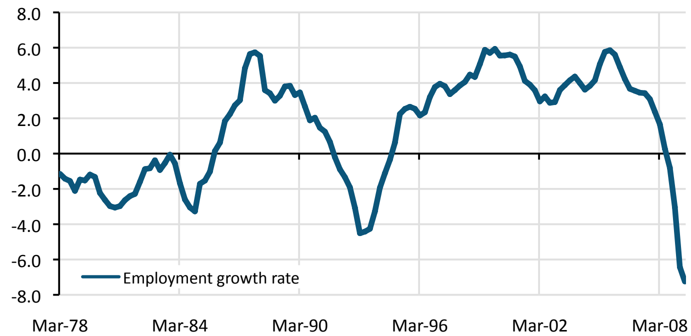


Figure A.8 Total Hours per Worker

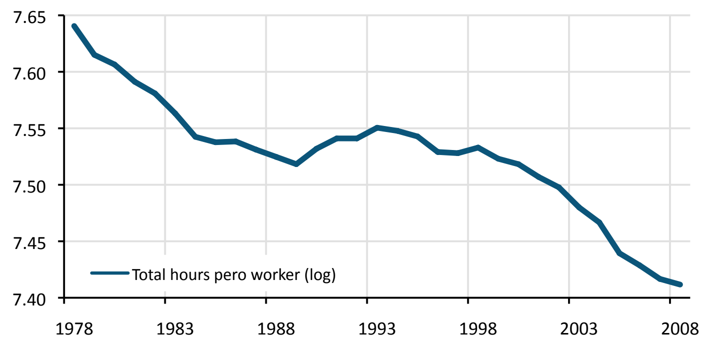


Figure A.9. Employment by gender

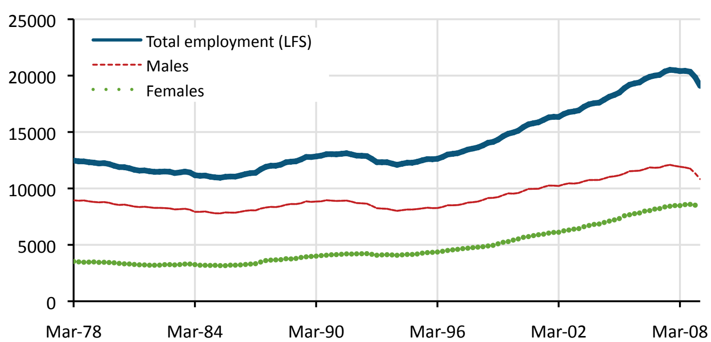


Figure A.10. Employment by Gender and Sector (annual growth, number of workers)

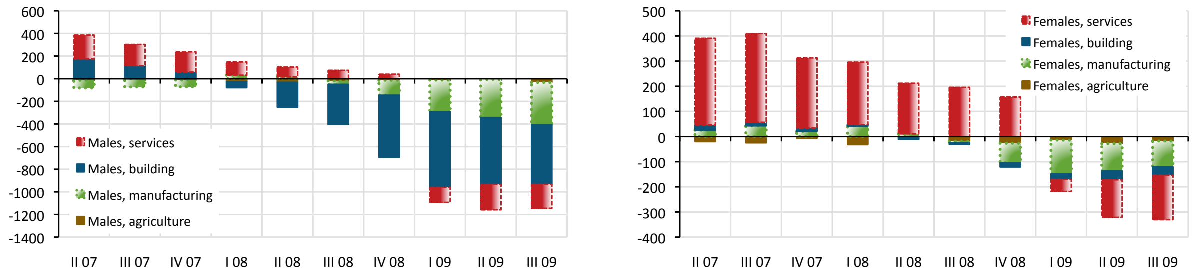


Figure A.11. Unemployment by Gender (annual growth, number of workers)

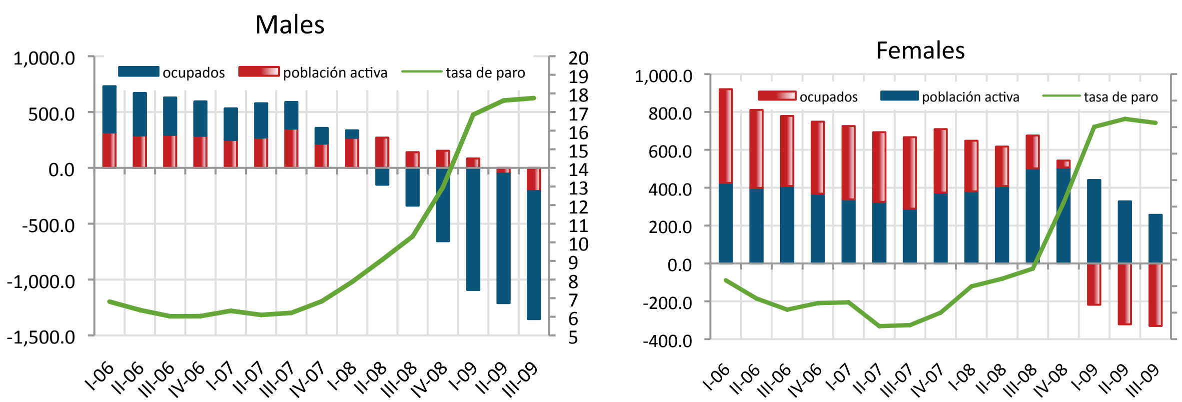


Figure A.12. Employment by Sector

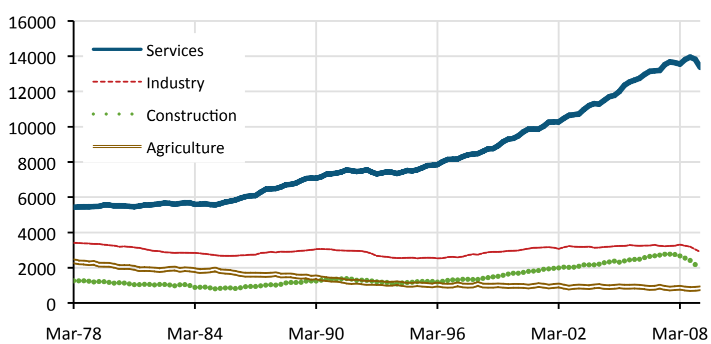


Figure A.13. Employment by Nationality

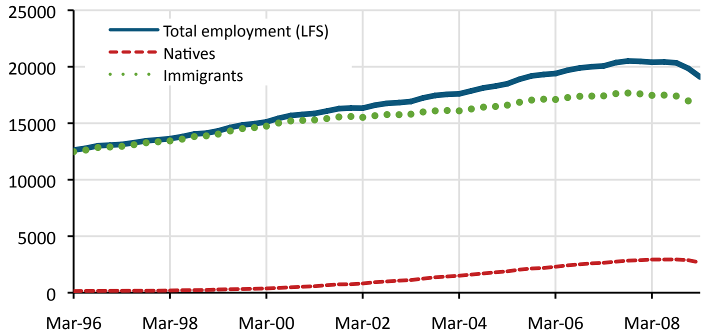


Figure A.14. Employment Rates

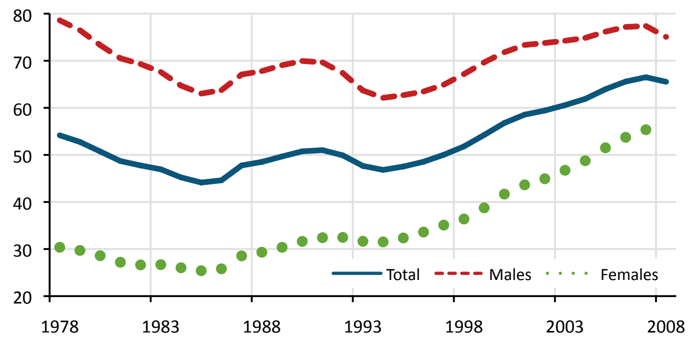


Figure A.15. Unemployment Rates

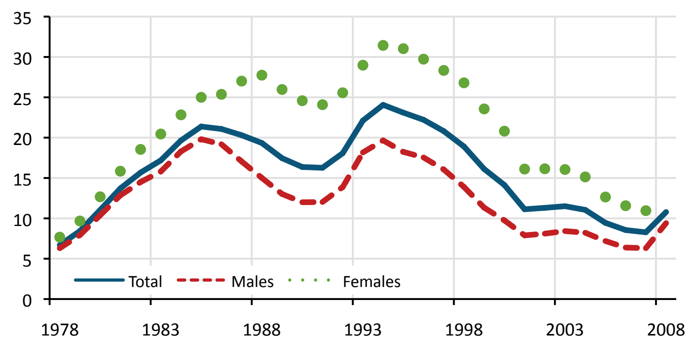


Figure A.16. Activity Rates

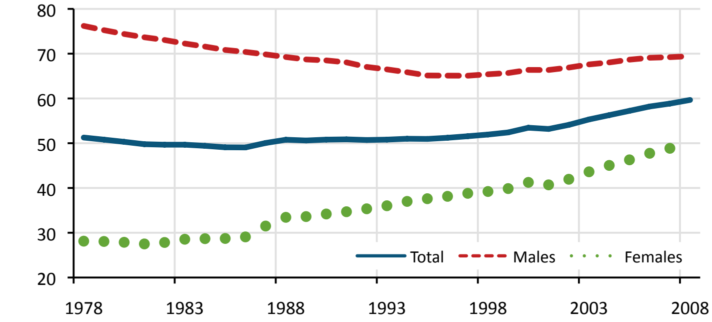
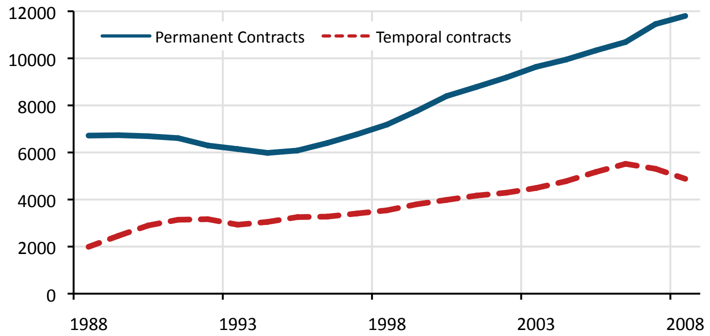


Figure A.17. Permanent vs Temporal Contracts



Production Function

Figure A.18. Employment, Capital and GDP Growth Rates

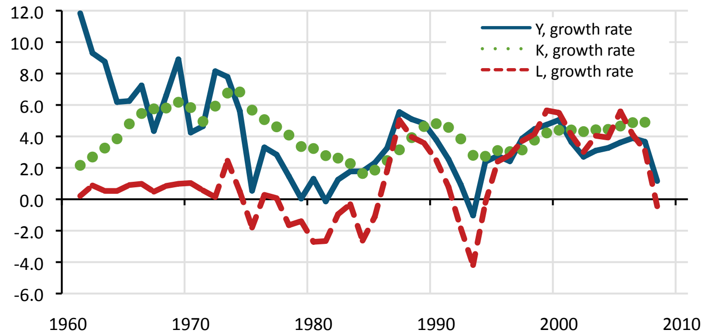


Figure A.19. Capital per Worker

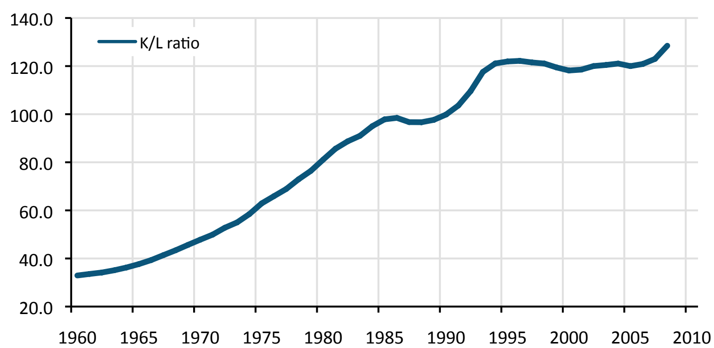


Figure A.20. Capital/Output per Sector

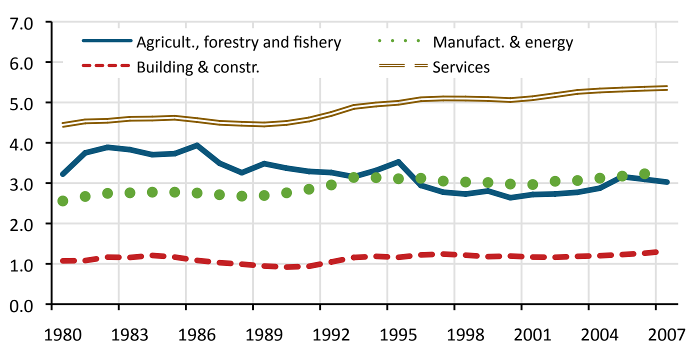
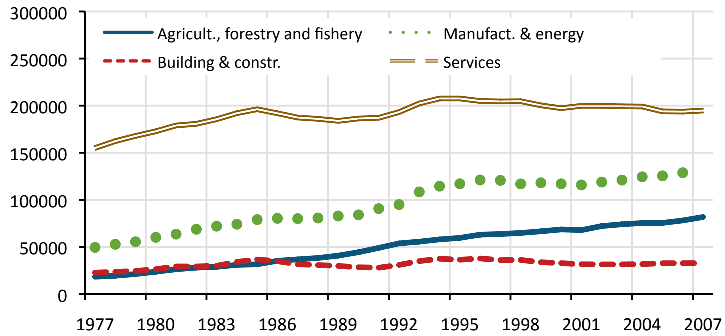


Figure A.21. Capital/Employment per Sector



Prices

Figure A.22. Relative Prices Equipment and Durable Goods

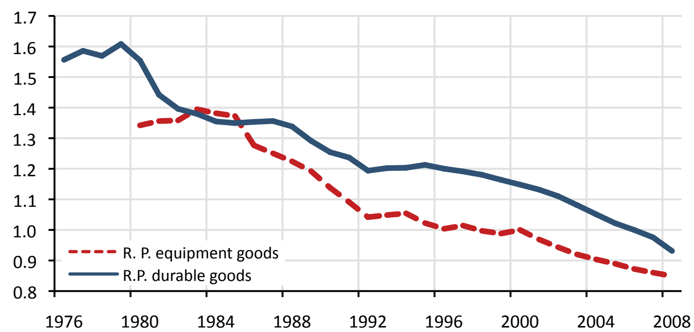


Figure A.23. CPI and GDP Deflactor

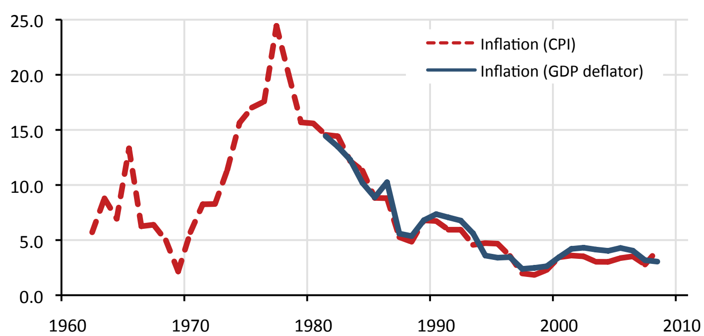


Figure A.24. Relative Prices: Tradeables and Non-tradeables

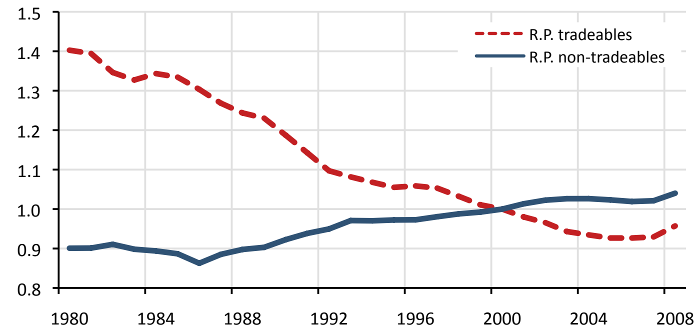


Figure A.25. Real Interest Rate

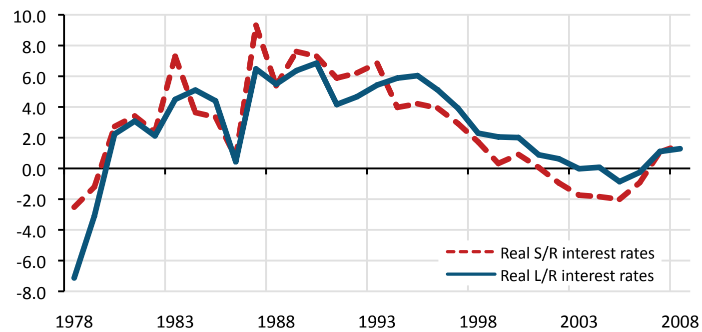
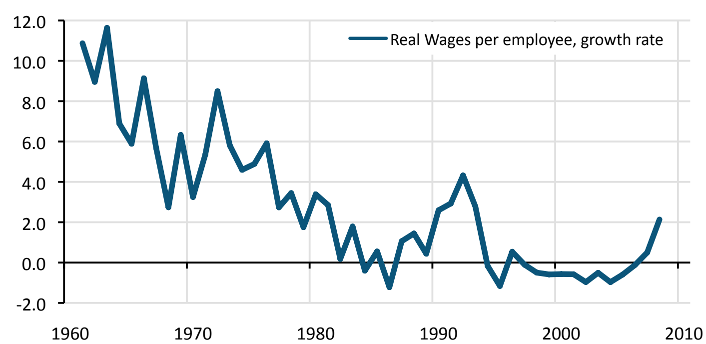


Figure A.26. Real Wage Growth Rate



Data Definitions

Output: Real GDP at 2000 constant prices. Source: European Commission (AMECO). **Capital stock**: Net capital stock at 2000 constant prices; total economy (using national deflator). Source: European Commission (AMECO). **Capital stock per sector**: Net capital stock at 2000 constant prices. Source: Fundación BBVA-IVIE. **TFP**: Total factor productivity, 2000=100. Source: European Commission (AMECO). **Labour share**: Ratio of compensation of employees to GDP at market prices less taxes linked to imports and production and subsidies, less gross operating surplus and mixed income of households and NPISH, and plus consumption of fixed capital by households. Source: European Commission (AMECO) and Instituto Nacional de Estadística (INE). **Capital share**: 1 - labour share. Source: European Commission (AMECO). **Total consumption**: Total consumption at 2000 constant prices. Source: European Commission (AMECO). **Private consumption**: Private final consumption expenditure at 2000 prices. Source: European Commission (AMECO). **Final consumption government**: Final consumption expenditure of general government at 2000 prices. Source: European Commission (AMECO). **GKF**: Gross capital formation at 2000 prices, total economy . Source: European Commission (AMECO). **GFKF construction**: Gross fixed capital formation at 2000 prices, construction. Source: European Commission (AMECO). **GFKF equipment**: Gross fixed capital formation at 2000 prices, equipment. Source: European Commission (AMECO). **Public Investment**: Ratio of gross fixed public capital formation to real GDP. Source: European Commission (AMECO) and Banco de España.

Government debt: General government consolidated gross debt: excessive deficit procedure (based on ESA 1995) and former definition, in percentage of GDP. Source: European Commission (AMECO). **Government Balance**: Government Balance in percentage of GDP. Source: European Commission (AMECO). **Exports**: Exports of goods and services at 2000 prices. Source: European Commission (AMECO). **Imports**: Exports of goods and services at 2000 prices. Source: European Commission (AMECO). **Trade Deficit**: Exports less imports over real GDP. Source: European Commission (AMECO).

Population: Total Population. Source: European Commission (AMECO). **Working-age population**: Population between 15-64 years. Source: European Commission (AMECO) and OECD. **Employment**: Civilian Employment. Source: European Commission (AMECO) and Instituto Nacional de Estadística (INE). **Unemployment**: Total unemployment . Source: European Commission (AMECO), Instituto Nacional de Estadística (INE) and OECD. **Hours Worked**: Total hours worked. Source: European Commission (AMECO).

R.P. equipment goods: Relative prices, ratio of equipment goods deflator to GDP deflator. Source: European Commission (AMECO). **R.P. durable goods**: Relative prices, ratio ofvprice index of durable goods to consumer price index. Source: European Commission (AMECO) **R.P. tradeables**: Ratio of industry gross value added deflator to GDP deflator. Source: European commission (AMECO). **R.P. non-tradeables**: Ratio of services and construction gross value added deflator and GDP deflator. Source: European commission (AMECO). **Real S/R interest rate**: 3 month interbank rate. Source: European commission (AMECO). **Real L/R interest rate**: 1979-1987 (state bonds of 2 to 4 years); 1988-1992 (central government bonds at more than two years); from 1993 (central government benchmark bond of 10 years). Source: European commission (AMECO) **Real wages**: Real compensation per employee, total economy, 2000=100. Source: European Commission (AMECO).

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