The Spanish Crisis from a Global Perspective
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Abstract

This paper studies the recent evolution of the Spanish economy in the context of the developments of the world economy and presents a benchmark model with financial frictions to assess the sources of these fluctuations. We pay particular attention to the comparison with the United States and some of Spain’s European peers in the 1994-2009 period. First, we document the long expansion between 1994 and early 2008 in terms of the main economic aggregates and the boom in the real estate market. Second, we also report on the fast downturn of these economies in the second half of 2008. Third, we use our benchmark model with financial frictions to evaluate how much we understand of the mechanism behind these large changes in aggregate behavior. We conclude with some policy remarks.

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1. Introduction

From 1994 to early 2008, the world experienced a second *Belle Époque*: a long period of widespread prosperity, fast economic growth, and price stability. Using data on annualized growth rates from the International Monetary Fund (IMF) World Economic Outlook, April 2009, figure 1.1 shows how, except for the slowdown in 2001, while a mild recession in the U.S. reduced the growth rate of the world economy, real world output was expanding at a swift annual average rate of around 3.8 percent.¹

![Figure 1.1: Real World Output](image)

The prosperity reached most countries, with emerging and developing economies witnessing even higher rates of growth that peaked at an unheard of rate of 8.3 percent in 2007. Of particular relevance during these years was the sudden re-appearance of China as a major player in the global economy after two centuries of disconnection from world linkages.² China’s growth was so fast that it added, all by itself, around a point to world output growth rates each year from 2003 to 2008. Furthermore, China’s presence generated huge capital flows and rearranged international trade to an extent that surprised most analysts, both for its size and for its suddenness.

¹Data for 2009 are forecasted values given observations up to the first quarter of 2009. Advanced economies include (ordered by the size of their output): the United States, Euro Area, Japan, the United Kingdom, Canada, Korea, Australia, Taiwan, Sweden, Switzerland, Hong Kong SAR, Czech Republic, Norway, Singapore, Denmark, Israel, New Zealand, and Iceland. Emerging and developing countries are the complement set.

²See Maddison (2007) for a historical perspective and Huang (2008) for an excellent introduction to China’s recent economic history and the process of reforms.
Unfortunately, these times of prosperity sharply ended in the second half of 2008. Since then, and until the early fall of 2009, output in advanced economies has been contracting (while in emerging and developing economies it is increasing but at the slowest rate since 1991), employment is falling, international trade has dropped at an alarming pace, and prices have edged dangerously close to the deflation zone. Moreover, since the summer of 2007, international financial markets have suffered from a soaring volatility, increased risk spreads, generalized disruptions in secondary markets, the collapse of institutions such as Lehman Brothers, AIG, Wachovia, WashMu, and Northern Rock that has forced massive government interventions, and the disappearance of investment banking as we used to know it. Only recently, a behavior vaguely resembling normal times has returned with some signs of recovery in economic activity (particularly in Asia and in manufacturing and world trade, and more weakly in the U.S. and some European economies), although the menacing shadow of a quick relapse lurks close to all of us.

In this paper, we will document how this world recession has combined four elements of a perfect economic storm. First, a substantial oil shock (and to some degree in other commodities) at its start. Second, the collapse of world trade at a speed faster than anyone had anticipated. Third, a massive reallocation from housing construction into other sectors, a phenomenon particularly intense in countries such as Spain and the U.S. that had experienced large construction booms. Finally, a remarkable level of financial turbulence.

Spain, an advanced, small open economy, has followed to the letter the pattern of expansion and contraction of the world economy. We illustrate this point with figure 1.2, where we again used data from the IMF to plot output growth rates for the world, advanced economies, and Spain from 1994 to today.
The Spanish economy went through an uninterrupted expansion from 1993 to 2008 but entered an acute recession in the second half of 2008. Although the expansion was more vigorous than in other advanced economies, the accelerations and slowdowns happened at the same time as in the world as a whole and in other advanced economies (except for Spain’s avoidance of the 2001 recession). This is the main observation that motivates this paper: we can only properly understand the Spanish business cycle and think about policy responses to the crisis if we frame the evolution of the Spanish economy in the context of what has occurred in the global economy over the last 15 years.

This paper pushes the argument even further. We document how the Spanish and the U.S. economies (and perhaps also the U.K.) present a surprising number of parallelisms that place them in a group that had an economic performance very different from that of Germany or Japan on the one hand, or France and Italy on the other.\(^3\)

Spain and the U.S. lived through a long period of expansion, disturbed only slightly for a few months in 2001-2002. Between 1995 and early 2008, real output increased by 58 percent in Spain and by 49 percent in the U.S., while employment improved, inflation was unusually low, gigantic trade deficits were accumulated, housing prices constantly broke new records, and a large number of immigrants arrived in both countries. Warning signs of problems to come were ignored, and both experts and public opinion seemed complacent while enjoying the fruits of prosperity.

On or around the spring of 2008, and to the surprise of most of us, the cycle changed rather abruptly in Spain and the U.S. After a few months of mild recession, both economies started to contract quickly by the fall of 2008, while inflation (which had grown above target levels by the summer of 2008 due to the oil-price shock) suddenly mutated into mild deflation and employment plummeted. At the same time, the large rally in housing prices was replaced by unprecedented falls in prices, a high number of foreclosures, and increasing difficulties in those financial institutions that had heavily engaged in real estate lending.

In comparison, during the years of the expansion, other advanced economies, such as Germany and Japan, had fast growth in exports and in their current surplus, but without high levels of economic growth. Germany’s output growth rates hovered around 1 percent for many years and even contracted in 2003. Meanwhile, the current account surplus went from close to -1.7 percent of output in 2000 to 7.5 percent in 2007. Japan came out of its lost decade around 2003 and started growing at around 2 percent per year, helped by sales to China and other emerging economies that were its natural markets. However, since even at the peak of the expansion gross fixed capital formation did not accelerate, Japan nearly doubled its current account surplus from 2000 to 2007 (from 2.6 percent of output to 4.8 percent). From a purely accounting perspective, Japan and Germany were generating the

\(^3\)We selected these countries as a natural set of peer advanced economies.
savings needed for the large investment and housing booms in the U.S. and Spain. Precisely because of this reliance on exports, German and Japanese economies have been particularly affected by the steep contraction of international trade and they will close 2009 with falls in output between 5 to 6 percent, bigger contractions than the ones in the U.S. or Spain. Perhaps not very surprisingly, Germany and Japan did not experience increases in housing prices or construction during the last two decades.

Finally, we have two countries, France and Italy, that are very close to Spain in terms of geography, culture, institutions, and income per capita (and share a common monetary and trade policy at the European level). France and Italy are intermediate cases. While their growth was low and closer to Germany’s and Japan’s than to Spain’s or the U.S.’s, their foreign sector did not show much dynamism and their current accounts moved into negative numbers, although not as quickly as in Spain or the U.S. France’s growth rate was slightly over 2 percent on average, and its current account went from a surplus of 1.7 percent in 2000 to a deficit of 1 percent in 2007. In the same years, Italy had a most disappointing growth in output (0.5 percent in 2002, 0 percent in 2003, 1.5 percent in 2004, and 0.7 percent in 2005), and its current account deficit increased from 0.5 percent in 2000 to 2.4 percent in 2007. At the same time, France and Italy witnessed important increases in real estate prices, possibly linked more to the low nominal interest rates that we will document below than to economic growth, which was in any case lukewarm.

All of these phenomena beget the natural questions of what accounts for the common and divergent factors in each country’s experiences of boom and recession, what prospects do we have of recovery in the middle run, and what policy lessons can be derived from our current troubles. While a thorough examination of all of these issues is beyond the scope of a single paper, we search for hints by organizing this work as follows. First, we will look at the basic variables of the world economy and compare Spain with countries like the U.S., Germany, France, the U.K., Italy, and Japan. Second, we will present and calibrate a benchmark model of financial frictions to evaluate how an economy like Spain reacts to a number of financial shocks. We close the paper with some policy remarks.

2. The World Economy

As illustrated by figure 1.1, Spain’s expansion from 1994 to 2007 must be framed in a context of global prosperity and price stability. While Spain’s growth rates were quite satisfactory during the whole period, they were not exceptional (such as those of Ireland, which in the period 1994-2007 were above 7 percent on average). To a large extent, Spain surfed through particularly good times with the help of an economic policy that emphasized balanced budgets but that eschewed painful reforms in the goods and labor markets.
The years of global expansion were also years of price stability. In figure 2.1, we plot the CPI in advanced economies and in Spain again using data from the IMF. During most of the period, the CPI of advanced economies was low and stable, between around 1.5 to 2.5 percent, approximately the inflation target, formal or implicit, of most central banks (this low inflation volatility being one of the key pieces of evidence for the so-called “great moderation,” Stock and Watson, 2003). Only in 2008 did prices accelerate to 3.4 percent as a consequence of the big increases in the prices of oil and other commodities. However, this spike was brief, as the recession quickly pushed the CPI into the negative region.

Figure 2.1 also shows how Spain’s prices grew at a faster rate than ones from other advanced economies for nearly the entire period. This might reflect the tensions generated by a monetary policy imposed from outside by the European Central Bank (ECB) that was, perhaps, excessively expansive for Spain’s conditions. Other possible explanations include a Samuelson-Balassa effect induced by the faster growth of the Spanish economy over other advanced economies (although this explanation has empirical problems with the Spanish data on prices and productivity) or the role of restrictions to competition in many markets in Spain that, in some cases (such as in the opening of big retail stores), became increasingly restrictive over time. As in other economies, a mild deflation has appeared in the past few months in Spain, a completely new phenomenon in an economy that for over a century had a strong inflationary bias.

A low and stable CPI was the result of many factors, but the role of commodity prices is probably a large component of it. Figure 2.2 plots an index of world commodity prices (oil, metals, and food) normalized at 100 in 1994. Metals and food were relatively stable (except
for metals between 2006 and 2008) and at historically low levels. In comparison, oil prices have fluctuated wildly and skyrocketed in 2007 and 2008, only to collapse in the fall of 2008, reaching a low of $36 a barrel on February 27, 2009. Hamilton (2009) attributes this boom to a strong world demand confronting stagnating world production from diminishing fields and underinvestment by nationalized oil companies. He also blames the rise in oil prices for triggering a recession in the U.S. as early as 2007.Q4 and that, without this shock, the recession might have been postponed until the fall of 2008.

A low CPI brought low nominal interest rates. This is easily appreciated in figure 2.3, where we plot the federal funds rate and the ECB intervention rates. Long rates and risk spreads moved with the policy rates and dropped to rather low levels. In the particular case of Spain, lower intervention rates and lower long-run rates were reinforced by the adoption of the euro in 1998 and the nearly total elimination of the risk premium of Spanish loans in comparison with Germany's. Spanish firms and households found themselves, for the first time in decades, able to borrow at attractive real rates and, more important, to assume that those low rates would survive into the middle run. Under those circumstances, a boom in investment and housing was a likely event.

4In fact, there is a view that stresses the key role of too-low nominal interest rates during the mid 2000s in our current maladies. For a forceful exposition of the U.S. case, see Taylor (2009) and for Spain, Recarte (2009). We do not evaluate here the plausibility of such perspectives.
The last part of figure 2.3 shows how these policy intervention rates have been lowered even further in response to quickly deteriorating economic conditions until reaching pretty much the zero lower bound.\footnote{These reductions occurred with a considerable degree of coordination. On October 8, 2008, six central banks (Fed, ECB, and the Banks of England, Canada, Sweden, and Switzerland), in an exceptional feat of international cooperation, simultaneously lowered their policy rates. The day before, ECOFIN had increased the limit of bank deposit guarantees all across Europe.} When this happened, many central banks decided to engage in extensive non-conventional monetary policy measures and to rapidly expand their balance sheets, partly because of a belief that further action was required to ensure the behavior of markets, and partly to reduce long rates, which stubbornly refused to fall. For example, the Fed has more than doubled the size of its assets and liabilities, a position not abandoned even with the recent lower volatility of financial markets. By the end of September 2009, the Fed was holding over $689 billion of mortgage-backed securities, a radical departure from historical practices.

The years of world economic expansion were also years of fast expansion of international trade and of widening divergences in current accounts. We plot in figure 2.4 the growth rates of international trade and in figure 2.5 the current accounts, in billions of dollars, of France, Germany, Italy, Spain, Canada, Japan, the U.K., the U.S., and China, with all data coming again from the IMF. International trade was experiencing growth rates that reached 12.2 percent in 2000 and 10.7 percent in 2004, which were more than twice the growth rates of world output. There was certainly something to the idea that the world was becoming flatter than ever. This process seems to have taken a step back as the sharp downturn of 2008-2009
sent international trade to an exceptional decline of 11 percent, a contraction not seen since the Great Depression.

With respect to the current accounts in figure 2.5 and the famous global imbalances, two countries get ahead of the rest in absolute value, one positive and one negative: the U.S. and China. The U.S., which started the period with significant but milder negative balances, deepened its current account deficit to $788 billion by 2006 (or around 6 percent of its GDP). In accumulated terms, between 1994 and 2008, the U.S. had a deficit in its current account of $6.35 trillion.
In the opposite direction, China’s surpluses on its current account went from $7.7 billion in 1994 (or 1.4 percent of GDP) to $496.6 billion in 2008 (a staggering 10.3 percent of a much bigger GDP). Many reasons have been proposed to account for this radical change in behavior by China. One history emphasizes the role of the Chinese government in creating a gigantic cushion of foreign reserves and assets to enhance its leverage power in international negotiations. The main piece of evidence in favor of this argument is the increase in China’s foreign reserves from $216.3 billion in 2001 to $2,134.5 billion in 2008 (World Economic Outlook, April 2008). A second explanation focuses on the absence of a proper social security and health insurance that forces households, in a rapidly aging population, to have large saving rates. A third mechanism is the lack of good financial markets, as explained by Song, Storesletten, and Zilibotti (2009). On the one hand, the absence of good enforcement of loans prevents the Chinese from lending at home. Instead, those savings are shipped abroad. On the other hand, firms and small entrepreneurs have serious problems financing their firms, and therefore, they are forced to save at an accelerated rate to self-finance their investments. This results in the paradoxical phenomenon of a high investment country that is still exporting capital.

Smaller in size but not in importance are the growing surpluses of Germany and the negative positions of Spain and the U.K. Within the EU, countries followed a pattern similar to the world: high savings nations (basically Germany, but also the Netherlands) were financing large trade deficits by Spain and the U.K. For the case of Spain, the current account deficit reached the level of 9.6 percent of GDP in 2008, with a total net foreign borrowing of nearly 870 billion Euros (80 percent of GDP). This phenomenon is particularly easy to see in the financing decisions of Spanish banks, which were borrowing over a quarter of their balance sheets in the interbank lending market from their German and Dutch competitors.

Interestingly enough, the large global imbalances were not related, to a first-order approximation, with large government deficits in the affected countries. As we can see in figure 2.6, where we report the consolidated government deficits over GDP, from 1994 to 2000, the countries in our sample experienced an energetic process of fiscal consolidation. Spain, for instance, went from a deficit of 6.9 percent of GDP in 1995 to a deficit of 1 percent by 2000. The mild recession of 2001 and the tax cuts in different countries like the U.S. weakened the government financial positions over the next few years. Spain was an exception, since fiscal probity became a pillar of the economic policies of both conservative and socialist governments and surpluses were accumulated until they reached a historical level of 2.2 percent of GDP in 2007 despite some relatively minor reductions in income taxes. In all countries, how-

A version of this argument also introduces internal political-economic considerations that have biased relative prices within China in favor of exporting-oriented cities and against the countryside. See Huang (2008) for documentary proof of such policy.
ever, the fiscal situation quickly deteriorated in 2008 and current government deficits range from 13.7 percent in the U.S. to 4.7 percent in Germany in 2009.\footnote{The 2009 numbers are, though, projections from the IMF subject to a considerable level of uncertainty. Spain’s deficit is more likely to close at 10 percent than the 7.5 percent assumed in the figure. For the U.S., the Congressional Budget Office forecasted in August 2009 a federal government deficit of 11 percent (although there are still some questions regarding the extent of transfers to the financial sector).}

We can decompose the government deficits as a combination of rising expenditures and falling revenues. The most relevant for us is the evolution of government revenues, since they tell us much about the long-run sustainability of active fiscal policies such as the ones implemented by many countries.\footnote{Also, increases in government expenditures are more complicated to compare across countries because of differences in the accounting of the myriad fiscal policy measures undertaken during the recession, such as the rescue of financial institutions and implicit government guarantees.}

We gathered data from Eurostat for European countries and from the Bureau of Economic Analysis for the U.S. for 2007, 2008, and 2009.Q1. We report the numbers in table 2.1. The first three columns compare government revenue in 2007 and 2008 and the next three the government revenue between 2008.Q1 and 2009.Q1 (in many countries government revenue has a strong seasonal component). The most relevant finding is that Spain has suffered the biggest fall in government revenue of all the countries in our sample, a whopping decrease of 4.4 percent over GDP between 2007 and 2008, with a further fall in 2009 that may be around 2.5/3.0 percent, all this despite the fact that there were no change in statutory rates. Of this 4-point drop between 2007 and 2008, around 2.2 points can be attributed to falls in direct taxes (the income and corporate
profits taxes) and close to 2 points to drops in the value added tax (VAT).\(^9\) In comparison, the fall in revenue in the U.S. between 2007 and 2008 was only 2.4 percent. This accelerated fall in government revenue differentiates this recession from previous ones, such as the 1992-93 recession, where government revenue did not fall as a share of GDP in Spain. In retrospect, it seems that a dominant component of the government surpluses of 2005-2007 in Spain was the extraordinary tax collections generated by the transaction tax, VAT, and capital gains tax associated with the real estate boom.\(^10\)

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<td>43.8</td>
<td>-0.2</td>
<td>43.8</td>
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<tr>
<td>Ireland</td>
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<td>34.6</td>
<td>-1.4</td>
<td>33.6</td>
<td>31.0</td>
<td>-2.7</td>
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<tr>
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<td>39.9</td>
<td>-0.2</td>
<td>39.9</td>
<td>42.4</td>
<td>2.5</td>
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<tr>
<td>Spain</td>
<td>41.1</td>
<td>36.7</td>
<td>-4.4</td>
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<td>France</td>
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<td>-0.3</td>
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<tr>
<td>Italy</td>
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<td>45.9</td>
<td>-0.3</td>
<td>39.8</td>
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<td>Austria</td>
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<td>0.1</td>
<td>38.9</td>
<td>37.5</td>
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<tr>
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<td>0.9</td>
<td>46.8</td>
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<td>-1.5</td>
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<td>-2.4</td>
<td>29.90</td>
<td>28.10</td>
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But Spain was not alone in this real estate boom. The big global imbalances were closely associated with large increases in real estate prices and activity in many countries. To illustrate this point, we plot in figure 2.7 the annual housing prices in France, Germany, Italy, Spain, the U.K., and the U.S. from 1995.Q1 to 2008.Q4 (the last quarter observations for Germany and Japan are missing).

In this figure, we see how in the U.K. and Spain price growth rates accelerated to over 20 percent in 2003 and 2004 and continued to have strong gains up to mid-2007. Italy, France, and the U.S. also went through a considerable rally, although smaller than the one in the U.K. and Spain. For comparison purposes, we include Germany and Japan, where real estate prices were flat or suffered a small drop. Note that the countries with the bigger housing price rallies were also the countries with the largest trade deficits and, conversely, countries that accumulated large trade surpluses were countries without large appreciations of real estate.

\(^9\) In 2009, the forecast is a further drop of 0.7 point of GDP in direct taxes and 1.3 points in indirect taxes, although part of it (around 0.5 point) is due to the change in the timing of VAT payments that should be recovered in 2010.

\(^10\) And, therefore, that the middle- and long-run budgetary outlook for Spain is grim, particularly if we remember Spain’s fast population aging and its impact on social security and the national health system.
It is important to assess how much of the increases in housing prices can be accounted for by fundamentals. The difference between actual prices and prices predicted by observables may give us an indication of possible future movements of housing prices. There are many alternative procedures for doing so, but we find it convenient to follow the measure of housing price misalignment proposed by the IMF (see Box 1.2. in World Economic Outlook, October 2008). This index is an estimate of the deviation of housing prices with respect to a simple regression of the growth of housing prices on dynamic components (past growth of housing prices and a lagged ratio of house prices over disposable income) and fundamentals (growth in per capita disposable income, working-age population, credit and equity prices, short-term and long-term interest rates). The data sample of the regression is 1970.Q1-2008.Q3 (some initial observations are missing for several countries: for instance, Spanish data start in 1971.Q1). Moreover, the misalignment measure is normalized to 0 in 1997.Q1.\footnote{An alternative measure is to compute the price-income ratio. The findings are similar to the ones reported in the paper, with fast increases in Spain, France, and the United Kingdom and falls in Japan and, particularly, Germany. Interestingly, the price-income ratio of the U.S. did not increase as much as we would have thought given the previous figure on housing prices. We will come back to this observation when we explain the strong regional component of the real estate boom in the U.S.}

We plot the results for this misalignment in figure 2.8. According to this measure, housing prices in Spain did not keep up with the increases in income due to the vigorous expansion during the late 1990s and, by 2001, they were nearly 10 percent below their predicted level. However, the tremendous rates of growth of 2002 to 2005 erased this difference and created a large positive gap that had peaked at around 27 percent by the end of 2007. Since then, the gap has been falling but, given the latest numbers (2008.Q3), there is still a 14.8 percent fur-
ther reduction predicted by fundamentals. This computed misalignment indicates that prices are likely to keep falling in Spain for several additional quarters. In the U.S., prices slowly increased above predicted values during the late 1990s and early 2000s, and only boomed substantially in 2004-2005. Interestingly enough, by late 2008, U.S. housing prices seem to be roughly at their predicted value, an observation that suggests that further significant reductions in prices are unlikely (despite the wave of foreclosures in the fall of 2009). On the other side, prices seem to be below their historical levels in Germany and roughly at their level in Japan.

![Figure 2.8: House Price Misalignments](image)

The housing price data in figures 2.7 and 2.8 are aggregate values, and therefore, they mask large inter-regional variations. In particular, for the U.S., the extent to which housing prices diverged from predicted values is biased down by the mix of areas in which prices increased only moderately (the South, most of the Midwest) and areas in which prices skyrocketed (the East and West coasts). To illustrate this point, we rely on the Case-Shiller index that tracks housing prices in a set of U.S. metropolitan statistical areas (MSAs). In figure 2.8, we plot the nominal housing prices in 6 of these MSAs, normalized to 100 in January 1995. This figure shows that MSAs such as Atlanta, Cleveland, and Denver did not witness a rally between 2000 and 2009, while others such as Los Angeles, Phoenix, and Las Vegas went through a gigantic rise and collapse of housing prices. In Spain, on the other hand, booming real estate prices were more evenly distributed across the country.

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12 This seems to be consistent with the evidence that housing prices in the U.S. stabilized during the spring-summer of 2009. See, for instance, the recent evolution of the Composite-20 Case-Shiller index, which showed increases in June 2009 for the first time in nearly three years, and the summary of current indicators in: [http://www.radarlogic.com/research/RPXMonthlyHousingMarketReportforJuly2009.pdf](http://www.radarlogic.com/research/RPXMonthlyHousingMarketReportforJuly2009.pdf).
It is interesting to compare, in figure 2.9, the evolution of housing prices in some U.S. MSAs and in the two main Spanish cities, Madrid and Barcelona, with all prices normalized to 100 in 1995.\textsuperscript{13} Data for the U.S. come from the Case-Shiller index and for Spain from the \textit{Ministerio de la Vivienda} (Ministry of Housing).\textsuperscript{14} We picked Los Angeles and Las Vegas as examples of MSAs with large price increases (as further motivation, there is a parallelism in geographic terms: Los Angeles and Barcelona are cities by the sea with physical limits to their growth, while Madrid and Las Vegas pretty much have unlimited space to build). While prices in Los Angeles increased more than in Madrid or Barcelona, they have also fallen faster. In Las Vegas the fall has been so deep that real estate prices are, in nominal terms, only 22.5 percent above the 1995 level, while the CPI has increased 43 percent. The high prices in Madrid and Barcelona predict, again, substantial drops in real estate prices in Spain over the next several months.\textsuperscript{15}

\textsuperscript{13}The behavior of Madrid and Barcelona was not exceptional. Smaller cities such as Sevilla or Zaragoza had even larger housing price appreciations.

\textsuperscript{14}We thank Tano Santos for sending us the time series for Spain.

\textsuperscript{15}There is a caveat here: the bias in the price index induced by a large drop in completed transactions. Some commentators have suggested that, once we take these into account, prices may have already fallen by a considerable amount in Spain.
The behavior of real estate prices was tracked by residential investment as a fraction of GDP. In figure 2.11 we plot this investment for the same group of countries as in figure 2.7. Again, we see Spain as an outlier, with residential investment going from 4.3 percent in 1995.Q1 to 9.4 percent of GDP in 2006.Q3, only to drop as the recession arrives to 7.2 of GDP in 2008.Q4, still high by historical standards but probably explained by the substantial amount of ongoing construction that will unfold over the next several quarters. In comparison, the increase of residential investment in the U.S. was considerably more moderate.
But real estate was not the only asset class to appreciate and later collapse. Figure 2.12 plots the stock market index for France, Germany, Italy, Spain, and the U.S., as reported by Global Insight, from 1995 until early 2009. First, all of the indexes moved surprisingly close to each other from the start of the sample: a big boom in the late 1990s, a loss of all gains once the internet boom fizzled out, a posterior rally, and finally very fast losses after the fall of 2008. Second, Spain’s stock market had an even bigger increase in the 2000s, more than doubling in value, but also losing much of these gains in a few months of financial turbulence. As with other variables, Spain had exactly the same behavior pattern as its peers, only more exaggerated. The spring and summer of 2009 witnessed a certain recovery of the stock market worldwide, with the S&P 500 roughly back at the levels of October 2008.

![Figure 2.12: Stock Market](image)

Although it is difficult to appreciate from the figure, the big stock market drops of the fall of 2008 and winter of 2009 were associated with large spikes in volatility. But an even clearer picture of the financial market turbulence can be seen in figure 2.13 where we plot the interbank lending spreads (in basis points) from 2001. The figure itself tells the history: after 8 years of extremely low spreads, 2008 saw huge increases in these spreads. After the collapse of Lehman Brothers, the spreads skyrocket so much that on October 10, 2008, they were, in the U.S., an astonishing 463.62 basis points. Again, most spreads have fallen sharply and something resembling normality seems to have come back to the lending markets.\textsuperscript{16}

\textsuperscript{16}Spreads also increased in other markets. For instance, the spread between the German Treasury bond and the Spanish Treasury bond, which was trivially small in the years before the crisis, jumped to over 100 basis points in the winter of 2009 and it was still above 50 basis points at the end of 2009.
To put these developments in perspective, it is useful to review some of the main characteristics of the Spanish financial sector. First, the industry is closely supervised by the monetary authority, the Banco de España. The central bank, with an eye on avoiding a repetition of the terrible banking crisis of 1977-1985 that affected over 50 percent of existing banks and 27 percent of total assets (Torrero, 1990), has imposed over the years a clear set of guidelines and provision requirements. These prevented, for example, Spanish banks from playing with complicated structured investment vehicles such as the ones so popular in the U.S. or the growth of an important shadow banking sector. Also securitization, even if it notably increased during the period considered, involved instruments much less complicated than in the U.S. and banks kept most of the credit risk in their own balances. Similarly, lending standards relaxed only slightly during the 2000s (the fall in nominal interest rates and the increased length of mortgages to 30 or 40 years seem a more important factor here).

Second, the Spanish financial sector is highly concentrated (and on its way to getting even more so). At the end of 2008, there were only 362 credit institutions operating in Spain, with 159 banks that represented 53.53 percent of total assets and 46 savings and loans, which accumulated an additional 38.40 percent, with the remaining 8 percent being divided between small credit cooperatives, the public Instituto de Crédito Oficial, and other credit companies. But these numbers mask an even higher degree of concentration. Among the banks, Banco Santander and BBVA are giants of the Spanish market and among the top banks worldwide. Santander controls assets of over $1.4 trillion and BBVA of around $0.75 trillion. In comparison, the third largest bank, Banco Popular, has assets of only around $150 billion. In a similar fashion, just two institutions, La Caixa and CajaMadrid, control nearly half of the assets of the savings and loan sector.

Third, Spanish banks and savings and loans are hyper-universal. Banks have long-standing
relations with industry, both in terms of controlling equity positions in companies (from telecommunications to airlines, food distribution, or energy companies) and through large credits. In addition, they finance export/import operations and other international activities of firms. For individuals, Spanish banks offer their clients not only deposits, mortgages, credit cards, pension funds, and other traditional financial products, but also a bewildering range of miscellaneous services from health insurance to an automatic toll payment service on highways and movie tickets. Despite this universal character, and in part as a response to the requirements of the central bank regarding collateral requirements, Spanish banks have concentrated the majority of their lending in the real estate sector. This has also translated into less interest in operations such as venture capital or other forms of financing of new firms.

In comparison, the U.S. financial sector is more lightly regulated, considerably more dispersed, and firms are less universal in the services provided. First, the U.S. financial sector is less regulated because the power to do so is divided among different agencies with gaps and overlaps in their coverage and there is a large shadow banking sector that has escaped close supervision. Second, the U.S. financial sector is highly fragmented, with 8,246 institutions insured by the FDIC. JPMorgan Chase, the biggest institution, has assets of $1.7 trillion, only 20 percent bigger than Banco Santander, and only two other institutions, Citigroup and Bank of America, manage assets bigger than those of BBVA, while 500 banks control assets of at least $1 billion. Finally, and despite some recent integration, different financial services are offered by different companies. A typical U.S. household will bank with a different institution than the one that issued its credit cards or the one that manages the household’s mortgage (and certainly the household buys its movie tickets at a very different place).

While the two main banks, Santander and BBVA, seem to be in a sound position for the near future (helped by the positive cash-flows generated outside Spain and their focus on the retail sector), the situation of the savings and loans is much more dire, with one of them already taken in conservatorship by the Bank of Spain, and many mergers underway. Since other papers in this volume study the Spanish financial sector and its situation in the near future, we do not elaborate on this point further.

Finally, we close our overview of the world economy with the labor markets. We plot, in figure 2.14, hourly earnings in the private sector in France, Germany, Spain, the U.K. and the U.S. since 1996 (first year for which we have comparable data) from the OECD. First, we see how hourly earnings had consistent growth in the U.K. (around 2.5 percent per year), and to a lesser degree, in France, the U.S., and Spain (around 1 percent per year). In Germany, the growth of earnings was noticeably slower. In 14 years, hourly earnings in Germany increased only by a meager 5 percent, which probably explains why there has been a widespread discontent in the country over the last few years.
The information on unemployment, using the standardized definition of the IMF, is plotted in figure 2.15.

The most remarkable change in the figure is the fast drop in Spain’s unemployment, from the breathtaking levels of 1994 (24.1 percent) to a much more manageable 8.3 percent in 2007. Behind this fall in unemployment was an incredible growth in employment in Spain, which increased by 48 percent in only 14 years, or nearly 3 percent per year (in absolute
numbers, from 13 million full-time equivalent jobs to 19.2 million jobs). In comparison, in the U.S., an economy traditionally considered to be particularly adept at creating new jobs, employment increased only 17 percent during the same period.

Some of the usual suspects for this behavior mentioned by observers can be quickly eliminated. Employment data in Spain are based on a household survey designed to measure both registered and non-registered employment (the EPA, Encuesta de Población Activa, or Survey of Labor Force). Therefore, this growth in employment cannot be accounted for by the “emergence” of an underground sector.\textsuperscript{17}

Immigration accounts, mechanically, for a large part of the increase in employment in Spain (around 3 million workers at the peak in 2008 and around 2.7 million currently, or roughly half of the increase in employment), although it does not explain why those immigrants were able to find jobs in an economy that, during the previous two decades, had generated very little new net employment. Moreover, even among nationals, employment grew at an accelerated pace, with an addition of more than 3 million new workers over an initial value of around 12.5 million, pushing the activity rate from the bottom of the OECD (47.6 percent in Spain in 1994 versus an OECD mean of 63.3 percent) to above its mean (65 percent in Spain in 2005 versus an OECD mean of 64.4 percent) in just 11 years.

A direct consequence of the bigger growth in employment than in output is that GDP per worker experienced very slow growth. At the peak of the employment boom, in early 2008, GDP per worker had grown only 6.6 percent in Spain, less than 0.5 percent a year for over 13 years. The situation is even more striking because, by the end of 2007, Spain was investing over 31 percent of its GDP, a figure closer to those of Asian countries than to the European standard. Even after subtracting the investment on housing, Spain was accumulating capital at an accelerated pace.\textsuperscript{18} The total effect of the large increase in employment and in investment is the low or even negative productivity growth in Spain (for instance, Burriel, Fernández-Villaverde, and Rubio-Ramírez, 2009, estimate that total productivity grew between 1995-2007 at a -0.03 percent rate).\textsuperscript{19}

Unfortunately, the employment situation in Spain turned around rather dramatically and

\textsuperscript{17}The emergence of the underground economy can be seen in that the number of workers registered with the social security system in Spain grew faster during the late 1990s than measured employment, but insofar as the surveys corrected properly for this underground activity (and there are statistical reasons to believe that this was the case), this emergence does not have any impact on the employment data we are citing.

\textsuperscript{18}While other advanced economies did not increase much their investment in equipment during the 2000s (if anything investment in equipment fell as a percentage of GDP in countries like the U.S.), Spain invested growing amounts, with a considerable number of companies undertaking ambitious programs of renewal of their equipment (which can be seen, for example, in the statistics of imports of investment goods, since Spain produces relatively little advanced machinery).

\textsuperscript{19}We acknowledge the existence of a compositional effect. It is likely that many of the new workers in the Spanish economy had lower human capital or experience than existing workers. Therefore, it is also likely that their entry into employment reduced observed mean productivity. We lack a thorough assessment of these compositional effects and how much productivity would have increased without them.
by the end of 2009 we are back to an unemployment rate of 18 percent. In other European countries and the U.S. unemployment rates have been more stable over time and even the recent increase is much smaller than in Spain. The high sensitivity of Spanish employment to the business cycle (something that we already saw in the 1992-1993 recession) can probably only be accounted for by the inefficient set of labor market institutions that Spain has been suffering for decades. For instance, even during the peak years of the boom, over a third of all employees were under a temporary contract that separated them from the remaining two-thirds with permanent contracts in terms of firing restrictions, wages and general job conditions. Both the conservative and the socialist governments have shied away from confronting the urgent need to reform the labor market (and, for that matter, many goods markets) and prefer to concentrate on the less polemic route of fiscal probity.

Now that we have mapped the main outlines of the Spanish crisis and framed them in the context of the world economy, we move into quantitative theory to try to understand how the mechanisms outlined above may have worked.

3. A Model of Financial Shocks

In this section, we present a benchmark dynamic stochastic general equilibrium (DSGE) model with financial intermediation based on the work of Bernanke, Gertler, and Gilchrist (1999), Carlstrom and Fuerst (1997), and Christiano, Motto, and Rostagno (2009). This model emphasizes the information asymmetries between lenders and borrowers and inefficiencies that they generate. In particular, we can use the model to gauge the possible contracting effects of deflation or the “Fisher effect” (since we have nominal debt), the consequences of increased volatility on real variables, or the impact of higher banking spreads.

We will calibrate the model to reproduce some of the basic observations of the Spanish economy and measure the extent to which the breadth and depth of the current recession can be accounted for by the financial shocks we were referring to. The structure of the model is relatively straightforward: we have a representative household that consumes and saves on deposits, a final good firm that bundles the intermediate goods produced by a continuum of monopolistic competitors, producers of capital, entrepreneurs that buy and rent capital subject to a number of shocks, and finally, a financial intermediary (a bank or investment fund) that takes the savings from the households and transforms them into loans to entrepreneurs.

20 There is a large literature on financial shocks and their interaction with the economy. See, for example, the models of liquidity of Diamond and Dybvig (1983) and Diamond and Rajan (2001), the models of banking in general equilibrium of Díaz Giménez et al. (1992) and Gerali et al. (2009), and the credit cycle models of Kiyotaki and Moore (1997 and 2008). For a recent review of the empirical evidence regarding financial crisis, see Reinhart and Rogoff (2009).
3.1. Households

As mentioned above, there is a representative household that maximizes:

\[ E_0 \sum_{t=0}^{\infty} \beta^t e^{d_t} \left\{ u(c_t, l_t) + v \log \left( \frac{m_t}{p_t} \right) \right\} \]

where \( E_0 \) is the conditional expectation operator, \( c_t \) consumption, \( l_t \) hours worked, \( m_t/p_t \) (where \( p_t \) is the price level) real money balances, \( \beta \) is the discount factor, and \( d_t \) is an intertemporal preference shock with law of motion:

\[ d_t = \rho_d d_{t-1} + \sigma_d \varepsilon_{d,t} \text{ where } \varepsilon_{d,t} \sim \mathcal{N}(0,1). \]

The representative household saves on three types of assets:

1. Money balances, \( m_t \).
2. Deposits at the financial intermediary, \( a_t \), that pay an uncontingent nominal gross interest rate \( R_t \).
3. Arrow-Debreu securities. Since, in equilibrium, the net supply of these must be zero, we do not include them in the budget constraint to save on notation.

Therefore, the household’s budget constraint is given by:

\[ c_t + \frac{a_t}{p_t} + \frac{m_{t+1}}{p_t} = w_t l_t + R_{t-1} \frac{a_{t-1}}{p_t} + \frac{m_t}{p_t} + T_t + F_t + tre_t \]

where \( w_t \) is the real wage, \( T_t \) is a lump-sum transfer, \( F_t \) are the profits of the firms in the economy (financial and non-financial), and \( tre_t \) is the net real transfer to new and from old entrepreneurs,

\[ tre_t = (1 - \gamma^e_t) n_t - w^e \]

that we will explain later.

The first-order conditions for the household are:

\[ e^{d_t} u_1 (t) = \lambda_t \]

\[ \lambda_t = \beta \mathbb{E}_t \{ \lambda_{t+1} \frac{R_t}{\Pi_{t+1}} \} \]

\[ -u_2 (t) = u_1 (t) w_t \]

where \( u_i (t) \) is the marginal utility with respect to the variable \( i \) evaluated at \( t \) and \( \lambda_t \) is the Lagrangian multiplier on the budget constraint.
3.2. The Final Good Producer

There is one final good produced using intermediate goods according to:

\[ y_t = \left( \int_0^1 y_{it}^{-\varepsilon} \, di \right)^{\frac{\varepsilon}{\varepsilon - 1}}. \]

(1)

where \( \varepsilon \) is the elasticity of substitution.

The final good producer is perfectly competitive and maximizes profits subject to the production function (1), taking as given all intermediate goods prices \( p_{ti} \) and the final good price \( p_t \). Thus, the input demand functions are:

\[ y_{it} = \left( \frac{p_{it}}{p_t} \right)^{-\varepsilon} y_t \quad \forall i, \]

where \( y_t \) is the aggregate demand and:

\[ p_t = \left( \int_0^1 p_{it}^{1-\varepsilon} \, di \right)^{\frac{1}{1-\varepsilon}}. \]

3.3. Intermediate Goods Producers

There is a continuum of intermediate goods producers. Each intermediate good producer \( i \) has access to a technology represented by a production function \( y_{it} = e^{z_t k_{it-1}^{\alpha}} l_{it}^{1-\alpha} \) where \( k_{it-1} \) is the capital rented by the firm, \( l_{it} \) is the amount of labor input rented by the firm, and where the productivity process \( z_t \) follows:

\[ z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_{z,t} \text{ where } \varepsilon_{z,t} \sim \mathcal{N}(0,1) \]

Cost minimization implies:

\[ k_{it-1} = \frac{\alpha w_t l_{it}}{1 - \alpha r_t} \]

\[ mc_t = \left( \frac{1}{1 - \alpha} \right)^{1-\alpha} \left( \frac{1}{\alpha} \right)^{\alpha} \frac{w_t^{1-\alpha} l_{it}^\alpha}{e^{z_t}} \]

Since all intermediate goods producers have the same conditions and by market clearing:

\[ \frac{k_{it-1}}{l_t} = \frac{\alpha w_t}{1 - \alpha r_t} \]

Firms are subject to a Calvo pricing mechanism. In each period, a fraction \( 1 - \theta \) of firms can change their prices while all other firms keep the previous price. Then, the relative reset
price $\Pi_t^* = p_t^*/p_t$ is set such that we satisfy the following recursive equations:

\[ \varepsilon g^1_t = (\varepsilon - 1) g^2_t \]
\[ g^1_t = \lambda_t m c_t y_t + \beta \theta E_t \Pi^\varepsilon_{t+1} g^1_{t+1} \]
\[ g^2_t = \lambda_t \Pi^*_t y_t + \beta \theta E_t \Pi^\varepsilon_{t+1} \left( \frac{\Pi^*_t}{\Pi^\varepsilon_{t+1}} \right) g^2_{t+1} \]

defined on the auxiliary variables $g^1_t$ and $g^2_t$.

Given Calvo’s pricing, the price index evolves as:

\[ 1 = \theta \Pi^\varepsilon_{t-1} + (1 - \theta) \Pi^{1-\varepsilon}_t \]

3.4. Capital Good Producers

Capital is produced by a perfectly competitive capital good producer that buys installed capital, $x_t$, and adds new investment, $i_t$, to generate new installed capital for the next period:

\[ x_{t+1} = x_t + \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t \]

where $S[.]$ is an investment-adjustment cost function that satisfies $S[1] = 0$, $S'[1] = 0$, and $S''[.] > 0$. The period profits of the firm are then:

\[ q_t \left( x_t + \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t \right) - q_t x_t - i_t = q_t \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t - i_t \]

where $q_t$ is the relative price of capital in the period. The discounted profits are:

\[ \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left( q_t \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t - i_t \right) \]

Note that this objective function does not depend on the level of $x_t$ and hence we can make it equal to $(1 - \delta) k_{t-1}$. The capital producer discounts the future using the pricing kernel $\beta^t \lambda_t / \lambda_0$, which corresponds to the preferences of the household that owns the firm.

The first-order condition of this problem is:

\[ q_t \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) - S' \left[ \frac{i_t}{i_{t-1}} \right] \frac{i_t}{i_{t-1}} + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} q_{t+1} S' \left[ \frac{i_{t+1}}{i_t} \right] \left( \frac{i_{t+1}}{i_t} \right)^2 = 1 \]

and the law of motion for capital is:

\[ k_t = (1 - \delta) k_{t-1} + \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t \]
This capital producer does not play any further role beyond allowing us to simplify the algebra, since derivations would become more complicated if the entrepreneurs that we describe momentarily would have to keep capital over time.

3.5. Entrepreneurs

Entrepreneurs use their (end-of-period) real wealth, \(n_t\), and a nominal bank loan \(b_t\), to purchase new installed capital \(k_t\):

\[ q_t k_t = n_t + \frac{b_t}{p_t} \]

The purchased capital is shifted by a productivity shock \(\omega_{t+1}\) that is lognormally distributed with CDF \(F(\omega)\) and parameters \(\mu_{\omega,t}\) and \(\sigma_{\omega,t}\) such that \(E_t \omega_{t+1} = 1\) for all \(t\). Therefore:

\[ E_t \omega_{t+1} = e^{\mu_{\omega,t+1} + \frac{1}{2} \sigma_{\omega,t+1}^2} = 1 \Rightarrow \mu_{\omega,t+1} = -\frac{1}{2} \sigma_{\omega,t+1}^2 \]

This productivity shock is a stand-in for more complicated processes such as changes in demand (if we were dealing with models with heterogeneous goods) or the stochastic quality of projects.

We postulate that the evolution of the standard deviation of this productivity shock is such that:

\[ \log \sigma_{\omega,t} = (1 - \rho_{\sigma}) \log \sigma_{\omega} + \rho_{\sigma} \log \sigma_{\omega,t-1} + \eta_{\sigma} \varepsilon_{\sigma,t} \text{ where } \varepsilon_{\sigma,t} \sim \mathcal{N}(0,1) \]

The shock \(t + 1\) is revealed at the end of period \(t\) right before investment decisions are made. Then:

\[ \log \sigma_{\omega,t} - \log \sigma_{\omega} = \rho_{\sigma} (\log \sigma_{\omega,t-1} - \log \sigma_{\omega}) + \eta_{\sigma} \varepsilon_{\sigma,t} \Rightarrow \tilde{\sigma}_{\omega,t} = \rho_{\sigma} \tilde{\sigma}_{\omega,t-1} + \eta_{\sigma} \varepsilon_{\sigma,t} \]

an expression that will be useful below when we loglinearize the model (from now on, \(\tilde{x}\) will be the logdeviation of a variable with respect to its steady state). To keep track of the value of \(\sigma_{\omega,t}\), we will make the dependence of the distribution function on this variable explicit and write \(F(\omega, \sigma_{\omega,t})\).

The entrepreneur rents the capital to intermediate goods producers, who pay a rental price \(r_{t+1}\). Also, at the end of the period, the entrepreneur sells the undepreciated capital to the capital goods producer at price \(q_{t+1}\). Therefore, the average return of the entrepreneur per nominal unit invested in period \(t\) is:

\[ R_t^k = \frac{p_{t+1} r_{t+1} + q_{t+1} (1 - \delta)}{p_t} \]
The debt contract is structured as follows. For every state with associated return on capital $R^k_{t+1}$, entrepreneurs have to either pay a state-contingent gross nominal interest rate $R^l_{t+1}$ on the loan or default. If the entrepreneur defaults, it gets nothing: the bank seizes its revenue, although a portion $\mu$ of that revenue is lost in bankruptcy procedures. Hence, the entrepreneur will always pay if it has generated enough revenue to do so. This will be the case if productivity is at least as high as a level $\omega_{t+1}$ at which the entrepreneur can just pay back its debt:

$$ R^l_{t+1} b_t = \omega_{t+1} R^k_{t+1} p_t q_t k_t $$

This equation tells us that $\omega_{t+1}$ moves in the same direction as $R^l_{t+1}$ all other variables being equal. The equation is also useful because, below, instead of characterizing the debt contract in terms of $R^l_{t+1}$, we will do it in terms of $\omega_{t+1}$, which is easier. If $\omega_{t+1} < \omega_{t+1}$, the entrepreneur defaults, the bank monitors the entrepreneur and gets $(1 - \mu)$ of the entrepreneur’s revenue. This is known in the literature as a costly state verification framework (Townsend, 1979).

The debt contract determines $R^l_{t+1}$ to be the return such that banks satisfy its zero profit condition in all states of the world:

$$ [1 - F(\omega_{t+1}, \sigma_{\omega,t+1})] R^l_{t+1} b_t + (1 - \mu) \int_0^{\omega_{t+1}} \omega dF(\omega, \sigma_{\omega,t+1}) R^k_{t+1} p_t q_t k_t = s_t R_t b_t $$

where $R_t$ is the (non-contingent) return of households that have saved in the bank and $s_t = 1 + \varepsilon^+ + \sigma^t$ is a spread caused by the cost of intermediation\(^{21}\) such that:

$$ \tilde{s}_t = \rho_s \tilde{s}_{t-1} + \sigma_s \varepsilon_{s,t} \text{ where } \varepsilon_{s,t} \sim \mathcal{N}(0,1). $$

For simplicity, we assume that the intermediation cost is rebated to the households in a lump-sum fashion (we can imagine, for instance, that intermediation costs are wages paid back to the household on an inelastically supplied amount of intermediation know-how). Note that the previous equation loads all the risk of delivering the right level of return to the bank through changes in $\omega_{t+1}$ and $R^l_{t+1}$. This spread shock is a simple way to think about the aggregate consequences of disturbances in the financial markets that increase the spreads among different financial assets. Having more explicit models of how these spreads are determined is an important research question that we do not tackle at this moment.

Although the debt contract we just outlined is not necessarily optimal in the context of our model, it is a plausible representation for a number of nominal debt contracts that we observe in the data. Also, the nominal structure of the contract creates a “Fisher effect” through which changes in the price level have an impact on real investment decisions.

\(^{21}\)See Curdia and Woodford (2008) for a similar approach.
To explore the debt contract further, define:

\[
\Gamma (\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) = \bar{\omega}_{t+1} (1 - F(\bar{\omega}_{t+1}, \sigma_{\omega,t+1})) + G(\bar{\omega}_{t+1}, \sigma_{\omega,t+1})
\]

Share of entrepreneurial earnings accrued to the bank

\[
G(\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) = \int_{0}^{\bar{\omega}_{t+1}} \omega dF(\omega, \sigma_{\omega,t+1})
\]

By the properties of the lognormal distribution:

\[
G(\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) = 1 - \Phi \left( \frac{\frac{1}{2} \sigma_{\omega,t+1}^2 - \log \bar{\omega}_{t+1}}{\sigma_{\omega,t+1}} \right)
\]

where \( \Phi \) is the CDF of a normal distribution. Thus, we can rewrite the zero profit condition of the bank as:

\[
\left[ \bar{\omega}_{t+1} [1 - F(\bar{\omega}_{t+1}, \sigma_{\omega,t+1})] + (1 - \mu) \int_{0}^{\bar{\omega}_{t+1}} \omega dF(\omega, \sigma_{\omega,t+1}) \right] \frac{R_{k,t+1} q_k t}{s_t R_t} \Rightarrow \frac{R_{k,t+1}}{s_t R_t} \left[ \Gamma (\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) - \mu G(\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) \right] q_k t = \frac{b_t}{p_t}
\]

which gives a schedule relating \( R_{k,t+1} \) and \( \bar{\omega}_{t+1} \), a key component of the model. For example, when \( R_{k,t+1} \) is low, \( \bar{\omega}_{t+1} \) is high, which increases the payoffs to the bank to compensate for the lower return on capital, although it also raises default rates.\(^{22}\)

Now, define the ratio of loan over wealth:

\[
\theta_t = \frac{b_t}{p_t} = \frac{q_k k_t - n_t}{n_t} = \frac{q_k k_t}{n_t} - 1
\]

and we get an expression for the zero profit condition of the form:

\[
\frac{R_{k,t+1}}{s_t R_t} \left[ \Gamma (\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) - \mu G(\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) \right] \frac{q_k k_t}{n_t} = \frac{b_t}{p_t} \Rightarrow \frac{R_{k,t+1}}{s_t R_t} \left[ \Gamma (\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) - \mu G(\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) \right] (1 + \theta_t) = \theta_t
\]

that tells us that all the entrepreneurs, regardless of their level of wealth, will have the same leverage, \( \theta_t \), a most convenient feature for aggregation.

The problem of the entrepreneur is then to pick \( \theta_t \) and a schedule for \( \bar{\omega}_{t+1} \) to maximize

\(^{22}\)We can show that for interior values of \( \bar{\omega}_t \), the rise in revenue is bigger than the higher losses due to default.
its expected net worth given the zero-profit condition of the bank:

$$
\max_{q_t, \omega_{t+1}} \mathbb{E}_t \left \{ \frac{R_{t+1}^k}{R_t} (1 - \Gamma (\omega_{t+1}, \sigma_{\omega,t+1})) (1 + q_t) + \eta_t \frac{R_{t+1}^k}{s_t R_t} \left[ \Gamma (\omega_{t+1}, \sigma_{\omega,t+1}) - \mu G (\omega_{t+1}, \sigma_{\omega,t+1}) \right] (1 + q_t) - q_t \right \}
$$

with FOC:

$$
q_t : \mathbb{E}_t \frac{R_{t+1}^k}{R_t} (1 - \Gamma (\omega_{t+1}, \sigma_{\omega,t+1})) + \eta_t \frac{R_{t+1}^k}{s_t R_t} \left[ \Gamma (\omega_{t+1}, \sigma_{\omega,t+1}) - \mu G (\omega_{t+1}, \sigma_{\omega,t+1}) \right] - 1 = 0
$$

$$
\omega_{t+1} : - s_t \Gamma_\omega (\omega_{t+1}, \sigma_{\omega,t+1}) + \eta_t \left[ \Gamma_\omega (\omega_{t+1}, \sigma_{\omega,t+1}) - \mu G_\omega (\omega_{t+1}, \sigma_{\omega,t+1}) \right] = 0
$$

Now, note that we can write the Lagrangian multiplier (and making the dependence on $\omega_{t+1}$ and $\sigma_{\omega,t+1}$ explicit) as:

$$
\eta (\omega_{t+1}, \sigma_{\omega,t+1}) = \frac{s_t \Gamma_\omega (\omega_{t+1}, \sigma_{\omega,t+1})}{\Gamma_\omega (\omega_{t+1}, \sigma_{\omega,t+1}) - \mu G_\omega (\omega_{t+1}, \sigma_{\omega,t+1})}
$$

Since:

$$
G_\omega (\omega_{t+1}, \sigma_{\omega,t+1}) = \omega_{t+1} F_\omega (\omega_{t+1}, \sigma_{\omega,t+1})
$$

$$
\Gamma_\omega (\omega_{t+1}, \sigma_{\omega,t+1}) = 1 - F (\omega_{t+1}, \sigma_{\omega,t+1})
$$

we get:

$$
\eta (\omega_{t+1}, \sigma_{\omega,t+1}) = s_t \frac{1 - F (\omega_{t+1}, \sigma_{\omega,t+1})}{1 - F (\omega_{t+1}, \sigma_{\omega,t+1}) - \mu \omega_{t+1} F_\omega (\omega_{t+1}, \sigma_{\omega,t+1})}
$$

Then:

$$
\mathbb{E}_t \left \{ \frac{R_{t+1}^k}{R_t} (1 - \Gamma (\omega_{t+1}, \sigma_{\omega,t+1})) + \eta (\omega_{t+1}, \sigma_{\omega,t+1}) \frac{R_{t+1}^k}{s_t R_t} \left[ \Gamma (\omega_{t+1}, \sigma_{\omega,t+1}) - \mu G (\omega_{t+1}, \sigma_{\omega,t+1}) \right] - 1 \right \} = 0
$$

and using the zero-profit condition for the bank

$$
\mathbb{E}_t \frac{R_{t+1}^k}{R_t} (1 - \Gamma (\omega_{t+1}, \sigma_{\omega,t+1})) = \mathbb{E}_t \eta (\omega_{t+1}, \sigma_{\omega,t+1}) \frac{n_t}{q_t k_t}
$$

which relates purchases of capital to the level of wealth and the finance premium, $R_{t+1}^k/R_t$, and shows how changes in net wealth have an effect on the level of investment and output in the economy.

Finally, at the end of each period, a fraction $\gamma_t^e$ of entrepreneurs survive to the next period and the rest die and disappear and their capital is confiscated by the government. They are replaced by a new cohort of entrepreneurs that enter with initial real net wealth $w^e$ (a transfer that also goes to surviving entrepreneurs even if they went bankrupt in the
Therefore, the average net wealth $n_t$ (here we are equating average wealth with the wealth of the entrepreneur we studied before, since all entrepreneurs get the same $\varphi_t$) evolves as:

$$p_t n_t = \gamma_t \left[ R_t^k p_{t-1} q_{t-1} k_{t-1} - s_{t-1} R_{t-1} b_{t-1} - \mu \int_2^{\infty} \omega dF (\omega, \sigma, \omega, t) R_t^k p_{t-1} q_{t-1} k_{t-1} \right] + p_t w^e$$

or, after boring algebra:

$$n_t = \gamma_t \frac{1}{\Pi_t} \left[ (1 - \mu G (\bar{\omega}_t, \sigma, \omega, t)) R_t^k q_{t-1} k_{t-1} - s_{t-1} R_{t-1} \frac{b_{t-1}}{p_{t-1}} \right] + w^e$$

The share $\gamma_t^e$ is equal to:

$$\gamma_t^e = \frac{1}{1 + e^{-\tau - n_t}}$$

where $\tilde{\gamma}_t^e$ follows:

$$\tilde{\gamma}_t^e = \rho_{\gamma} \tilde{\gamma}_{t-1} + \sigma_{\gamma} e_{\gamma, t} \text{ where } e_{\gamma, t} \sim N(0, 1).$$

The transformation ensures that $\gamma_t^e$ is bounded in the unit interval, while $\tilde{\gamma}^e$ controls the mean of the survival rate.

The death process ensures that entrepreneurs do not accumulate enough wealth so as to make the financing problem irrelevant. Shocks to the death rate represent events such as waves of technology evolution of exogenous changes to the wealth of entrepreneurs (for instance, as a result of government policies).

### 3.6. The Financial Intermediary

There is a representative competitive financial intermediary (we can think of it as a bank but it may include other financial firms) that intermediates between households and entrepreneurs. The bank lends to entrepreneurs a nominal amount $b_t$ at rate $R_t^c$, but recovers only an (uncontingent) rate $R_t$ because of default and the (stochastic) intermediation costs. Therefore, the bank pays interest $R_t$ to households.

### 3.7. The Monetary Authority Problem

The monetary authority sets the nominal interest rates according to a rather standard Taylor rule:

$$\frac{R_t}{R} = \left( \frac{R_{t-1}}{R} \right)^{\gamma_R} \left( \frac{\Pi_t}{\Pi} \right)^{\gamma_{\Pi}(1 - \gamma_R)} \left( \frac{y_t}{y} \right)^{\gamma_y(1 - \gamma_R)} \exp (\sigma y m_t)$$

through open market operations that are financed through lump-sum transfers $T_t$. The variable $\Pi$ represents the target level of inflation (equal to inflation in the steady-state), $y$ is the
steady state level of output, and \( R = \frac{\Pi}{\Pi_t} \) the steady state nominal gross return of capital. The term \( \varepsilon_{mt} \) is a random shock to monetary policy distributed according to \( \mathcal{N}(0, 1) \).

This specification implies a huge simplification. Short-run interest rates in Spain are determined by the ECB, which considers inflation and output of the whole Euro area and not only Spain. However, as long as Spanish inflation and output are correlated with the rest of the area (and we just saw in section 2 that they are because most relevant shocks are likely to be common across Europe), this is not a terribly bad assumption. Take the loglinear approximation of the Taylor rule evaluated at the Euro Area values:

\[
\hat{R}_t = \gamma_R \hat{R}_{t-1} + (1 - \gamma_R) \gamma_{\Pi} \hat{\Pi}_t^{EA} + (1 - \gamma_R) \gamma_y \hat{y}_t^{EA} + \sigma_m \varepsilon_{mt}
\]

and assume that

\[
\begin{align*}
\hat{y}_t^{SPAIN} &= \hat{y}_t^{EA} + \varepsilon_{1t} \\
\hat{\Pi}_t^{SPAIN} &= \hat{\Pi}_t^{EA} + \varepsilon_{2t}
\end{align*}
\]

where \( \varepsilon_{1t} \) and \( \varepsilon_{2t} \) are zero mean shocks. Then, we get

\[
\hat{R}_t = \gamma_R \hat{R}_{t-1} + (1 - \gamma_R) \gamma_{\Pi} \hat{y}_t^{SPAIN} + (1 - \gamma_R) \gamma_y \hat{\Pi}_t^{SPAIN} + \varepsilon_{1t} + \varepsilon_{2t} + \sigma_m \varepsilon_{mt}
\]

and we can proceed reinterpreting the shock to monetary policy as a stand-in for the pure monetary shock plus the deviations of interest rates created by the idiosyncrasies of the Spanish economy in relation to its European partners.

### 3.8. Aggregation

Using conventional arguments, we find expressions for aggregate demand and supply in our economy:

\[
y_t = c_t + i_t + \mu G(\bar{z}_t, \sigma_{\omega, t}) (r_t + q_t (1 - \delta)) k_{t-1}
\]

\[
y_t = \frac{1}{v_t} e^{zt} k_{t-1}^{1-\alpha} l_t^{1-\alpha}
\]

where \( v_t = \int_0^1 \left( \frac{p_t}{p_{t-1}} \right)^{-\varepsilon} \, di \) is the inefficiency created by price dispersion. By the properties of the index under Calvo’s pricing, this inefficiency evolves as:

\[
v_t = \theta \Pi_t^\varepsilon v_{t-1} + (1 - \theta) \Pi_t^{\varepsilon - \varepsilon}.
\]

Note that we have inflation in the steady state equal to \( \Pi \). Therefore, the first-order approximation of this inefficiency will not be zero in general and monetary policy has an impact on
the level and evolution of measured productivity.

3.9. Equilibrium

The definition of equilibrium in this economy is standard and we omit it in the interest of space. The following equations can be solved for the 28 endogenous variables of the model: $c_t, \lambda_t, l_t, r_t, w_t, g_t^1, g_t^2, mc_t, \Pi_t, \Pi_t^*, \bar{w}_t, b_t/p_t, n_t, q_t, k_t, R_t, R^l_t, R^k_t, y_t, v_t, i_t, d_t, z_t, \bar{s}_t, \bar{s}_t, \gamma_t^e, \tilde{\gamma}_t^e$, and $\sigma_{\omega,t}$.

- The first-order conditions of the household:

$$e^{dt}u_1(t) = \lambda_t$$

$$\lambda_t = \beta \mathbb{E}_t \{ \lambda_{t+1} \frac{R_t}{\Pi_{t+1}} \}$$

$$-u_2(t) = u_1(t)w_t$$

- The first-order conditions of the intermediate firms:

$$\varepsilon g_t^1 = (\varepsilon - 1)g_t^2$$

$$g_t^1 = \lambda_t mc_t y_t + \beta \mathbb{E}_t \Pi_{t+1}^\varepsilon g_t^1_{t+1}$$

$$g_t^2 = \lambda_t \Pi_t^* y_t + \beta \mathbb{E}_t \Pi_{t+1}^{\varepsilon-1} \left( \frac{\Pi_t^*}{\Pi_{t+1}^*} \right) g_t^2_{t+1}$$

$$k_t = \frac{\alpha w_t}{1 - \alpha r_t}$$

$$mc_t = \left( \frac{1}{1 - \alpha} \right)^{1-\alpha} \left( \frac{1}{\alpha} \right)^{\alpha} \frac{w_t^{1-\alpha} r_t^\alpha}{e^{zt}}$$

- Price index evolves:

$$1 = \theta \Pi_t^{\varepsilon - 1} + (1 - \theta) \Pi_t^{1-\varepsilon}$$

- Capital good producers:

$$q_t \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] - S' \left[ \frac{i_t}{i_{t-1}} \right] \frac{i_t}{i_{t-1}} \right) + \beta \mathbb{E}_t \lambda_{t+1} \frac{q_{t+1}}{\lambda_t} S' \left[ \frac{i_{t+1}}{i_t} \right] \left( \frac{i_{t+1}}{i_t} \right)^2 = 1$$

$$k_t = (1 - \delta) k_{t-1} + \left( 1 - S \left[ \frac{i_t}{i_{t-1}} \right] \right) i_t$$
Entrepreneur problem:

\[ R_{t+1}^k = \Pi_{t+1} \frac{r_{t+1} + q_{t+1} (1 - \delta)}{q_t} \]

\[ \frac{R_{t+1}^k}{s_t R_t} [\Gamma (\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) - \mu G (\bar{\omega}_{t+1}, \sigma_{\omega,t+1})] = \frac{q_t k_t - n_t}{q_t k_t} \]

\[ \mathbb{E}_t \frac{R_{t+1}^k}{R_t} (1 - \Gamma (\bar{\omega}_{t+1}, \sigma_{\omega,t+1})) = \left( \mathbb{E}_t s_t \frac{1 - F (\bar{\omega}_{t+1}, \sigma_{\omega,t+1})}{1 - F (\bar{\omega}_{t+1}, \sigma_{\omega,t+1}) - \mu \bar{\omega}_{t+1} F (\bar{\omega}_{t+1}, \sigma_{\omega,t+1})} \right) \frac{n_t}{q_t k_t} \]

\[ R_{t+1} b_t = \bar{\omega}_{t+1} R_{t+1}^k p_t q_t k_t \]

\[ q_t k_t = n_t + \frac{b_t}{p_t} \]

\[ n_t = \gamma_t e \frac{1}{\Pi_t} \left[ (1 - \mu G (\bar{\omega}_t, \sigma_{\omega,t})) R_t q_{t-1} k_{t-1} - s_{t-1} R_{t-1} \frac{b_{t-1}}{p_{t-1}} \right] + w^e \]

The government follows its Taylor rule:

\[ \frac{R_t}{R} = \left( \frac{R_{t-1}}{R} \right)^{\gamma_R} \left( \frac{\Pi_t}{\Pi} \right)^{\gamma_R (1-\gamma_R)} \left( \frac{y_t}{y} \right)^{\gamma_R (1-\gamma_R)} \exp (\sigma_m m_t) \]

Market clearing

\[ y_t = c_t + i_t + \mu G (\bar{\omega}_t, \sigma_{\omega,t}) (r_t + q_t (1 - \delta)) k_{t-1} \]

\[ y_t = \frac{1}{\nu_t} e^{z_t} k_{t-1}^{1-\alpha} \]

\[ v_t = \theta \Pi_t^e v_{t-1} + (1 - \theta) \Pi_t^{e-\varepsilon} \]

Stochastic processes:

\[ d_t = \rho_d d_{t-1} + \sigma_d \varepsilon_{d,t} \]

\[ z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_{z,t} \]

\[ s_t = 1 + \varepsilon_{s,t} \]

\[ \tilde{s}_t = \rho_s \tilde{s}_{t-1} + \sigma_s \varepsilon_{s,t} \]

\[ \gamma_t^e = \frac{1}{1 + e^{-\gamma_t}} \]

\[ \tilde{\gamma}_t = \rho_{\gamma} \tilde{\gamma}_{t-1} + \sigma_{\gamma} \varepsilon_{\gamma,t} \]

\[ \log \sigma_{\omega,t} = (1 - \rho_\sigma) \log \sigma_\omega + \rho_\sigma \log \sigma_{\omega,t-1} + \eta_\sigma \varepsilon_{\sigma,t} \]
3.10. Calibration and Computation

We calibrate our economy to reproduce some basic features of the Spanish economy on a quarterly basis. First, we pick as a utility function a standard log-CRRA form:

$$u(c_t, l_t) = \log c_t - \psi \frac{l_t^{1+\vartheta}}{1 + \vartheta}$$

that delivers a steady state with constant labor supply.

We have three preference parameters: $\beta$, $\psi$, and $\vartheta$. The discount factor, $\beta = 0.995$, is selected to deliver an average nominal interest rate of 4 percent (and a real rate of 2 percent). We choose $\psi$ to ensure that households work one-third of their available time in the steady state. The inverse of the Frisch elasticity, $\vartheta = 0.5$, is a conventional value in the literature.

There are four technology parameters: $\alpha$, $\delta$, $\varepsilon$, and $S''[1]$. For $\alpha = 0.33$ gives us a participation of labor income of 0.6 (remember that we have mark-ups), roughly in line with the evidence from the Spanish NIPA. A value of $\delta = 0.023$ matches the capital/output ratio. The parameter controlling elasticity of substitution, $\varepsilon = 8.577$ and the adjustment cost $S''[1] = 14.477$ come from the mean of the estimates of Burriel, Fernández-Villaverde, and Rubio-Ramírez (2009). Similarly, the level of nominal rigidities is calibrated to 0.75 to match the evidence on changes of prices on an annual basis.

The evidence regarding the parameters of the entrepreneur’s problem is weaker. Christiano, Motto and Rostagno (2009) estimate a value for $\mu = 0.1$ for the Euro Area. Since the Spanish judicial system is less efficient than the average European system, we increase that number by 50 percent to 0.15. This number is close to the value of 0.12 proposed by Bernanke, Gertler, and Gilchrist (1999). The average dispersion of productivity shocks $\sigma_\omega$ is chosen to given us 2.528 percent of firms going into bankruptcy each period and the mean survival rate is set at 0.978 (roughly matching the average life of a business). We calibrate the wealth transfer $w^e$ to get

$$\frac{n}{n-k} \approx 2$$

and the mean spread to be 25 basis points per quarter.

For the Taylor rule, $\Pi = 1.005$ is the target of the ECB, and $\gamma_R = 0.95$, $\gamma_\Pi = 1.5$, and $\gamma_y = 0.1$ are conventional values.

For the stochastic processes we specify that all the autoregressive components are 0.95 (the estimates of Christiano, Motto, and Rostagno, 2009, for the Euro Area fluctuate around that number). For the standard deviations, we pick the deviation of the survival shock to ensure

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23Spanish National Income and Product Accounts compute the direct participation of wages in income to be around 0.5 (somewhat lower than in other developed countries). In line with standard practice, we are attributing an extra 10 percent to proprietors’ income (similar results are obtained if one estimates an aggregate production function to get $\alpha$).
that a one-standard-deviation negative shock lowers the entry rate from 0.978 to 0.9424 and a one-standard-deviation positive shock raises it to 0.9918, the standard deviation of the shock to the spread to increase the spread by 0.25 basis points per quarter, the standard deviation of the shock to volatility to induce a 20 percent increase in cross-sectional dispersion, and the standard deviation of the shock to productivity to the classical 0.007. Finally, we set, somewhat arbitrarily, the standard deviations of the preference and monetary shocks to each account for about 1/3 of aggregate fluctuations. Since we will not focus on these shocks and the impulse response functions (IRFs) are scale-invariant, these choices are not terribly important.

Finally, we compute the model by loglinearizing the equilibrium conditions around the deterministic steady state and solving the resulting linear system of difference equations. A higher order approximation, although potentially desirable, gets complicated because of the need to take derivatives of implicit functions (see the appendix for details of how we loglinearize).

3.11. Quantitative Results

Our model offers a rich framework for the analysis of aggregate fluctuations, but we cannot undertake a careful assessment of its behavior because of space constraints. Suffice it to say here that the model can match the business cycle statistics of economies like Spain as well as other, more traditional policy-oriented models (see the discussion in Burriel, Fernández-Villaverde, and Rubio-Ramírez, 2009, for a model of the Spanish economy, Christoﬀel, Coenen, and Warne, 2008, for a model of the Euro Area, and Edge, Kiley, and Laforte, 2009, for a model of the U.S.).

Instead, we focus our attention on the IRFs of the economy to the six shocks in the model: shocks to preferences, productivity, volatility of idiosyncratic shocks, spreads, survival rates, and monetary policy. By looking at these shocks and how they propagate over time, we can distinguish among the possible channels behind the present crisis and gauge how large of a shock we will need to deliver the desired goal of matching the data. For each shock, we plot the responses in the first 20 quarters in terms of log-deviations with respect to the steady state to a one-standard-deviation positive shock. Since we have loglinearized our model, the IRFs to a negative shock are the same as the IRFs to a positive shock except with a ﬂipped sign along the curve.

24The implications for steady-state values of the variables can be, however, rather different from the ones from the New Keynesian models, basically because of the presence of spreads that work as wedges. This is a point that the literature has not emphasized enough.
We start by plotting the IRFs of the model to a shock to preferences in figures 3.1 and 3.2. An increase in $d_t$ brings a desire for early consumption, which translates into higher aggregate demand and, through the nominal rigidities in prices, into a higher level of output, hours, wages, rental rate of capital, and inflation (panels (1,1), (2,1), (3,1), (2,3), and (3,3) respectively). Also, the Fisher effect lowers the real value of outstanding entrepreneurs’ debt, allowing them to borrow larger amounts in the future. Investment and capital suffer, though, because consumption grows more than output and we still need to respect the resource constraint of the economy.

In figure 3.2, we see how the financial premium (panel (1,3)) falls after the shock: higher demand increases the returns of entrepreneurs (panel(1,2)) and the price of capital (panel(2,1)), with both components reducing the cost of bankruptcy for the financial intermediary. Moreover, fewer entrepreneurs will go bankrupt. Also, the amount of debt (panel (2,3), the interest rates (panel (1,1)), and the productivity cutoff for bankruptcy (panel(3,1)) increase. The efficiency cost of price dispersion (panel (3,2)) goes up because, as a response to the demand pull, a share of firms can update their prices while others cannot, pushing us away from the efficient allocation.
The shock to preferences is usually understood as a stand-in for the effects of fiscal policy or some other sudden change in the desire to consume. By itself, this shock helps us little, though, to understand the current maladies through the lens of our model. A large negative preference shock, perhaps caused by an increased level of uncertainty (which we cannot directly capture in a loglinearized model), will indeed deliver a large drop in output, consumption, and inflation, but investment will slightly increase, a counterfactual observation given the big reduction in fixed investment experienced by Spain over the last quarters. However, below we will argue that this shock may have played a role in combination with some of the financial shocks. In fact, if preference shocks capture uncertainty toward the future triggered, for instance, by developments in the financial markets, it is plausible to think that the shocks may be correlated.

The IRFs of the model to a productivity shock appear in figures 3.3 and 3.4. The behavior of the model is rather similar to the one from the standard real business cycle (RBC) model, since, at its core, our model is nothing more than an RBC with some nominal rigidities and financial frictions. After a positive productivity shock, output, investment, and consumption all go up and inflation goes down. The only difference is that, at impact, hours go down (this is a well-understood channel: with price rigidities, prices do not go down sufficiently fast, output does not grow as quickly as it should, and hours suffer because we are more productive and firms do not require as many workers). This goal is achieved through lower
wages at impact, although they later recover.

Also, the financial spread goes up to reflect the lower price of capital (that is more productive but less of which is needed because of the output effect described above) and its consequences for new wealth, debt, and the productivity cutoff. The Fisher effect now goes in an opposite direction: lower inflation has a negative balance sheet effect on entrepreneurs and fluctuations are damped. Finally, the interest rates go down, the monetary authority’s response to lower inflation.

A large negative productivity shock then could explain the big drops in output, consumption, and employment, but it has a much harder time accounting for financial variables. After the negative shock, we would have high interest rates and small spreads, not low interest rates and big spreads as we have now (and measured productivity is actually rising rather briskly, although composition effects make this statement thorny to assess with certainty). Similarly, inflation should be high, not low, as we are currently observing.
The effects of a shock to the volatility of idiosyncratic shocks (a spread in the cross-section) are documented by figures 3.5 and 3.6. The volatility shocks contract output (after a couple of quarters in which higher consumption slightly raises output, and this higher consumption is caused by the relative rise in investment prices), investment, and hours, and raises inflation. The channel is as follows: a mean-preserving spread of the distribution of productivities puts more firms in the lower ranges of profitability and forces them to go bankrupt. This increases the cost to the financial intermediary, which responds by requiring higher net worth and allowing for less debt as the optimal leverage falls (although this channel is eased by the positive Fisher effect triggered by higher inflation). Therefore, the economy switches from investment to consumption.

That is also the reason why an increase in volatility raises the finance premium (panel (1,3)) and lowers the price of capital (there is too much installed capital in the economy that entrepreneurs now cannot purchase). The monetary authority responds to higher inflation by raising the interest rate.
The shock to volatility gets more things right: output, consumption, and investment all go down (even if the timing is sometimes off), as we see in the data. Also, if we relate the q with valuations in the stock market, a common exercise in the literature, the model helps us to understand the large drops in stock prices of the fall of 2008 and winter of 2009. However, the shock misses in terms of inflation, which goes up after the shock, but it is unusually low right now in the data. Fortunately, the increase in inflation is rather small and could be, for instance, reconciled with the data if we simultaneously hit the economy with a negative demand shock, which drives inflation down considerably more than it rises from the volatility shock (and gets the Fisher effect to go in the direction that amplifies the negative consequences of the shock).

The relevant question is: how big of a shock to volatility would we need to account for the current recession? After a few quarters, output has fallen by 0.4 percent, which will imply a 10-standard-deviation negative shock to get a fall in output of 4 percent. This number is not plausible. A more promising route is to look at the joint effect of several shocks hitting the economy simultaneously. If we combine a 2-standard-deviation shock to volatility followed a few quarters later by 2-standard-deviation negative preference shock (we are thinking here about a big increase in volatility in 2007 that triggers a response of households in the fall of 2008 modelled as the preference shock we were referring to), we could account for roughly a
2 percent fall in output, still short of our objective. On the positive side, we would get the numbers roughly right in terms of inflation and co-movements across variables.

Figure 3.6: Shock to Volatility, 2

In addition, there is the issue of what is, in the data, the increase in the dispersion of productivity shocks. The simplest interpretation can be a change in technology. We can think, for instance, about information technologies as increasing the dispersion of outcomes, allowing more productive managers to be more productive. A second interpretation is to re-think the idiosyncratic productivity shocks as shocks to demand of a differentiated good (nearly all the main thrust of the model would go through with this more complicated framework but at the cost of more cumbersome algebra). Then an increase in the dispersion is just a statement about higher turbulence in individual demands, perhaps induced by the changing importance of sectors. This interpretation is useful because it illustrates that we can rationalize this dispersion as the reduced form of a more complicated underlying process for entrepreneurs.

We move now to a shock to spreads reported in figures 3.7 and 3.8. An increase in spreads of 25 basis points has effects very similar to the effects of a shock to the volatility of individual

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25 On the other hand, we have omitted from our models several amplification mechanisms that could be of interest. Among the most important are: 1) changing utilization of capital, 2) working capital, and 3) firm-specific capital. 1) and 2), in particular, can be easily rigged to generate a considerable amplification mechanism. See King and Rebelo (2000) for details on some of these amplification mechanisms.

26 See Fernandez-Villaverde and Rubio-Ramirez (2008) for more on this interpretation of time-varying parameters as a way for the model to capture unmodelled dynamics.
productivity. However, the fall in output, even 10 quarters after impact, is rather small (less than 0.2 percent), which tells us that increases in this intermediation cost cannot help us much in generating a large effect on output of financial frictions.\textsuperscript{27}

The increase in intermediation costs also raises the finance premium (panel (1,3)) and the cutoff for productivity while lowering the price of capital, net wealth of entrepreneurs, and debt.

\textsuperscript{27}It would be interesting to check if this result is robust to a more detailed model of financial intermediation or where the real constraint is a quantity one.
Figures 3.9 and 3.10 plot the IRFs to a shock to the survival rate of entrepreneurs. Again, we see that the effects are very similar to the shocks to volatility but smaller in size. This is an indication that, if we were estimating the model instead of calibrating it, it would be difficult to separately identify the shocks but that, in any case, they are not a key part of the history.  

There are some differences in the IRFs of net wealth, the productivity cutoff, and the average rate of return of entrepreneurs, but trying to lever those into a precise estimate is complicated. First, the data on net wealth are likely to be more contaminated by measurement error than other variables. Second, it is not immediately obvious what the counterpart of the productivity cutoff is in the data. Third, the average rate of return of entrepreneurs is difficult to observe, at least without detailed micro data.

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28 There are some differences in the IRFs of net wealth, the productivity cutoff, and the average rate of return of entrepreneurs, but trying to lever those into a precise estimate is complicated. First, the data on net wealth are likely to be more contaminated by measurement error than other variables. Second, it is not immediately obvious what the counterpart of the productivity cutoff is in the data. Third, the average rate of return of entrepreneurs is difficult to observe, at least without detailed micro data.
Finally, in figures 3.11 and 3.12, we report the effects of an increase in the interest rate implemented by the monetary authority. The patterns for real variables are well-known and
resemble the ones from other standard DSGE models (Christiano, Eichenbaum, and Evans, 2005, and Smets and Wouters, 2003). Therefore, we do not spend further space explaining them.

Figure 3.11: Shock to Monetary Policy, 1
How can we summarize the quantitative evidence from our previous IRFs? First, standard DSGE models have problems reconciling dropping output, consumption, investment, inflation, and increasing financial spreads with low interest rates. A number of financial shocks can deliver drops in real variables but they also increase inflation. The reason is that a tightening of financial conditions pushes marginal costs up and, with them, prices. Productivity and demand shocks also have problems of their own, as they induce covariances at odds with our observations in this recession. On the positive side, our evidence shows that it is relatively easy to generate important fluctuations out of these shocks: in particular, the shock to the dispersion of idiosyncratic productivity levels is a potentially crucial one to understanding Spain’s recent experience. Those effects are, nevertheless, smaller than the ones in the data over the last quarters.

While much work remains, our model is a progress report on how we can use the tools of standard economic theory to quantitatively think about the interactions between the macroeconomy and the financial markets. In particular, we read our findings as a call to open the box of financial intermediation and incorporate more fleshed out mechanisms in our DSGE models.
4. Concluding Remarks

Spain is going through its worst crisis since the 1970s. However, its experience is not so different from the situation of its peers in terms of income, location, and economic structure and it is unlikely that even the most virtuous economic policy during the last decade would have made much difference.

Moreover, it is important to put things in perspective: Spain went through much more difficult times between 1975 and 1983, with a huge reduction in growth rates, inflation getting out of control, a collapse in real estate prices, a near breakdown in labor relations, and a major banking crisis with bailout costs between 5.6 percent to 16.8 percent of output (Frydl, 1999), and all of this in the middle of a major regime transformation from dictatorship to democracy. Perhaps the most telling sign of all of these troubles is that the Spanish stock market lost, in real terms, 90 percent of its value between 1975 and 1983, ruining many companies and families (including the grandfather of one of the authors of this paper).

Figure 4.1: Real GDP Per Capita: Spain versus Portugal

But after these optimistic words, there are also reasons for concern. The real danger for welfare from this recession lies in the set of possible institutional reforms and policies that may be adopted in a rush as a response to the clamor for decisive action. The comparison of Spain with Portugal makes this case. Both countries entered the European Union in 1986 and, as shown in figure 4.1., they grew at a very similar rate for many years, aided

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And no, this is not an idle worry. Cole and Ohanian (2004) document the perverse effects of the NRA in the recovery of the U.S. after 1933. It is hard to see such a misguided piece of legislation being passed in normal economic times.
by access to a common internal market, flows of foreign investment and generous transfers from Brussels. The parallel lives of both countries diverged only around 2001, when Spain continued growing at a fast pace and Portugal stagnated (Portugal’s output per capita is now at the level of 1999). What were the main differences in policies between the two countries? Basically, the behavior of the public sector (monetary policy being in both cases transferred to the ECB). While Spain undertook a serious effort of fiscal consolidation, Portugal opted for large increases in transfers and public consumption that peaked in 2006 with a government deficit of 6.12 percent of GDP despite being in the middle of a global expansion. Figure 4.1 is a warning that whatever we do now may have long-lasting consequences and that fiscal expansions, while they may help us in the short run, also carry a substantial danger in the middle run.

We have three issues at the top of our concerns. First, while the size of the recession is not unusual given the amount of shocks incurred by the economy (as partially accounted for by our DSGE model with financial frictions), the behavior of unemployment is abysmal. It defies reason that we jumped from 8 percent unemployment to over 18 percent (and growing) given the size of the drop in output. Worse yet, real wages, even if we account for compositional effects, are still growing. The paranoia of Spain’s collective bargaining system and its paleolithic labor market institutions require urgent attention. Second, the financial sector has not undertaken a deep restructuring. In particular, savings and loans continue postponing the day of reckoning of their misguided real estate loans through creative accounting that they are not even ashamed to report in press releases. Third, the public deficit has significantly worsened and, given the middle-run implications of an aging population and regional financing, re-balancing the budget will become an increasingly challenging task.

Unless these three issues are urgently tackled, the disappointing growth experiences of Portugal or Italy during the 2000s may be the mirror of things to come for Spain: *Mutato nomine, de te fabula narratur.*

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30 See also Alesina and Perotti (1997), Alesina and Ardagna (1998), and Von Hagen, Hughes-Hallett and Strauch (2001) for supportive evidence on the effects of fiscal consolidations (or the absence of).
5. Appendix

In this appendix we present the steady state of the model and offer some further details on the loglinearization.

5.1. Steady State

To determine the steady state, we define $\bar{b} = b/p$ as the steady-state level of real debt. Also, note that $\Pi$ is a parameter and that we can set up all the stochastic processes to their mean. Then, the steady-state equilibrium conditions for the household are:

$$\frac{1}{c} = \lambda$$

$$R = \frac{\Pi}{\beta}$$

$$\psi l^0 c = w$$

for the firm, the law of motion for prices, and capital producers:

$$\varepsilon g^1 = (\varepsilon - 1)g^2$$

$$g^1 = \lambda mc y + \beta \theta \Pi^{\varepsilon} g^1$$

$$g^2 = \lambda \Pi^{\varepsilon} y + \beta \theta \Pi^{\varepsilon-1} g^2$$

$$k = \frac{\alpha w}{1 - \alpha r}$$

$$\frac{m}{l} = \left( \frac{1}{1 - \alpha} \right)^{1 - \alpha} \left( \frac{1}{\alpha} \right)^{\alpha} w^{1 - \alpha} r^{\alpha}$$

$$\Pi^* = \left( \frac{1 - \theta \Pi^{\varepsilon-1}}{1 - \theta} \right)^{\frac{1}{1 - \varepsilon}}$$

$$q = 1$$

$$i = \delta k$$

From the entrepreneur problem (where we already use $q = 1$), we get:

$$R^k = \Pi (1 + r - \delta)$$

$$\frac{R^k}{sR} \left[ \Gamma (\bar{\omega}, \sigma_\omega) - \mu G (\bar{\omega}, \sigma_\omega) \right] = \frac{\bar{b}}{\kappa}$$

$$\frac{R^k}{R} (1 - \Gamma (\bar{\omega}, \sigma_\omega)) = s \frac{1 - F (\bar{\omega}, \sigma_\omega)}{1 - F (\bar{\omega}, \sigma_\omega) - \mu G_\omega (\bar{\omega}, \sigma_\omega) \kappa}$$

$$R^k \bar{b} = \bar{\omega} R^k k$$
\[ \bar{b} + n = k \]
\[ n = \frac{1}{\Pi} \left[ (1 - \mu G(\omega, \sigma)) R^k k - s R b \right] + w^e \]

and the market-clearing conditions:

\[
y = c + i + \mu G(\omega, \sigma)(1 + r - \delta) k \\
y = \frac{1}{\nu} \frac{1}{1 - \alpha} \\
v = \frac{1 - \theta}{1 - \theta \Pi^*} \Pi^{* - \varepsilon}
\]

We start working on these equations. First, from the firms’ conditions, we have that:

\[
mc = \frac{\varepsilon - 1}{\varepsilon} \frac{1 - \beta \Pi^*}{1 - \beta \Pi^* - 1} \Pi^*
\]

To solve for the rest of the steady state, we calibrate \( \frac{\bar{b}}{k} = b_k \) and \( l = 1/3 \). To get this value of \( \frac{\bar{b}}{k} \), note that in the Spanish economy:

\[
\frac{n}{n-k} \approx 2 \Rightarrow \bar{b} = \frac{1}{3}
\]

Now, we can use:

\[
\frac{R^k}{s R} \left[ \Gamma(\omega, \sigma) - \mu G(\omega, \sigma) \right] = b_k
\]

\[
\frac{R^k}{R} = \frac{1}{1 - \Gamma(\omega, \sigma)} \frac{1 - F(\omega, \sigma) - \mu G(\omega, \sigma) \left(1 - b_k \right)}{1 - F(\omega, \sigma) - \mu G(\omega, \sigma)}
\]

to solve for \( R_k \) and \( \omega \). A simpler system is:

\[
\Gamma(\omega, \sigma) - \mu G(\omega, \sigma) = b_k
\]

\[
\Gamma(\omega, \sigma) = \frac{\frac{1}{\nu} \frac{1}{1 - \alpha} - \frac{1 - F(\omega, \sigma)}{1 - F(\omega, \sigma) - \mu G(\omega, \sigma)} \left(1 - b_k \right)}{\Omega(\omega, \sigma)}
\]

and then:

\[
b_k = \frac{\Omega(\omega, \sigma)}{1 + \Omega(\omega, \sigma)} \Rightarrow \omega = f \left( b_k, \sigma \right)
\]

\[
R^k = \frac{b_k / s R}{\Gamma(\omega, \sigma) - \mu G(\omega, \sigma)}
\]

Given \( \omega \), we pick the right \( \sigma^2 \) (and then \( \mu = -\frac{1}{2} \sigma^2 \)) given our observation of \( F(\omega) \).
With these results, we can get:

\[ r = \frac{R^k}{\Pi} - 1 + \delta \]

\[ R' = \frac{\varphi}{b_k} R^k \]

With \( r \),

\[ w = (1 - \alpha) \left( \left( \frac{1}{\alpha} \right)^{\frac{1}{\alpha^1}} \frac{1}{mc} \right)^{\frac{1}{\alpha^1}} \]

and with \( r \) and \( l = 1/3 \)

\[ k = \frac{\alpha}{1 - \alpha} \frac{w}{l} \]

\[ b = b_k * k \]

\[ n = k - b \]

\[ i = \delta k \]

\[ y = \frac{1}{\nu} \]

\[ c = y - \delta k - \mu G (\varphi, \sigma_\omega) (1 + r - \delta) k \]

and the three auxiliary conditions:

\[ \lambda = 1/c \]

\[ g^1 = \frac{mc\lambda y}{1 - \beta \theta \Pi^\varepsilon} \]

\[ g^2 = \frac{\Pi^\varepsilon \lambda y}{1 - \beta \theta \Pi^\varepsilon - 1} \]

Now, we have two equations left:

\[ n = \gamma e \frac{1}{\Pi} \left[ (1 - \mu G (\varphi, \sigma_\omega)) R^k k - s R b \right] + w^e \]

\[ \psi \lambda^\varepsilon c = w \]

and we use them to back up the values of \( w^e \) and \( \psi \) that justify our calibration:

\[ \psi = \frac{w}{\lambda^\varepsilon c} \]

\[ w^e = n - \gamma e \frac{1}{\Pi} \left[ (1 - \mu G (\varphi, \sigma_\omega)) R^k k - s R b \right] \]

51
Finally, we calibrate $\bar{s}$ and $\bar{\gamma}$. Note that $e^{\bar{s}} = s - 1$ and

$$\gamma^e = \frac{1}{1 + e^{-\bar{\gamma}}}$$

using the fact that $\gamma^e$ is observable as follows:

$$e^{-\bar{\gamma}} = \frac{1 - \gamma^e}{\gamma^e}$$

### 5.2. Loglinearization

Loglinearizing all the equilibrium conditions of our model is relatively straightforward except for the four equations where $\bar{w}_{t+1}$ and $\bar{\sigma}_{\omega, t+1}$ appear as explicit arguments. We provide below some further details in the algebra.

**Equation 1** We start with:

$$\mathbb{E}_t \frac{R^k_{t+1}}{R_t} (1 - \Gamma (\bar{w}_{t+1}, \bar{\sigma}_{\omega, t+1})) = \mathbb{E}_t s_t \frac{1 - F (\bar{w}_{t+1}, \bar{\sigma}_{\omega, t+1})}{1 - F (\bar{w}_{t+1}, \bar{\sigma}_{\omega, t+1}) - \mu \bar{w}_{t+1} F_{\omega} (\bar{w}_{t+1}, \bar{\sigma}_{\omega, t+1})} n_t \Rightarrow$$

$$\mathbb{E}_t \frac{R^k_{t+1}}{R_t} \Psi^1 (\bar{w}_{t+1}, \bar{\sigma}_{\omega, t+1}) = \frac{n_t}{q_t \bar{k}_t} \mathbb{E}_t \Psi^2 (\bar{w}_{t+1}, \bar{\sigma}_{\omega, t+1})$$

which loglinearizes to:

$$\mathbb{E}_t \tilde{R}^k_{t+1} - \tilde{R}_t + \mathbb{E}_t \left( \frac{\Psi^1 (\bar{w}, \bar{\sigma}, \bar{\omega})}{\Psi^1 (\bar{w}, \bar{\sigma}, \bar{\omega})} - \frac{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})}{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})} \right) \tilde{w}_{t+1} + \left( \frac{\Psi^1 \bar{\sigma}_{\omega, \bar{\omega}, \bar{\sigma}}}{\Psi^1 (\bar{w}, \bar{\sigma})} - \frac{\Psi^2 \bar{\sigma}_{\omega, \bar{w}, \bar{\sigma}}}{\Psi^2 (\bar{w}, \bar{\sigma})} \right) \tilde{\sigma}_{\omega, t+1} = \frac{s - 1}{s} \tilde{s}_t + \tilde{n}_t - \tilde{q}_t - \tilde{k}_t$$

or:

$$\mathbb{E}_t \tilde{R}^k_{t+1} - \tilde{R}_t + \omega_a \mathbb{E}_t \tilde{w}_{t+1} + \bar{\sigma}_{\omega, t+1} = \frac{s - 1}{s} \tilde{s}_t + \tilde{n}_t - \tilde{q}_t - \tilde{k}_t$$

where:

$$\frac{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})}{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})} = \Gamma (\bar{w}, \bar{\sigma}, \bar{\omega}) \bar{\omega} = \frac{1 - F (\bar{w}, \bar{\sigma}, \bar{\omega})}{1 - F (\bar{w}, \bar{\sigma}, \bar{\omega}) - \mu \bar{w}_{t+1} F_{\omega} (\bar{w}, \bar{\sigma}, \bar{\omega})}$$

$$\omega_a = \frac{\Psi^1 (\bar{w}, \bar{\sigma}, \bar{\omega})}{\Psi^1 (\bar{w}, \bar{\sigma}, \bar{\omega})} = \frac{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})}{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})}$$

and

$$\sigma_a = \frac{\Psi^1 \bar{\sigma}_{\omega, \bar{\omega}, \bar{\omega}}}{\Psi^1 (\bar{w}, \bar{\sigma}, \bar{\omega})} = \frac{\Psi^2 \bar{\sigma}_{\omega, \bar{w}, \bar{\sigma}}}{\Psi^2 (\bar{w}, \bar{\sigma}, \bar{\omega})}$$
a coefficient we will compute numerically.

**Equation 2** The second equation is:

\[
\frac{R_{t+1}^k}{R_t} \left[ \Gamma (\varpi_{t+1}, \sigma_{\omega, t+1}) - \mu G (\varpi_{t+1}, \sigma_{\omega, t+1}) \right] = \frac{b_t}{q_t} \Rightarrow
\]

\[
\frac{R_{t+1}^k}{s_t R_t} \psi^3 (\varpi_{t+1}, \sigma_{\omega, t+1}) = \frac{b_t}{q_t k_t}
\]

which loglinearizes to:

\[
\hat{R}_{t+1}^k - \hat{R}_t - \tilde{s}_t + \frac{\psi^3 (\varpi, \sigma_\omega) \omega_{t+1}}{\psi^3 (\varpi, \sigma_\omega)} \tilde{\omega}_{t+1} + \frac{\psi^3 (\varpi, \sigma_\omega) \sigma_\omega \sigma_{\omega, t+1}}{\psi^3 (\varpi, \sigma_\omega)} \tilde{\varpi}_{t+1} = \hat{b}_t - \hat{q}_t - \hat{k}_t
\]

Now, note that \(s_t = 1 + e^{\sigma + \tilde{s}_t}\) implies that:

\[
\tilde{s}_t = \frac{s - 1}{s} \tilde{s}_t
\]

and then

\[
\hat{R}_{t+1}^k - \hat{R}_t - \frac{s - 1}{s} \tilde{s}_t + \omega_b \tilde{\omega}_{t+1} + \sigma_b \tilde{\sigma}_{\omega, t+1} = \hat{b}_t - \hat{q}_t - \hat{k}_t
\]

where

\[
\omega_b = \frac{\psi^3 (\varpi, \sigma_\omega) \omega}{\psi^3 (\varpi, \sigma_\omega)} = \frac{1 - F (\varpi, \sigma_\omega) - \mu \varpi F_\omega (\varpi, \sigma_\omega) \varpi}{\Gamma (\varpi, \sigma_\omega) - \mu G (\varpi, \sigma_\omega)}
\]

\[
\sigma_b = \frac{\psi^3 (\varpi, \sigma_\omega) \sigma_\omega}{\psi^3 (\varpi, \sigma_\omega)}
\]

where \(\sigma_b\) will be computed numerically.

Also, note that since this equation holds state by state, it is better to write it as:

\[
\hat{R}_t^k - \hat{R}_{t-1} - \frac{s - 1}{s} \tilde{s}_{t-1} + \omega_b \tilde{\omega}_t + \sigma_b \tilde{\sigma}_{\omega, t} = \hat{b}_{t-1} - \hat{q}_{t-1} - \hat{k}_{t-1}
\]

**Equation 3** Since

\[
\gamma_t^e = \frac{1}{1 + e^{-\tau^e - \gamma_t}}
\]

we have that:

\[
\hat{\gamma}_t^e = e^{-\tau^e} \gamma_t^e \hat{\gamma}_t = \frac{1 - \gamma_t^e}{\gamma_t^e} \gamma_t^e \hat{y}_t = (1 - \gamma_t^e) \hat{y}_t
\]

Then:

\[
n_t = \gamma_t^e \frac{1}{\Pi_t} \left[ (1 - \mu G (\varpi_t, \sigma_{\omega, t+1})) R_t^e q_{t-1} k_{t-1} - s_{t-1} R_t \frac{b_{t-1}}{p_{t-1}} \right] + w_t^e
\]
that loglinearizes to:

\[ \hat{n}_t = a_1 \left( 1 - \gamma^e \right) \hat{\gamma}_t^e - \hat{\Pi}_t + a_2 \left( \omega_c \hat{\omega}_t + \sigma_c \hat{\sigma}_\omega, t \right) + a_3 \left( \hat{R}^b_t + \hat{q}_t - \hat{\kappa}_{t-1} \right) + a_4 \left( \hat{R}_{t-1} + \frac{s - 1}{s} \hat{s}_{t-1} + \hat{b}_{t-1} \right) \]

where

\[
\begin{align*}
a_1 &= \frac{\gamma_e}{\Pi_n} \left( 1 - \mu G \left( \bar{\omega}, \sigma_\omega \right) \right) \text{R}^k_k - \text{R}^b_b \\
a_2 &= -\frac{\gamma_e}{\Pi_n} \mu \text{R}^k_k \\
a_3 &= \frac{\gamma_e}{\Pi_n} \left( 1 - \mu G \left( \bar{\omega}, \sigma_\omega \right) \right) \text{R}^k_k \\
a_4 &= -\frac{\gamma_e}{\Pi_n} \text{R}^b_b \\
\omega_c &= \frac{G_\omega \left( \bar{\omega}, \sigma_\omega \right) \bar{\omega}}{G \left( \bar{\omega}, \sigma_\omega \right)} = \frac{\bar{\omega}^2 F_\omega \left( \bar{\omega}, \sigma_\omega \right)}{G \left( \bar{\omega}, \sigma_\omega \right)} \\
\sigma_c &= \frac{G_{\sigma_\omega} \left( \bar{\omega}, \sigma_\omega \right) \sigma_\omega}{G \left( \bar{\omega}, \sigma_\omega \right)}
\end{align*}
\]

Equation 4 Finally, \( y_t = c_t + i_t + \mu G \left( \bar{\omega}_t, \sigma_\omega, t+1 \right) \left( r_t + q_t (1 - \delta) \right) \hat{k}_{t-1} \)

loglinearizes to:

\[ \hat{y}_t = \frac{c}{y} \hat{c}_t + \frac{i}{y} \hat{i}_t + \frac{\mu}{y} G \left( \bar{\omega}, \sigma_\omega \right) \left[ \left( r \hat{k} (\hat{r}_t + \hat{k}_{t-1}) + (1 - \delta) k (\hat{q}_t + \hat{k}_{t-1}) \right) + (r + 1 - \delta) k \left( \omega_c \hat{\omega}_t + \sigma_c \hat{\sigma}_\omega, t \right) \right] \]

5.3. Loglinearized Equilibrium Conditions

The conditions are:

\[
\begin{align*}
\hat{d}_t - \hat{c}_t &= \hat{\lambda}_t \\
\hat{\lambda}_t &= \mathbb{E}_t \{ \hat{\lambda}_{t+1} + \hat{R}_t - \hat{\Pi}_{t+1} \} \\
\hat{c}_t &= \hat{\omega}_t \\
\hat{g}_1^1 &= \hat{g}_2^1 \\
\hat{g}_1^2 &= (1 - \beta \theta \Pi^c) \left( \hat{\lambda}_t + \hat{m}_c t + \hat{g}_1 t \right) + \beta \theta \Pi^c \mathbb{E}_t \left( \epsilon \hat{\Pi}_{t+1} + \hat{g}_1^t \right) \\
\hat{g}_2^2 &= (1 - \beta \theta \Pi^{-1}) \left( \hat{\lambda}_t + \hat{\Pi}_t^* + \hat{g}_1 t \right) + \beta \theta \Pi^{-1} \mathbb{E}_t \left( \epsilon - 1 \right) \hat{\Pi}_t + \hat{\Pi}_t^* + \hat{g}_2^t \\
\hat{k}_{t-1} &= \hat{\omega}_t + \hat{\lambda}_t - \hat{r}_t
\end{align*}
\]
\[
\widehat{mc}_t = \alpha \bar{r} + (1 - \alpha) \widehat{w}_t - z_t \\
\widehat{N}_t = \frac{1 - \theta}{\theta} (\Pi^* \Pi)^{1-\epsilon} \widehat{N}_t^* \\
\widehat{q}_t = S'' [1] \left( \gamma_t - \gamma_{t-1} \right) - \beta S'' [1] \mathbb{E}_t \left( \gamma_{t+1} - \gamma_t \right) \\
\widehat{k}_t = (1 - \delta) \widehat{k}_{t-1} + \delta \hat{t}_t \\
\widehat{R}^k_{t+1} = \widehat{N}_{t+1} + \frac{\Pi \widehat{r}_{t+1}}{\widehat{R}^k_{t+1}} + \frac{\Pi (1 - \delta)}{\widehat{R}^k_{t+1}} \widehat{q}_{t+1} - \widehat{q}_t \\
\mathbb{E}_t \widehat{R}^k_{t+1} - \widehat{R}_t + \omega_a \mathbb{E}_t \widehat{w}_{t+1} + \sigma_a \widehat{\sigma}_{\omega,t_{t+1}} = \frac{s - 1}{s} \widehat{s}_t + \widehat{n}_t - \widehat{q}_t - \widehat{k}_t \\
\widehat{R}^k_t - \widehat{R}_{t-1} = \frac{s - 1}{s} \widehat{s}_{t-1} + \omega_b \widehat{w}_t + \sigma_b \widehat{\sigma}_{\omega,t_{t-1}} = \widehat{b}_{t-1} - \widehat{q}_{t-1} - \widehat{k}_{t-1} \\
\widehat{n}_t = a_1 \left( (1 - \gamma^c) \gamma^c_{t-1} - \widehat{N}_t \right) + a_2 \left( \omega_c \widehat{w}_t + \sigma_c \widehat{\sigma}_{\omega,t} \right) + a_3 \left( \widehat{R}^k_t + \widehat{q}_{t-1} + \widehat{k}_{t-1} \right) + a_4 \left( \widehat{R}_{t-1} + \frac{s - 1}{s} \widehat{s}_{t-1} + \widehat{b}_{t-1} \right) \\
\widehat{R}_t = \gamma_R \widehat{R}_{t-1} + (1 - \gamma_R) \gamma_B \widehat{N}_t + (1 - \gamma_R) \gamma_B \gamma_t + \sigma_m \varepsilon_{mt} \\
\widehat{y}_t = \frac{c_t}{y_t} + \frac{\gamma_t}{y_t} + \frac{\mu}{y_t} G \left( \overline{y} \right) \left[ r k \left( \widehat{r}_t + \widehat{k}_{t-1} \right) + (1 - \delta) k \left( \widehat{q}_t + \widehat{k}_{t-1} \right) \right] + (r + 1 - \delta) k \left( \omega_c \widehat{w}_t + \sigma_c \widehat{\sigma}_{\omega,t} \right) \\
\widehat{y}_t = z_t + \alpha \widehat{k}_{t-1} + (1 - \alpha) \widehat{l}_t - \widehat{v}_t \\
\widehat{v}_t = \theta \Pi^c \left( \varepsilon \widehat{N}_t + \widehat{v}_{t-1} \right) - \varepsilon \left( (1 - \theta \Pi^c) \widehat{N}_t^* \right) \\
\text{plus the stochastic processes:} \\
\begin{align*}
d_t &= \rho_d d_{t-1} + \sigma_d \varepsilon_{d,t} \\
z_t &= \rho_z z_{t-1} + \sigma_z \varepsilon_{z,t} \\
\widehat{\sigma}_{\omega,t} &= \rho_\sigma \widehat{\sigma}_{\omega,t-1} + \eta_\sigma \varepsilon_{\sigma,t} \\
\widehat{s}_t &= \rho_\sigma \widehat{s}_{t-1} + \sigma_\sigma \varepsilon_{\sigma,t} \\
\gamma^c_{t} &= \rho_\gamma \gamma^c_{t-1} + \sigma_\gamma \varepsilon_{\gamma,t}
\end{align*}
\]
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