NBER WORKING PAPER SERIES

THE PORTUGUESE SLUMP AND CRASH AND THE EURO CRISIS

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Working Paper 19288
http://www.nber.org/papers/w19288

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2013

I am grateful to the editors, David Romer and Justin Wolfers, to my discussants Olivier Blanchard and Gita Gopinath, to Javier Bianchi, Luca Fornaro, Vitor Gaspar, Stephanie Schmitt-Grohé, Mike Treadway, and Martin Uribe for many comments, and to Stéphane Dupraz for excellent research assistance. Participants in conferences at the Fundação de Serralves, Encontros da Junqueira-AIP, and Columbia University gave useful feedback on earlier drafts. All errors are mine. The views expressed herein are those of the author and do not necessarily reflect the views of the National Bureau of Economic Research.

The author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w19288.ack

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NBER Working Paper No. 19288
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JEL No. E32,E65,F32,F44,N14,O52

ABSTRACT

Between 2000 and 2012, the Portuguese economy grew less than the United States during the Great Depression and less than Japan during its lost decade. This paper asks why this happened, with a particular focus on the slump between 2000 and 2007. It describes the main facts of Portugal's recent economic history, evaluates some possible explanations for its dismal performance, and proposes a new hypothesis based on the misallocation of abundant capital flows from abroad. I put forward a model of credit frictions to show that if financial integration exceeds financial deepening, productivity will fall, generating a slump as relatively unproductive firms in the nontradables sector expand at the expense of more productive tradables firms. This explanation can also potentially account for the similarities and the differences between Portugal on the one hand, and Ireland and Spain on the other, during this period, and for some features of the crash in Portugal after 2010.

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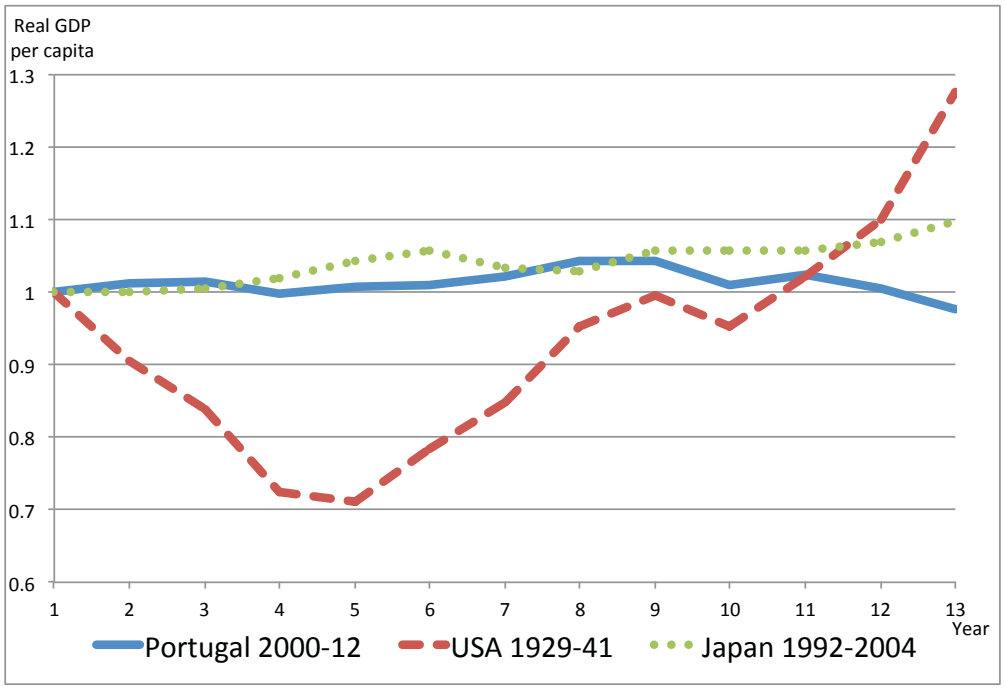
Writing 10 years after the introduction of the European common currency, the vice president of the European Central Bank, Lucas Papademos, stated unequivocally that "the euro has been a resounding success" (Papademos 2009). The euro was by then a reserve currency, and inflation was stable and on target. Economic growth in the euro area had not fallen relative to the previous two decades, and employment had increased significantly, while capital markets had become more integrated, and southern Europe had benefited from sustained low interest rates. Papademos (2009) further argued that the countries within the euro area had been better protected from the financial crisis of 2007-08 than others in the European Union.

Yet even before the global financial crisis, there were warning signs about some of the countries in the euro area. One of the more pressing alerts came from the small country of Portugal and was brought to the attention of economists and policymakers in a notable article by Olivier Blanchard (2007). Portugal, Blanchard observed, had been in a slump since 2000, with anemic productivity, almost no economic growth, and increasing unemployment. At the same time, wages had been rising and the country's competitiveness falling, and both the government and the country's private sector were accumulating debt at a rapid pace. Most, but not all, of the same issues were also present in Greece, Ireland, and Spain, but did not seem so pressing since their economies were growing and, with the exception of Greece, fiscal consolidation was under way.

Many dismissed these alarm signs at the time. Portugal's extensive borrowing from abroad could be justified as borrowing against expected future growth, as the Portuguese economy converged with the European core. Or perhaps Portugal was becoming the Florida of Europe, to which wealthy northern Europeans were sending their capital in the expectation of migrating for their retirement. The Portuguese slump was greeted with recommendations for structural reforms that are as often repeated as they are sterile—the constant verdict on the country regardless of the state of its economy.

The severity and extent of the crisis that has affected so many European countries since 2009 dismisses this complacency. Understanding what has been happening in Europe—and the European periphery in particular—is one of the great challenges facing macroeconomists today (Shambaugh 2012). Portugal in the 2000s experienced neither a housing boom like Spain and Ireland, nor as rampant an increase in public debt as Greece, nor does it suffer from Italy's chronic political instability. Yet since 2010 all five countries have been in a similar state of crisis. Because Portugal was one of the first countries where the symptoms were identified, it is a good place to look for clues on what is behind the crisis.

Figure 1: Lost Decades: Portugal, Japan, and United States



There are a few more reasons why understanding what has happened to the Portuguese economy since 2000 is of interest. First, economic growth has been as bad as it gets for a developed economy. Figure 1 shows real GDP per capita in Portugal since 2000, along with the same measure for the United States from 1929 to 1941 and Japan from 1992 to 2004. Although Portugal never went through as steep a contraction as did the United States in the 1930s, its population today is poorer, relative to the start of the slump, than Americans were at the end of the Great Depression or the Japanese after their lost decade. These extreme periods of dismal economic performance offer an opportunity to learn about the mechanisms that drive the macroeconomy, beyond the obvious potential for improving welfare.

Second, in the postwar era before 2000, Portugal gradually integrated with the rest of Europe, and the milestones in this process came with periods when Portugal was one of the fastest-growing countries in the world. Income per capita doubled in the decade after 1960, when Portugal joined the European Free Trade Association. The years after joining the European Community in 1986 were likewise marked by great progress. Yet the advent of European monetary union marked the beginning of Portugal's prolonged slump. Understanding the difference between these episodes should yield lessons on the benefits and costs of economic integration.

Third, the main features of the crisis bear a remarkable similarity to the well-documented

history of capital inflows and sudden stops in Latin America in the past 20 years (Calvo, Leiderman, and Reinhart 1996), and to the crisis in the Nordic countries in the early 1990s. The events in the euro crisis provide a new testing ground for our understanding of capital account liberalization (Henry 2007), sudden stops (Calvo 1998), and currency unions (Schmitt-Grohé and Uribe 2011). In spite of the similarities, Portugal's slump in 2000-07, following a mild boom in 1995-2000 and followed by a crash after 2008, is a distinctively new phenomenon relative to these previous instances of sudden stops. Understanding the slump may thus provide valuable hints about the mechanisms through which large and sudden capital inflows may have harmful effects, and what can policy do about them.

As important as it is, explaining the Portuguese economy since 2000 is not easy. Why did Portugal receive such large capital inflows? Why did they come even though productivity had stopped growing? Why did the economy slump, in spite of the availability of this capital? And why did Greece, Ireland, and Spain, under similar circumstances and facing similar shocks, enjoy a boom at the same time? These are some of the questions this paper tries to answer.

Section 1 presents the key facts that make the recent behavior of the Portuguese economy both interesting and puzzling. Because Portugal did not experience a deep and rapid contraction, like that in the United States during the Great Depression, it is hard to identify any one sudden shock that triggered the events that followed. Portugal's experience is instead closer to that of Japan, with a prolonged period of little or no growth, and like Japan's experience it has generated competing hypotheses to explain it. Section 1 puts forward a narrative to explain the 2000-07 period, when the economy was barely growing in spite of large capital inflows. I propose that the Portuguese slump was the combined result of one major shock and one persistent feature of its economy: the large capital flows that came with the integration of capital markets that followed the euro, and the underdeveloped Portuguese financial market. I argue that the weakness of Portugal's financial sector caused the capital inflows to be largely misallocated, leading to an expansion in the country's relatively unproductive nontradables sector, and thus to a fall in measured productivity. On top of this, taxes were increased to meet past commitments to old-age pensions that had not been dealt with in timely fashion. Section 1 also critiques some proposed alternative causes for the slump, including trade shocks, discretionary fiscal spending, and rigid labor markets.

To further investigate this proposed explanation, section 2 presents a model of an open economy with two key ingredients. First, the economy comprises both a tradables and a nontradables sector. Second, credit is allocated to the nontradables sector through a banking

system that collects funds domestically and from abroad, subject to collateral constraints. In the model, the shock that triggers the slump is the relaxation of the financing constraint on foreign capital; in the real world this can be interpreted as the introduction of the euro. Yet because the domestic credit market is underdeveloped, banks are unwilling to extend credit to existing productive firms, which are already operating at their collateral constraint. Instead the new funds flow into new, inefficient firms, worsening the misallocation of capital in the economy. The economy therefore slumps even as the real exchange rate strengthens and the nontradables sector expands.

A growing recent literature explores the role of capital misallocation in explaining why differences in income per capita persist across countries (see Restuccia and Rogerson 2013 for a survey). I suggest in this paper that the same mechanisms may also be behind major slumps at the medium-term, business-cycle frequency, like that experienced recently by the Portuguese economy. Future work might be able to test whether relative poverty and propensity for slumps are related through the economic mechanisms that this literature suggests.

Section 3 explores the model further in three directions. First, it investigates whether the misallocation story can quantitatively account for the size of the slump. Second, it considers the predictions of the model for other countries, trying especially to understand the many similarities, but also the few differences, between Portugal and two other countries on the European periphery, Ireland and Spain. I suggest that, if one assumes that taxes had not risen and that the economy were more financially developed, then the same model that explains the Portuguese slump can also account for the booms in Ireland and Spain during this period. Third, the paper assesses the relative contributions of capital misallocation and the increase in taxes.

Section 4 looks at the period before the slump, between 1995 and 2000 when the Portuguese economy boomed, and after the slump, especially the crash from 2010 onward. I present the main facts and interpret them in a way consistent with my account of the slump. The Portuguese experience is not markedly different from existing models of the euro crisis, so I discuss their key ingredients and how they match the Portuguese evidence. Section 5 concludes.

1 The Portuguese Slump: Facts and a Narrative

The typical paper describing the weaknesses of the Portuguese economy invariably mentions the following:

- Portugal's low average educational attainment, an inheritance of the dictatorship that ruled between 1933 and 1974 without making a serious investment in literacy or higher education. In Robert Barro and Jong-Wha Lee's (2010) data set, average years of schooling for those aged above 25 was 4.1 in Portugal in 1975, compared with 8.9 in Ireland, 6.3 in Greece, and 5.7 in Italy. By 1995 these gaps had only barely been reduced.

- Portugal's low total factor productivity (TFP), which meant that even periods of catch-up to the European average in the last 50 years were driven by capital deepening rather than by productivity increases. Reis (2011) performs a development accounting exercise on Portugal's income per capita in 2000 and concludes that half of the gap to the incomes of Spain, Germany, or the United States is due to differences in TFP, with the other half due to low schooling.

- The rapid increase in the size of the government following the democratic revolution of 1974. Portugal had trouble controlling its public finances, and debt crises brought about International Monetary Fund (IMF) programs in 1977-78 and in 1983-85. During the 1980s and 1990s, there was extensive hiring in the public sector (Carreira 2011).

- The rigid labor market, with high costs of firing. Blanchard and Pedro Portugal (2001) note that although the unemployment rate in Portugal and the United States was on average the same over 1985-2000, the flow of workers through the labor market as a proportion of employment in Portugal was about one-quarter as large.

- The inefficient legal system, with long judicial delays. Simeon Djankov and others (2003) estimate that it took 420 days to collect a check returned for nonpayment in Portuguese courts, compared with 234 days on average in their sample of 109 countries, and 272 days among countries with a legal system based on the French model.

- The inability to compete in world trade markets because of specialization in low-wage and low-value-added goods, which were especially hurt by competition in the late 1990s from Eastern Europe and China.

All of these factors are surely important to an understanding of Portugal's level of development and income relative to other countries in Europe over the last 40 years. What is disappointing is that discussions of the slump since 2000 often start from the same list of facts. This risks confusing levels and changes. Ultimately, the facts listed above are not an answer for what caused Portugal to stop growing after 2000, instead of in some other year when all of these same hindrances to growth were also present.[1]

The account that follows focuses on the period of the slump. I proceed in the style of a narrative, describing the main features of the data in a way that suggests a compelling reason for the slump. In each of the following subsections, I also present alternative hypotheses that have been put forward, along with at least one salient feature of the data that casts doubt on these alternative accounts. The reader is referred to Blanchard (2007), the volumes edited by Francesco Franco (2009) and Pedro Lains (2009), Vitor Bento (2010b), Fernando Alexandre and others (2012), and IMF (2013) for alternative discussions of these hypotheses, which I sometimes defend in this paper, but sometimes also criticize.

1.1 Dismal Macroeconomic Performance

Table 1 shows the levels of some of Portugal's main economic indicators in 2007 and their changes from 2000 to 2007. (The sources for all of the data in the paper are listed in appendix A.) In 2000 Portugal was a rich country by world standards, but the poorest of the 12 countries that initially formed the euro area. From then through 2007, real GDP per capita grew by a meager 4.3 percent, for a 0.6 percent annual growth rate. Consumption grew faster than output during this period, and real wages increased in spite of rising unemployment. The unemployment rate in 2007 was 8.9 percent, the highest it had been since 1960 with the exception of 1985, and almost half of that unemployment rate was generated between 2000 and 2007. Portugal was going through a slump, and consumers and workers bore the consequences.

The last two columns of the table compare these growth rates with those in two comparison groups: the euro area as a whole, and a weighted average of Spain (50 percent), Germany (30 percent) and France (20 percent), three countries that accounted for approximately half of all Portuguese exports and imports during this period (the weight for each country is given

[1]Moreover, Portugal has seen structural reforms and progress, in spite of its poor economic performance. For instance, large investments in education in the 1990s raised average years of schooling from 6.8 in 2000 to 7.7 in 2010, and scores on the PISA (Program for International Student Assessment) mathematics and science assessments increased markedly, from 454 and 359, respectively, in 2000 to 487 and 493 in 2009.

Table 1. Selected Macroeconomic Indicators in Portugal and Its Trading Partners, 2000-07

Indicator	Portugal, 2007	Growth rate or change, 2000-07		
		Portugal	Euro area[a]	Main trading partners[b]
		Annualized growth rate (percent)		
Real GDP per capita	€15,961	0.61	1.34	1.55
Real consumption per capita	€10,429	1.04	0.95	1.38
Real consumption per employee		0.38	0.27	-0.10
		Change (percentage points)		
Unemployment rate	8.9%	4.40	-0.90	-1.61
Annual interest rate on 10-year government bonds	4.42%	-1.17	-1.13	-1.14

Sources: See appendix A.

a. The 12 countries that had adopted the euro as their currency by 2000.

b. Weighted average of Spain (50 percent), Germany (30 percent), and France (20 percent), which together account for roughly half of Portugal's exports and imports during 2000-07.

in parentheses).[2] GDP growth during this period in the euro area, and among the countries that are Portugal's main trading partners, was more than twice as rapid as in Portugal. And while unemployment was rising in Portugal, it was falling elsewhere in Europe.

One explanation for the Portuguese slump argues that it was due to irresponsible wage growth in the country, rendering it uncompetitive in international markets and causing the rise in unemployment. The fact commonly cited to support this hypothesis is that unit labor costs in Portugal rose about 20 percent relative to those in Germany during this period. However, this statistic is misleading for two reasons. First, although during this period real wages fell significantly in Germany, this decline was not representative of the euro area as a whole or of Portugal's other trading partners. Second, most of the increase in relative unit labor costs was due not to rising wages in Portugal—as the table shows, Portuguese wages did not much rise faster than in the two comparison groups—but to the fact that output per worker barely changed in Portugal during those 7 years, whereas it grew significantly elsewhere in Europe. As Blanchard (2007) emphasizes, adjusting wages to productivity would have required falling real wages throughout this period, which, as

[2]In most of the tables, "euro area" refers to the original 12 participants in European monetary union (EA12): Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. In some cases, however, data were available only for the euro area 15, which also includes Cyprus, Malta, and Slovenia. Because these three countries account for well under 1 percent of the GDP of the euro area, the numbers for the EA12 and the EA15 are almost identical for the indicators that I use in this paper.

Table 2. Selected Capital and Current Account Indicators in Portugal, 2000-07

Indicator	Percent of 2007 GDP
Capital account	
Stock of net foreign assets, 2007	-101.0
Change in net foreign assets, 2000-07	-78.5
Current account (cumulative)	
Current account balance, 2000-07	-51.0
Trade balance, 2000-07	-46.5
Trade balance ex-EU, 2000-07	-19.0

Sources: See appendix A.

Stephanie Schmitt-Grohé and Martin Uribe (2011) note, is a rare occurrence in developed economies.

The last row of the table shows the large reduction in long-term interest rates in Portugal during these 7 years, in line with what happened all over the euro area. It is open to debate to what extent this decline was due to the removal of the exchange rate risk premium with the adoption of the euro, or to unrealistically low expectations of default risk. Either way, it was associated with a flow of capital from abroad, which I discuss next.

1.2 The Shock: Capital Flowing from Abroad

Portugal owed foreigners €165 billion in 2007, an amount approximately equal to the whole of its GDP for that year (table 2). Most of this debt was accumulated during the slump; if one goes further back, to the mid-1990s, Portugal's net foreign debt was close to zero. During the slump Portugal borrowed vast amounts from abroad, in one of the largest capital influxes the country has ever experienced.

One explanation for the slump would argue that productivity exogenously stopped growing temporarily during the early 2000s, explaining the fall in output, but was expected to grow faster in the future. In the meantime Portugal would borrow abroad to sustain a steady growth rate of consumption, in the reasonable expectation that growth would resume shortly. This demand-based explanation for the surge in Portuguese borrowing faces three problems. First, the expected future growth never materialized. Moreover, as table 1 showed, consumption was also stagnant, even if not as stagnant as GDP. Second, large capital inflows, coming mostly from Germany, were also going to Greece, Ireland and Spain during these

years (Lane 2013), even though these countries were booming. Third, the interest rate at which Portugal borrowed fell during this period. Rather than a shock to Portugal's demand for borrowing, these facts suggest a euro area-wide supply shock to capital.

The last three rows in table 2 break down the sources of the accumulation of foreign debt. The change in net foreign assets is by definition equal to the cumulative current account balance plus valuation effects on the initial stock of net assets. Adverse valuation effects are important during this period, although, as Philip Lane and Gian Maria Milesi-Ferretti (2007) document, they were common across Europe, especially vis-à-vis the United States. The current account balance in turn equals the balance of trade in goods and services, plus transfers from abroad, of which the main item is remittances from emigrants. Although this last item has traditionally been large for Portugal, it played almost no role during the slump.[3]

Finally, one can separate Portuguese exports and imports into those within the European Union and those outside. The table shows that most of the borrowing from abroad came through trade deficits with the rest of the European Union. The pace at which these deficits grew is remarkable, especially since Portugal is not particularly open for a country of its size: exports plus imports were 72 percent of GDP in 2007. During these years Portugal was receiving one-third more goods and services from abroad than it was sending in return.

Banks were at the center of these capital flows, serving as the intermediary between the foreigners and Portuguese firms and households. R. Chen, Milesi-Ferretti, and T. Tressel (2010) estimate that in 2007, banks accounted for approximately half of the Portuguese foreign debt. Categorizing gross capital flows into equity, foreign direct investment, and debt, Lane (2013) estimates that between 2003 and 2007, debt accounted for 68 percent of these flows.

1.3 Competitiveness and the shift to nontradables

As Guillermo Calvo and coauthors (1996) document for the Latin American economies in the 1990s, large capital inflows typically come with increases in the real exchange rate, that is, in the ratio of the prices of goods at home to those of goods abroad, expressed in domestic currency. Table 3 shows that Portugal's real exchange rate against all its trading partners as a group rose by almost 12 percent during the slump.

[3]After the democratic revolution and especially with membership in the European Union, Portugal gradually became a net recipient of migrants from Brazil, the former colonies in Africa, and Eastern Europe. Moreover, as standards of living increased in the home country, Portuguese emigrants abroad gradually stopped sending resources back home.

Table 3. Changes in Exchange Rates and Relative Prices between Portugal and Its Trading Partners, 2000-07

	Percent change, 2000-07, relative to		
Indicator	All trading partners	Euro area[a]	Main trading partners[a]
Nominal exchange rate	7.70	0	0
Real exchange rate[b]	11.91	5.98	4.01
Terms of trade	1.33	1.70	-5.74
Relative price of nontradables[c]	10.58	4.28	9.74
Value-added measures of prices[d]			
All industries	8.81	10.71	-0.77
Manufacturing		2.41	-4.22

Sources: See appendix A.

a. See table 1 for the countries included.

b. Real exchange rates are calculated using the consumer price index as the measure of inflation.

c. Calculated as the residual.

d. The value-added measures are all for the change 2000-06, with the exception of the 8.81 number, which refers to 2000-07.

Another hypothesis for the slump is that on entering monetary union, Portugal set the exchange rate at which it traded escudos for euros at too high a value. This would explain the large trade deficit with the rest of the euro area, as Portuguese firms would then have had difficulty selling their overpriced goods abroad. If this were the case, however, the real exchange rate should have tended to fall back to its equilibrium level. Yet during the slump not only did the real exchange rate continue to rise, but it remains today above its 2000 level.

Moreover, as table 3 also shows, of Portugal's 11.9 percent real appreciation against all trading partners, 7.7 percentage points is due to a rise in the nominal exchange rate.[4] Thus, even though most of the Portuguese trade deficit occurred in trade within the euro area, the largest driver of the change in Portugal's real exchange rate was the appreciation of the euro relative to other currencies, especially the British pound and the dollar. The other columns in the table confirm this, by calculating the change in Portugal's real exchange rate with the euro area and with Portugal's three main trading partners, all of which use the euro. Relative to these trading partners, Portugal's real appreciation has been modest.

Table 3 also shows a standard decomposition of the change in the real exchange rate

[4]Let Q be the real exchange rate and E the nominal exchange rate, both defined such that an increase means an appreciation. Then $Q = EP/P^*$, where P and P^* are the price indexes at home and abroad, respectively.

into the sum of the change in the terms of trade and the change in the relative price of nontradables as the residual.[5] Most of the change in the real exchange rate was due to an increase in the relative price of Portuguese nontradables.

Yet another hypothesis for the Portuguese slump is that the accession of China to the World Trade Organization in 2001 introduced a fierce competitor for Portuguese exports, one that, like Portugal, specialized in exploiting its low wages relative to the richer EU countries. Although the growing role of China in world markets has left no country unaffected, there are a few reasons to be skeptical of the Chinese ascent as providing a trade-based explanation for the Portuguese slump. First, as table 3 shows, Portugal's terms of trade deteriorated only slightly during this period. Second, although Portugal's export share in world markets declined, those of Spain, Greece, and Italy declined by almost the same amount, yet these countries avoided Portugal's slump. Third, it is not clear why Chinese competition would cause a slump in distant Portugal, at a time when so many other middle-income countries in Southeast Asia and Latin America were booming. These countries also exported goods in low-wage sectors, which were likely closer substitutes for Chinese exports than were Portuguese goods.

A more promising avenue to explore is what is behind the increase in the relative price of nontradables. There are two caveats to measuring this relative price as a residual. First, the difficulties in measuring both the real exchange rate and the terms of trade may translate into even greater inaccuracy in measuring their difference. Second, there are important input-output links between tradables and nontradables in every economy, so that using gross price deflators does not allow for a proper separation between the relative prices of the two sectors.

The last two rows of table 3 provide an alternative means of decomposition, by using instead measures of value added both for the whole economy and for manufacturing alone as a proxy for tradable goods. Relative to the country's main trading partners, the relative price of all goods in Portugal actually fell, mostly driven by a large increase in prices in Spain. More to the point, taking manufacturing as a proxy for the tradables sector, it is clear that the evidence for uncompetitive Portuguese tradables is slim, whereas the relative price of nontradables clearly increased against all benchmarks.

Is the increase in Portugal's prices relative to the euro area due to a Balassa-Samuelson effect, whereby as Portugal converges in income to the rest of Europe, productivity in the

[5]Let γ denote the weight of nontradables in the price index, and assume for simplicity that this weight is constant and the same in the home country and abroad. Then $Q = E(P_T/P_T^*)^{1-\gamma}(P_N/P_N^*)^{\gamma}$, where P_T and P_N are the price indexes for tradables and nontradables, respectively. The terms of trade are defined as $E(P_T/P_T^*)$.

Table 4. Changes in Sector Composition in Portugal and Its Trading Partners, 2000-06

Indicator and sector	Portugal, 2006	Change, 2000-06 (percentage points)		
		Portugal	Euro area[a]	Main trading partners[a]
Share in employment				
Manufacturing	17.74	-2.72	-1.94	-2.14
Construction	10.22	-1.33	0.16	0.53
Real estate	6.38	0.96	1.40	1.39
Community services	24.06	1.12	1.07	0.94
Wholesale and retail trade	17.42	1.95	-0.14	-0.28
Share in value added				
Manufacturing	14.43	-2.66	-1.34	-2.23
Construction	6.61	-1.00	0.37	1.74
Real estate	14.59	0.14	0.75	1.91
Community services	26.51	2.53	0.11	0.06
Wholesale and retail trade	12.85	-0.52	-0.72	-0.63

Sources: See appendix A.

a. See table 1 for the countries included.

tradables sector grows, raising wages and the price of nontradables? Angel Estrada, Jordi Galí, and David Lopez-Salido (forthcoming) argue that this effect can explain little of the inflation differentials in the euro area. In the case of Portugal, there was no convergence in income to the euro area during the slump, nor was there any significant productivity growth in the tradables sector, so it is hard to justify the starting point for this explanation.

1.4 Growth and Decline by Sector

Table 4 turns to the shares of the tradables and nontradables sectors in the Portuguese economy, to further investigate the consequences of the change in their relative price. Starting with manufacturing's share in employment and nominal value added, the table shows their values in 2006, and the change in both shares from 2000 to 2006. There is a clear decline in both, which can be associated with a decline in the tradables sector and a corresponding increase in the nontradables sector. Indeed, growth in the nontradables sector is a distinctive feature not only of the slump in Portugal, but also of the boom in the other euro crisis countries (Bento 2010a, Giavazzi and Spaventa 2010).

However, manufacturing has been in relative decline for decades throughout the developed world as employment shifts toward services. As table 4 also shows, the fall in manufacturing employment turns out to be only slightly more pronounced in Portugal than in the rest of the euro area during this period. Moreover, because the relative price of manufactured goods

has been falling, the decline in manufacturing's share in nominal output overstates the slight fall in its real share.

To dig deeper, the rest of the table shows the shares in employment and in value added not just for manufacturing, but also for the other four largest sectors, all of which are dominated by nontraded products and services. A unique feature of the Portuguese economy, relative to the other euro crisis countries, stands out: the construction sector declined significantly, both relative to other European countries and in absolute terms. Whereas in Spain the share of value added in construction rose from 8.3 percent to 12.2 percent, in Portugal it fell from 7.6 percent to 6.6 percent. At the same time, Portugal saw quite large increases in employment in wholesale and retail trade and in the real output of community services, particularly in education, health care, and social work. Thus, the growth in nontradables was uneven across sectors.

1.5 Misallocation of Resources across Sectors

Two conventional inputs into macroeconomic models are the level of productivity and the extent of competition in the economy. A long literature has measured the first using Robert Solow's concept of total factor productivity, and the second using the negative of the log of the labor income share. Table 5 shows the changes in these measures for Portugal, both for the overall economy and for the five largest sectors.

Productivity declined during the slump across all sectors. Notably, however, the decline was largest in real estate and in wholesale and retail trade. Thus, the sector that had employment grow fastest during the slump, wholesale and retail trade, was also one of the worst performers in terms of productivity growth. At the same time, even as markups fell across most industries, they rose in one sector, community services, which had the second-fastest employment growth. This suggests a misallocation of the resources coming into the country, as the sectors that grew their employment the most either are relatively unproductive or have rising rents.

1.6 More Evidence of Misallocation

If the preceding discussion is correct, then the misallocation of resources should not be unique to the capital inflows since 2000 but should be a steady, salient feature of the Portuguese economy. There is some evidence that it is so.

Serguey Braguinsky, Lee Branstetter and Andre Regateiro (2011) estimate the size distri-

Table 5. Changes in Productivity and in Markups in Portugal and Its Trading Partners, by Sector

Indicator and sector	Portugal	Euro area[a]	Main trading partners[a]
Total factor productivity	*Annualized growth rate, 2000-05 (percent)*		
All industries	-1.85	0.07	-0.21
Manufacturing	-0.81	0.92	0.63
Construction	-2.46	-0.60	-0.74
Real estate	-4.44	-0.76	-0.92
Community services	-1.77	-0.19	-0.48
Wholesale and retail trade	-2.96	0.34	-0.16
Markups[b]	*Average annual change, 2000-06 (percentage points)*		
All industries	0.00	0.39	0.84
Manufacturing	-0.58	0.31	0.35
Construction	-0.93	1.16	1.42
Real estate	-0.49	-1.02	0.10
Community services	0.58	0.11	0.29
Wholesale and retail trade	-1.42	0.01	0.13

Sources: See appendix A.
a. For the markup measures, euro-area refers to 12 countries, as in table 1. For the total factor productivity panel, the euro-area includes only 8 countries: Austria, Belgium, Spain, Finland, France, Germany, Italy and the Netherlands.
b. The markup for each sector is defined as the negative of the log of the labor share.

bution of Portuguese firms from 1986 to 2009. They find, first, that this distribution is quite skewed to the left, pronouncedly more than in, for example, Denmark or the United States. Portugal has many very small firms, even as productivity tends to be higher in medium-size and larger firms. Second, they find a pronounced shift to the left in the distribution throughout this period, unlike what is observed in any other country. Changes in data coverage of the informal sector, or the shift to services, can account at best for half of the shift. Instead, Braguinsky and coauthors argue, thresholds in labor law impose higher taxes on large than on small firms, encouraging an inefficiently low equilibrium firm size.

Nicholas Bloom and John Van Reenen (forthcoming) produce cross-sectional distributions of management practices across firms for different countries. The estimates for Portugal show a strong left tail of firms that appear to be very poorly managed and unproductive, but somehow remain in operation year after year.

Eric Bartelsman, John Haltiwanger, and Stefano Scarpetta (2009) have put together a data set of firm-level productivity estimates for many sectors in many countries. It includes data on labor productivity for Portugal in the years 1991-94 and 2000, but they focus their analysis only on the early 1990s. Using their supplementary information, I took the cross-sectional average of their coefficients of variation of labor productivity across firms, within

a sector, weighted by firm size. The result is 0.017. The same calculation for Germany yields a result of 0.002. If one is willing to focus solely on manufacturing, one can also compare Portugal with France, another of its main trading partners. The average coefficient of variation for Portugal is 0.023, whereas for France it is 0.013. Using Bartelsman and others' (2009) publicly available data for 2000 in Portugal and Germany, I also calculated this statistic for two important nontradables sectors: construction, which was contracting in Portugal during the period, and retail trade, which was expanding. I also distinguish among existing firms, new entrants, and exiting firms. Across all categories, productivity in Portugal is considerably more dispersed than it is in Germany, and there is no clear pattern of the dispersion being higher just in the sector that was growing, or just among entering firms. All considered, this is suggestive evidence that there are many unproductive firms in operation in Portugal, which do not seem in danger of closing down.

1.7 The Government: Taxes and Old-Age Pensions

Having discussed monetary and exchange rate policy, productivity, and markups, I now turn to fiscal policy as another usual candidate to explain recessions and slumps. Table 6 shows the changes in the main fiscal variables over 2000-07.

Portugal's ratio of public debt to GDP rose substantially during the 7 years of the slump, especially relative to the other countries in Europe. In this regard Portugal is close to Greece during this period. However, unlike Greece, this increase in public debt came during a period of economic stagnation and rapidly rising unemployment. It would therefore be surprising if the debt had not increased. For comparison, in the United States in the 4 years since 2008, the unemployment rate increased by less than in Portugal during its slump, yet federal debt held by the public, relative to GDP, increased in the United States by twice as much as in Portugal.

The data on the components of the fiscal deficit confirm the impression that the period was not marked by fiscal profligacy. Taxes increased significantly, both on consumption and on labor income, even as they were falling in most of the euro area. Moreover, the decline in interest rates ensured that although the debt was growing, interest payments were roughly constant. The rise in debt was therefore driven by increases in spending and, as has become the norm in developed countries (Oh and Reis 2012), the bulk of it was in social transfers. It is difficult to see signs of large increases in discretionary spending in the data. Not only did gov-ernment purchases slightly fall, but so did spending on education, culture, and economic affairs.

Table 6. Public Finances in Portugal and Its Trading Partners, 2000-07

Indicator	Portugal, 2007	Change, 2000-07 (percentage points except as noted)		
		Portugal	Euro area[a]	Main trading partners[a]
Government debt as share of GDP	68.27	17.87	-2.90	-8.70
Taxes as share of GDP				
Total	32.80	1.70	-0.90	0.56
On consumption	12.60	0.80	-0.40	-0.47
On labor	12.40	0.90	-1.20	-0.46
On capital	7.80	-0.10	0.60	1.44
Government spending as share of GDP				
Total	44.4	2.8	-0.1	-0.3
Purchases	22.54	-0.53	0.32	0.61
Social protection	15.30	3.30	-0.40	-0.22
Old age	9.30	3.20	n.a.	0.05
Memoranda:				
Percent of the population older than 65	17.25	1.22	1.59	1.12
Pensioners as percent of the labor force	59.00	3.40	n.a.	n.a.
Effective average retirement age (years)	66.32	2.50	n.a.	0.49

Sources: See appendix A.

a. See table 1 for the countries included; n.a. = not available.

More than 100 percent of the increase in total spending comes from a single subcategory of social protection spending: old-age pensions. The last three rows of table 6 show some relevant statistics. Portugal's population is aging, but not at a faster rate than in other European countries, and the retirement age actually increased during the slump. Thus, the source of this higher spending was not more retirees, but rather more generous pensions.

One can identify two channels through which the system's generosity worked (Organisation for Economic Cooperation and Development [OECD] 2009). First, because Portugal has one of the highest rates of old-age poverty in the OECD, it addresses this social concern by having a minimum pension for everyone. The combination of population aging and the slump implied large increases in spending in this antipoverty aspect of the public pension system. Second, the expansions in the generosity of the system occurred in the early 1990s, especially for public servants. It was during 2000-07 that these past promises came due, and spending rose. Notably, in 2000 and 2002, pension reforms that tried to curtail this increase in spending were mostly unsuccessful, and only in 2007 was a more significant reform enacted, which indexed the retirement age to life expectancy and lowered the net replacement rate for the median worker to 73 percent. Thus, the more promising candidate in the fiscal domain to explain the slump is the hike in labor and consumption taxes to fund past

promises to pensioners.

1.8 Changes in the Portuguese Labor Market

A familiar mantra about the Portuguese labor market is that it is highly rigid, with strong restrictions on firing and generous unemployment insurance. By the OECD's measures of employment protection, Portugal in 2000 had the second most rigid labor market in a sample of 28 countries. Blanchard and Portugal (2001) estimate low quarterly rates of job creation and destruction in Portugal between 1983 and 1995 and convincingly argue that these were due to high levels of employment protection.

Thus, another hypothesis to explain the slump is that even small adverse shocks may have been compounded through the rigidity of the labor market. However, the labor market in Portugal has changed significantly since 2000. M. Pereira (2012) documents the numerous reforms of unemployment insurance since 2000, all of which have made it considerably less generous.

Much the same can be said about restrictions on firing. Labor law reforms have made it easier to sign temporary contracts, which have a fixed term after which the worker can be easily let go at little cost. In 2007 temporary employment was 22 percent of Portuguese employment, against an EU-21 average of 15 percent and an OECD average of 12 percent.[6] Among workers aged 15-24, who entered the labor market recently and so were not covered by outstanding permanent contracts, 52 percent are on temporary contracts, against averages of 43 percent and 26 percent for the EU-21 and the OECD, respectively. Using detailed job flows data, M. Centeno and A. Novo (2012) estimate that between 2002 and 2006, 85 percent of all Portuguese workers leaving unemployment went into a temporary job, and that the share of temporary contracts was particularly large in firms expanding employment. The OECD's index of employment protection of temporary workers in 2008 ranks Portugal only 12th out of 40 sampled countries.

The gap between worker flows in Portugal and in the United States is also significantly smaller today than in the earlier estimates of Blanchard and Portugal (2001). Centeno, Novo, and C. Machado (2007) estimate that for 2001-07, the average quarterly rates of job creation and job destruction in Portugal were 5.3 percent and 5.1 percent, respectively; both figures are 1.9 percentage points lower than for the United States during the same period. The annual job turnover rate in Portugal was 25.1 percent, very close to the U.S.

[6]The EU-21, defined by the OECD, includes all EU countries prior to May 2004, plus the four eastern European member countries of the OECD, namely Czech Republic, Hungary, Poland, Slovak Republic.

level. Alexandre and others (2010) estimate that between 2003 and 2009, the job turnover rate among workers on temporary contracts was 44 percent, compared with 19 percent for permanent contracts.

All combined, the Portuguese labor market since 2000 is best described as a dual market (Centeno and Novo 2012). Most workers still have permanent contracts, and are thus highly protected. This has an effect on average productivity and may well be one of the crucial reasons behind Portugal's productivity and income gap relative to the rest of Europe. However, in adjusting to macroeconomic shocks like the 2000-07 slump, the relevant marginal worker, the one who is hired or fired to adjust to changes in demand, is on a temporary contract, which is relatively flexible.

1.9 The Takeaway

In 2000-07 Portugal went through a slump in production and employment, in spite of large capital inflows and low long-term interest rates that modestly raised real wages and the real exchange rate. The relative prices of most nontradables sectors rose, yet the expansion in employment and value added was concentrated in wholesale and retail trade and in community services, while construction prominently contracted. Worryingly, wholesale and retail trade was also the sector with the second largest relative decline in productivity, and community services was the only sector with an increase in estimates of markups. This suggests that an explanation for the Portuguese slump is that the large inflows of capital were misallocated across sectors of the economy, causing the observed fall in the growth of productivity.

This account leaves a few questions open. First, how were the resources misallocated, and why did this happen in the 2000s in the nontradables sector? Second, how does the misallocation translate into low measured TFP? And third, what was special about Portugal that led it to experience a slump even as Ireland and Spain boomed? To make progress on these questions, one needs a model that separately identifies some of these mechanisms and spells out what assumptions are required to make the account hold together. The next section takes on this challenge.

2 A Model of Misallocation of Foreign Capital Inflows

The theoretical literature on sudden stops (for example, Mendoza 2006) has already spelled out the mechanism by which an increase in capital flows can lead to a reallocation from the tradables to the nontradables sector. Gabriel Fagan and Vitor Gaspar (2007) provide one of

the first applications of these ideas to the euro area experience. A fall in the interest rate at which a country can borrow from abroad causes a consumption boom and large capital inflows to finance it, so that net foreign assets fall. The higher consumption of tradables is sustained through imports, whereas nontradables must be produced domestically. This requires a reallocation of inputs into the nontradables sector, and with it an increase in employment in that sector, an increase in real wages, and a real appreciation.

This description fits the Portuguese slump well, with one important exception: there was no boom in consumption or output. Gianluca Benigno and Luca Fornaro (2012) introduce an additional mechanism to explain stagnant output. They assume that technology in the tradables sector improves through learning by doing, so that the reallocation of factors of production away from this sector causes productivity growth to fall. This can account for the fall in measured TFP during the slump. However, productivity in Portugal's nontradables sector also stagnated, whereas their model would predict that it would be unchanged, or perhaps slightly accelerate if there is some learning by doing in this sector as well.

I present an alternative model that focuses on the misallocation of resources across sectors, especially within nontradables. I make simplifying assumptions that shut off the two mechanisms I just described, not because they are not important, but so as to focus on the facts that they fail to explain. I anticipate that combining them would provide a working comprehensive model of the behavior of the euro crisis countries in 2000-07.

I present the model in blocks. I start with a model, inspired by Kosuke Aoki, Benigno, and Nobuhiro Kiyotaki (2010), of domestic credit market frictions that lead resources to be misallocated across firms. Next, I present a model of capital inflows from abroad that, interacting with domestic frictions, can lower productivity. Philippe Aghion, Philippe Bacchetta, and Abhijit Banerjee (2004) and Ricardo Caballero and Arvind Krishnamurthy (2001) are important precursors. Third, I present a simple model of labor supply to make the conventional case that higher taxes will depress economic activity, and a standard model of the allocation of inputs between the tradables and the nontradables sectors.

2.1 Credit Markets and the Misallocation of Capital

For simplicity, I assume that the nontradables sector produces a single good produced by a continuum of entrepreneurs, each with her own production function with productivity drawn from the set $[0, \bar{a}]$. If resources were allocated perfectly, only the entrepreneur with the highest productivity, $\bar{a}$, would be in business. It is a symptom of misallocated resources when some of the nontradable good is produced by any other entrepreneur, leading to average

TFP below $\bar{a}$.

In the model such misallocation happens because of imperfect financial markets. Each entrepreneur draws at date t its productivity a_t from the distribution $G(a)$. For simplicity, I assume these draws are i.i.d. and that they are the only source of uncertainty in the economy. An entrepreneur maximizes expected discounted utility,

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\beta^t \ln(c_t)\right],$$

subject to an intertemporal budget constraint,

$$p_t c_t + k_t + \frac{d_{t+1}}{r_t} - \frac{b_{t+1}}{r_t^b} = p_t^N a_{t-1} k_{t-1}^{\alpha} n_t^{1-\alpha} - w_t n_t + d_t - b_t.$$

On the left-hand side of this equation are consumption c_t (bought at price p_t), investment in capital that will be productive next period k_t, investment in a financial institution d_{t+1} with return r_t, and borrowing b_{t+1} to finance production at interest rate r_t^b. On the right-hand side is the revenue from production, specified using a Cobb-Douglas production function that combines labor n_t and capital to generate the nontradable good, which sells for price p_t^N. With this revenue plus whatever financial investments she has made, the entrepreneur must pay her workers at wage rate w_t and repay her financiers from the last period. Capital fully depreciates after one period. To make the words "borrowing" and "investing" substantive, the following constraints hold: $d_{t+1} \geq 0, b_{t+1} \geq 0, k_t \geq 0$.

Without any further constraints, the most productive entrepreneur would borrow to invest in the optimal amount of capital, while all others would save in the financial markets, providing the funds for this borrowing. The friction that prevents this efficient allocation of resources is a collateral constraint. Each entrepreneur can pledge only an amount θ of her future revenue after paying wages to collateralize her loans:

$$b_t \leq \theta\left[p_t^N a_{t-1} k_{t-1}^{\alpha} n_t^{1-\alpha} - w_t n_t\right].$$

I assume that $\theta < 1$ and that this constraint will bind for the most productive entrepreneur, who is thus unable to raise all the capital needed to supply the efficient amount of the good.

The parameter θ captures limits to credit in the model but can be more broadly interpreted as standing in for a general misallocation of resources across firms, within and across subsectors of the nontradables sector, that prevents the most efficient firms from grow-

ing. It could also refer to government regulations, inefficiency of the judicial system, or the cartelization of sectors by a few large economic groups with privileged access to policymakers or protection from regulators.

Appendix B solves this problem. Because in equilibrium, $r_t \geq r_t^b$, if an entrepreneur is active in production, she will borrow up to the constraint. This allows her to earn a leveraged return, R_t, which rises with the price of the good relative to the labor cost to produce it, p_t^N/w_t, and with the entrepreneur's productivity a_{t-1} relative to the cost of borrowing r_{t-1}^b.

Entrepreneurs sort themselves into two groups, depending on whether their productivity is above or below a threshold a_t^*. Those with low productivity do not produce and instead use their net worth to invest in financial assets, earning r_t. Those with higher productivity produce and borrow to the point where their collateral constraint binds, earning R_t. An economy with an underdeveloped financial market therefore suffers from two inefficiencies in production. On the extensive margin, many inefficient firms are in operation, so $a_t^* < \bar{a}$. On the intensive margin, the most efficient entrepreneur produces below the efficient scale, since she can only borrow up to a multiple of her net worth.

This simple model of capital misallocation can capture the relevant features of the Portuguese economy highlighted in section 1. There are many small firms, most of which are very unproductive. Because the country is still accumulating capital in its convergence process, the net worth of entrepreneurs is small, and the production of the most efficient firms will be severely curtailed. Finally, average firm-level TFP in the economy is $\int_{a_t^*}^{\bar{a}} a_t dG(a_t)/\left[1 - G(a_t^*)\right]$ which increases with a_t^*. A shock that causes a_t^* to fall lowers measured productivity.

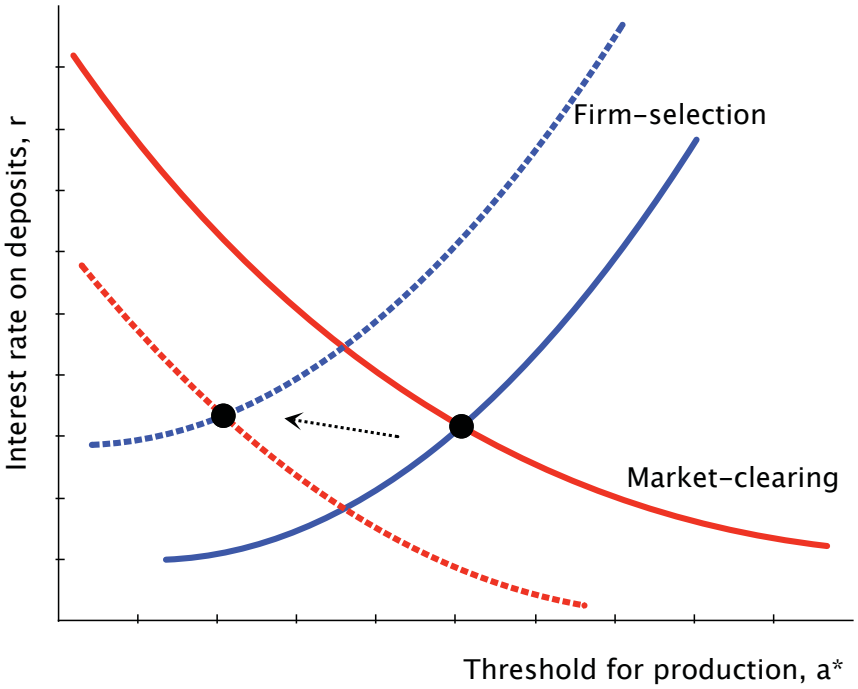
2.2 Capital Inflows and the Expansion of Nontradables

Most Portuguese firms, especially in the nontradables sector, do not have access to international financial markets. Lacking expertise in the local market, foreigners must channel their capital investments through the domestic financial system. In the model, a competitive financial sector receives funds from inactive entrepreneurs and foreigners and channels them to the entrepreneurs that are in business. This sector is the only one that can make loans, because it is the only one that can seize collateral from failing entrepreneurs. One can think of the collateral parameter θ as their technology, so that underdeveloped credit markets are synonymous in the model with an inefficient financial sector.

Financing from abroad comes at an exogenous interest rate, r^f. However, the financial sector can secure funding only by offering as collateral a fraction $\phi \in (0, 1)$ of its loans.[7] The

[7]Because the loans are to the nontradables sector, one could adopt the following technological interpreta-

Figure 2: Equilibrium with a Production Threshold for Nontradables Firms



parameter ϕ measures the integration of the country into capital markets. An increase in ϕ comes with an influx of foreign capital into the country.

For banks to make zero profits, the rate of return charged on loans must equal

$$\frac{1}{r_t^b} = \frac{\phi}{r^f} + \frac{1-\phi}{r_t}.$$

As long as $\phi < 1$, since $r_t > r^f$, one can see that $r_t > r_t^b$ as I assumed earlier. Combining this equation with the threshold for an entrepreneur to be active in production gives a firm-selection curve, depicted in figure 2. If the interest rate paid to inactive entrepreneurs is higher, the interest rate charged on loans must rise with a competitive financial sector. As this lowers the leveraged return that producers can earn, more entrepreneurs choose to stay inactive, leading to an increase in the threshold for production. The firm-selection curve therefore is upward sloping.

In equilibrium, domestic investment in the financial sector must fund a share $1-\phi$ of the loans. This market-clearing condition gives a downward-sloping relationship between r_t and

tion of this constraint: banks have access to a technology that allows them to transform nontradable seized collateral into tradable output, the only kind that foreigners are willing to accept, at transformation rate ϕ.

a_t^*, denoted in figure 2 by the market-clearing line. Intuitively, if fewer entrepreneurs are active and need financing, so that a_t^* is higher, then fewer loans are made, which lowers the demand for deposits and so lowers the interest rate r_t that banks must pay. The intersection of the two schedules gives the unique equilibrium for a_t^* and r_t.

The introduction of the euro removed exchange rate risk for European investors investing in Portugal. Moreover, in its main refinancing operations, the European Central Bank (ECB) started accepting as collateral the bonds of many Portuguese public companies, providing a new source of funds. More generally, the monetary union actively promoted the integration of capital markets in Europe, making foreigners more willing to supply funds to the Portuguese economy. Therefore, I take the capital inflow shock to correspond to an increase in ϕ.

A higher ϕ shifts both schedules in figure 2 to the left: for a fixed r_t, it lowers r_t^b, increasing the leveraged returns to firms and shifting the firm-selection curve; for a fixed r_t^b, it lowers r_t, so fewer entrepreneurs wish to invest their funds in the financial system, and the market-clearing curve shifts. Unambiguously, a_t^* falls; that is, more entrepreneurs start producing. After 2000, capital from the rest of Europe flowed into Portugal, lowering domestic saving while expanding leverage. Many inefficient firms in the nontradables sector could now obtain financing, so they went into business. Measured TFP fell, and in a simple extension of the model with multiple sectors, it fell the most in those sectors where the expansion was largest, because more unproductive firms entered the market.

Meanwhile, along the intensive margin, the most productive firms do not expand because they are against their collateral constraint, and they may even contract if the price of the nontradable good falls. The euro and the integration of European capital markets did not significantly improve the ability of the domestic financial sector to allocate capital: financial integration did not lead to financial deepening. In terms of the model, ϕ rose but θ did not change. Therefore, the most productive firms were unable to access the newly abundant funds.

2.3 The Tradables Sector and Taxes

The consumption basket in the economy is a Cobb-Douglas aggregator of the nontradable good and a tradable good, with expenditure shares γ and $1-\gamma$, respectively. The price of the tradable good-the terms of trade-is normalized to 1, and the good is supplied competitively using a Cobb-Douglas technology that is identical to that for nontradables but has a TFP of A. The owner of this technology is a representative household, who also supplies the labor

in the economy and has preferences

$$\sum_{t=0}^{\infty} \beta^t \ln \left(\hat{C}_t - \frac{L_t^{1+\psi}}{1+\psi} \right).$$

The aggregate consumption of the household is $\hat{C}_t$, while they supply all of the labor in the economy L_t, and ψ is the inverse of the Frisch elasticity of labor supply. Labor income is taxed at rate τ, with the proceeds rebated to the household every period. This is the only form of fiscal policy that I consider, since section 1 concluded that an increase in these taxes was the major change in fiscal policy during the slump.

The budget constraint of the households is similar to that of the entrepreneurs, but they do not need to use the local financial system. Because they produce tradable goods, they can pledge their output to foreigners, and for simplicity I assume they can do so fully. Therefore, all of the production of tradables can be financed using funds from abroad, and the change in financial integration does not affect this sector directly. This is, of course, an extreme assumption, but the important premise for the misallocation hypothesis of the Portuguese slump is only that the nontradables sector is less financially deep than the tradables sector, and so more affected by an influx of new funds from abroad.

Three important results come out of this model of household behavior and production of tradables. First, because there are constant returns to scale in production, the condition of zero profits in the tradables sector requires that the wage rate for the overall economy is pinned down by the foreign real interest rate r^f. This extreme property makes the model quite tractable and is not too dissimilar from the relative stagnation of real compensation discussed in section 1. It also implies that changes in the interest rate at which Portugal finances itself abroad have a direct impact on output. This will be important for understanding the crash after 2007.

Second, higher taxes lower after-tax wages and immediately discourage labor supply. Therefore, the increase in taxes in Portugal to finance old-age pension commitments, discussed in section 1, will have played a part in lowering output during the slump. The next section asks whether this effect is large.

Third, a condition for the model economy to be credit constrained is that entrepreneurs earn a return above the foreign interest rate; for the economy to be in steady state, this requires that $\beta < 1/r^f$. As a result, the household has no savings and lives hand to mouth using foreign capital to finance the production of tradables. This is an extreme result, due to the simplicity of the model, but the key fact that is captured is that the tradables sector

has better access to external financing. This result implies that when capital flows from abroad, it goes into the nontradables sector. Because that sector competes for labor with the tradables sector, financial integration implies a relative decline in the production of tradables, as well as an increase in the price of nontradables, driving a real appreciation.

3 Further application of the model to the data

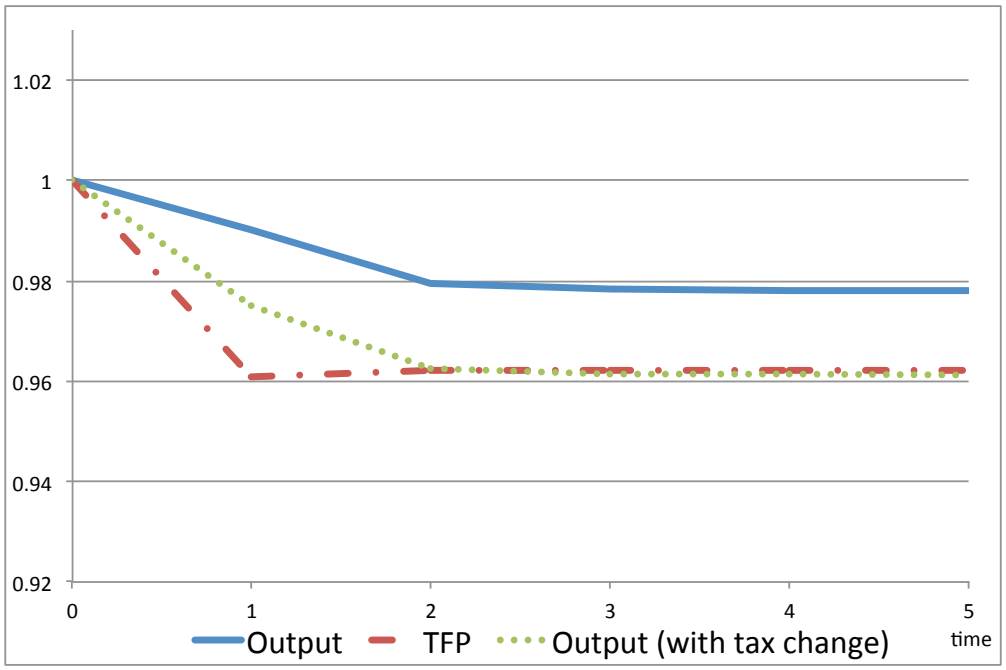
The model's predictions in section 2 appeared to fit almost all of the facts about the Portuguese economy described in section 1. This section explores this match further in three ways. The first is by solving the model and verifying whether the partial-equilibrium intuition in section 2 survives in general equilibrium. I also ask how far the misallocation hypothesis can explain the slump quantitatively. The second is by asking whether the model can explain why Ireland and Spain boomed during this period, even though they also saw an expansion in nontradables, current account deficits, and a real appreciation. The third is by investigating the role that taxes play in conjunction with the misallocation channel.

The appendix describes the nonlinear algorithm that solves the model without any approximation. The entire model, from steady state to the responses to shocks, takes a couple of seconds to solve, as long as I assume that the distribution of nontradables productivity $G(a)$ is uniform, which I will.[8] The model is too simple to seriously calibrate to the data, so instead I set parameter values to reasonable values based on the literature. In particular, I take the time period to be 4 years, so that I can abstract from nominal rigidities and make more plausible the assumption that firm-level productivity is i.i.d. I set $r^f = 1.08$, for an annualized real interest rate of 2 percent, which matches the average during this period, and $\beta = 0.84$ for a steady-state return on capital that is twice as large. I set $\alpha = 0.3$, $\gamma = 0.5$, and $\psi = 1$, to match standard business-cycle values for the capital share, the weight of tradables, and the inverse of the Frisch elasticity of labor supply, respectively. The top productivity for nontradables is $\bar{a} = 1$, so that one can interpret $1 - a_t^*$ as the share of projects that are funded, and the parameter A determines only average hours worked. Finally, for the initial value of τ, I use the values in table 6, which imply that the average effective tax on working was 20.8 percent in 2000.

The two most important parameters for the misallocation hypothesis are θ, the degree of financial deepening, and ϕ, the degree of financial integration. Insofar as these proxy

[8] If instead I assume that $a^{1/\alpha}$ is uniform, the model can still be solved with pencil and paper. Outside of these cases, one would have to numerically solve an integral.

Figure 3: Impulse Responses to a Sudden Increase in Financial Integration



for general misallocation, it is hard to pin down their values. An active research literature, surveyed in D. Restuccia and R. Rogerson (2013), tries to measure them across countries, but no definite conclusions have been reached. Here I take a very simple back-of-the-envelope approach. Since θ is the share of capital investment by the entrepreneurs that comes from outside sources, I set it equal to the share of bank financing of nonfinancial corporations. That value fluctuated in Portugal from the mid-1990s to 2007 between 0.2 and 0.3, so I set it to 0.25. As for ϕ, recall the basic national income accounting identity that gross saving minus the current account balance must equal gross investment. In the model ϕ measures the share of investment coming from abroad. Because before the slump, Portugal had close to balanced external accounts, I set ϕ to 0 before the slump.

3.1 The Impact of Financial Integration

From 2000 onward, capital inflows to Portugal were very large. Calculating ϕ as the average of the ratio of the current account deficit to gross investment for the period 2000-07 gives a new value of approximately 0.35. I therefore simulate the model for the case where ϕ unexpectedly increases by 0.35, starting from a steady state. Figure 3 shows the path of output and measured unweighted average TFP in the nontradables sector.

Table 7. Impact of Financial Integration on Output under Different Scenarios[a]

	Change in extent of financial integration ϕ				
	0.25	0.30	0.35	0.40	0.45
Output on impact	1.007	0.989	0.990	0.991	0.992
Output in steady state	0.978	0.998	0.978	0.978	0.978
	Level of financial deepening θ				
	0.25	0.30	0.35	0.40	0.45
Output on impact	0.990	1.031	1.003	1.009	1.013
Output in steady state	0.978	1.020	0.988	0.992	1.002

Source: Author's calculations using the model described in the text.
a. Output is set equal to 1.0 in period 0.

The model is able to generate a sizable slump in economic activity. As capital flows into the nontradables sector, a_t^* falls as more lower-productivity firms are financed, leading to a fall in average productivity. At the same time, labor is drawn away from the tradables sector, lowering its output. Because the relative price of nontradables rises, some of the more efficient nontradables firms can expand, so output may rise or fall. For the baseline parameters, it barely moves initially but then falls significantly.

Table 7 investigates the sensitivity of the change in output to the size of the shock. I vary the increase in ϕ and report the resulting change in output, both on impact and in the new steady state. If financial integration is even more intense, GDP can fall by as much as 2.2 percent. These are rough estimates, but they suggest that there is potential for the misallocation channel to make financial integration lead to slumps.

3.2 Other Countries

A successful model of the Portuguese slump should also be able to account for what was happening in Ireland and Spain at the same time. These economies are sufficiently similar in their structure, and in 2000-07 all of them experienced large capital inflows, an expansion of nontradables, a real appreciation, and a decline in productivity growth. However, unlike Portugal, they all boomed during these years.

One difference relative to Ireland and Spain is that Portugal has a less developed financial system, and judging from the cross-sectional distribution of productivity and management practices across firms, it also likely has more misallocation of capital. In the model this would be captured by a higher θ. Ireland and Spain would then have a higher starting a_t^*, so

they would be more productive than the Portuguese economy to start with and have more efficient firms operating at a larger scale.

Table 7 shows the impact of financial integration on output when financial markets are deeper, by increasing θ from the Portuguese value of 0.25. Now, when the capital market integrates with the introduction of the euro and ϕ increases, there is still a fall in TFP in all cases, due to the expansion of the nontradables sector. The model can also still explain the real appreciation, the current account deficits, and most of the other facts shared by Portugal, Ireland, and Greece. However, with deeper financial markets, there is now a larger increase in the capital employed by the more efficient firms, and a smaller rate of entry of unproductive firms. Output in the nontradables sector booms, at the expense of the tradables sector, and the economy booms as well.

The joint lesson from this and the previous section is that if the increase in ϕ is accompanied by an increase in θ, output and welfare will rise. That is, according to the model, a slump is the result of financial integration without financial deepening. If the economy is already more financially developed, or can become so as it opens capital markets to foreign funds, then prosperity will result.

3.3 The Role of Taxes

Section 1 also showed that taxes rose in Portugal during the period of the slump. Faced with the need to keep up with rapidly rising expenditure on pensions, the government raised the effective tax on working by 1.4 percentage points through increases in consumption and labor taxes. Figure 3 shows the impact of the rise in taxes, modeled as an unexpected permanent change. As one would expect, the slump is now deeper: the model can generate a fall in output of almost 4 percent.

The increase in the average tax rate likely understates the increase in the marginal tax rate. If the marginal rate increased by twice the average rate, the fall in output would be as much as 5.6 percent. At the same time, I assume a value of 1 for the Frisch elasticity of labor supply, standard in the macro literature and which is consistent with the micro evidence that takes into account the extensive margin, but the findings in the literature are also consistent with an elasticity of 0.5 (Chetty 2012). When the calculations are repeated with this lower elasticity, output in steady state falls less now, by 2.8 percent.

4 The Boom before the Slump, and the Crash after

Because the slump between 2000 and 2007 is what makes the Portuguese case distinctive and puzzling, it has been the main focus of this paper so far. The period immediately before the slump, between 1995 and 2000, is also interesting because by then Portugal's adoption of the euro was already very likely, and some of its consequences were already being felt. Section 4.1 discusses this period in light of the data and the model. Section 4.2 then looks at the period from 2007 until the present, when Portugal was one of several countries in Europe going through a deep crisis. Again I present the main facts and use the model to shed light on them. Other, complementary accounts of the euro crisis have been offered into which Portugal fits naturally, and I discuss these in section 4.3.

4.1 The Boom of 1995-99

Between 1995 and 2000, Portuguese real GDP per capita grew at an annual rate of 3.8 percent, which was 1.7 percentage points faster than the average in what was to become the euro area. Blanchard and Francesco Giavazzi (2002) note that this rapid growth was likely a result of the launch of European monetary union in 1994. With every passing year it became more likely that Portugal would be an original member of the euro area, and Portuguese long-term interest rates gradually fell, as shown in figure 4. The current account gradually went into deficit, as Portugal could now borrow at more favorable terms than it had in decades.

These facts did not seem surprising. Blanchard and Giavazzi (2002) highlight that, in standard open-economy models, a fall in the foreign real interest rate r^f should naturally cause a temporary boom and a current account deficit. However, writing a few years later, Fagan and Gaspar (2005) raise the question of why, after the initial boom, Portugal did not experience a gradual growth slowdown and convergence to a new, higher level of income, but instead entered a slump.

The change that this paper has highlighted is that whereas the shock in 1995 was a reduction in the foreign real interest rate, from 2000 onward the gradual integration of European capital markets relaxed foreign borrowing constraints. The ECB allowed banks to pledge a variety of securities, including many nontradable utilities bonds, as collateral against its euro repurchase agreements. Portuguese banks, which until then had funded themselves abroad almost exclusively through the interbank market, were now able to place bonds with foreign investors.

Figure 4: Ten-Year Interest Rates on Government Bonds in Portugal and Its Main Trading Partners, 1993-2013

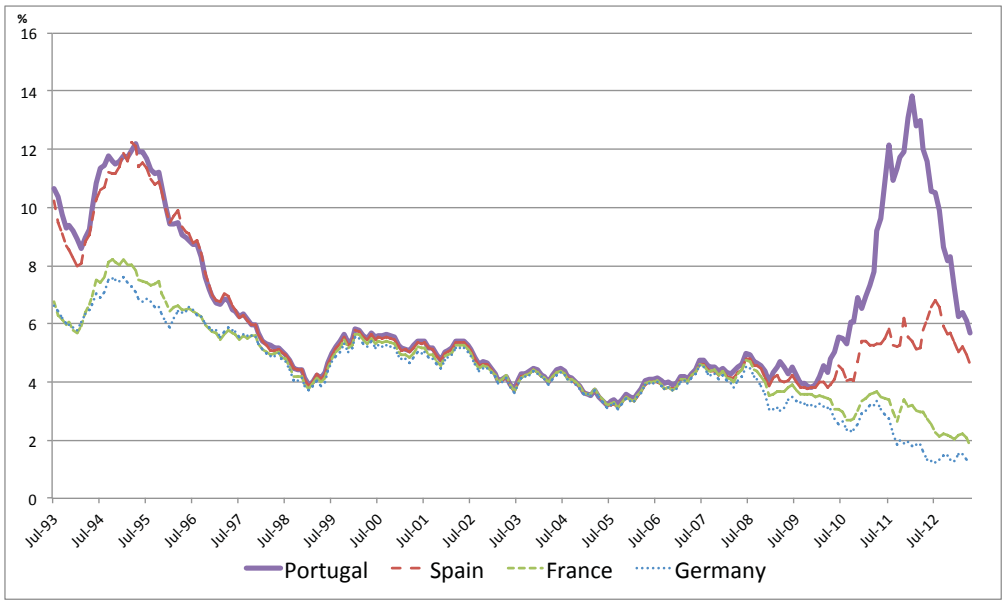
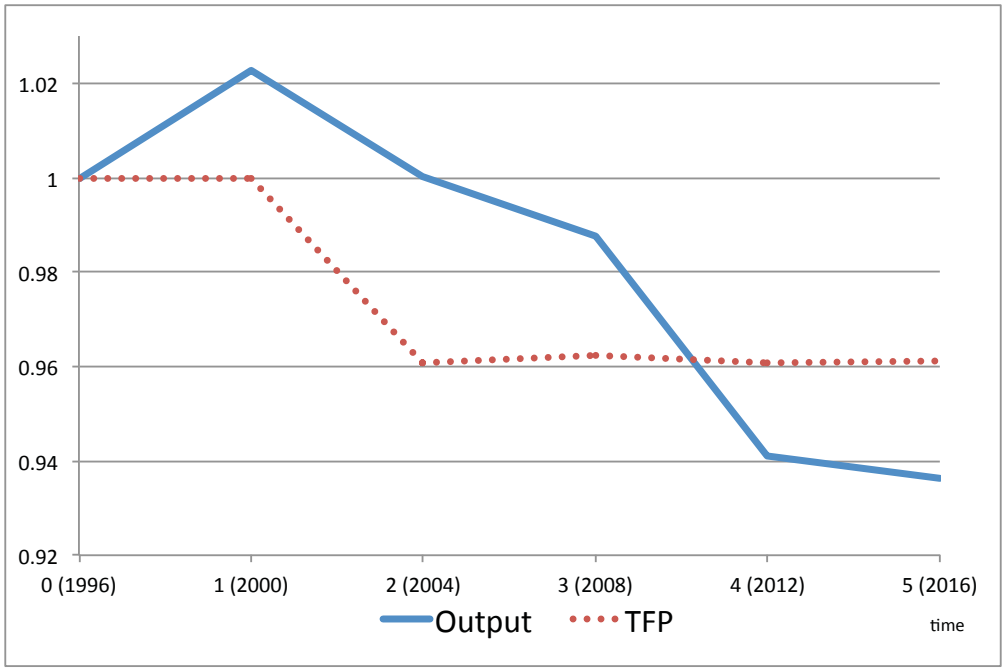


Figure 5 simulates the model after a sequence of unexpected shocks. This is not entirely satisfactory, as many of these changes were at least partly anticipated, but it gives a first pass at understanding the dynamics predicted by the model. In period 1 the foreign real interest rate r^f falls by 4 percentage points, or 1 percentage point per year, as in Blanchard and Giavazzi (2002) and Fagan and Gaspar (2005). Then, in period 2, financial integration occurs, with an increase in ϕ by 0.35 and an increase in taxes by 1.4% as in the previous section. Approximately 8 years, or two model periods, after the first shock, the foreign real interest rate increases by 2 percentage points per year, to capture the jump in the data in figure 4.

The model captures the boom as well as the slump. It underpredicts the intensity of both of these, but it gets a long way in doing so. The model also predicts a sudden and steep crash in 2008-12. Because the sudden hike in foreign interest rates comes after a period of financial integration, foreign debt is high, and many firms close down once credit becomes more expensive. Therefore, the sudden stop has a larger impact than it would otherwise have had.

Figure 5: Boom, Slump and Crash in the Model After a Series of Financial Shocks



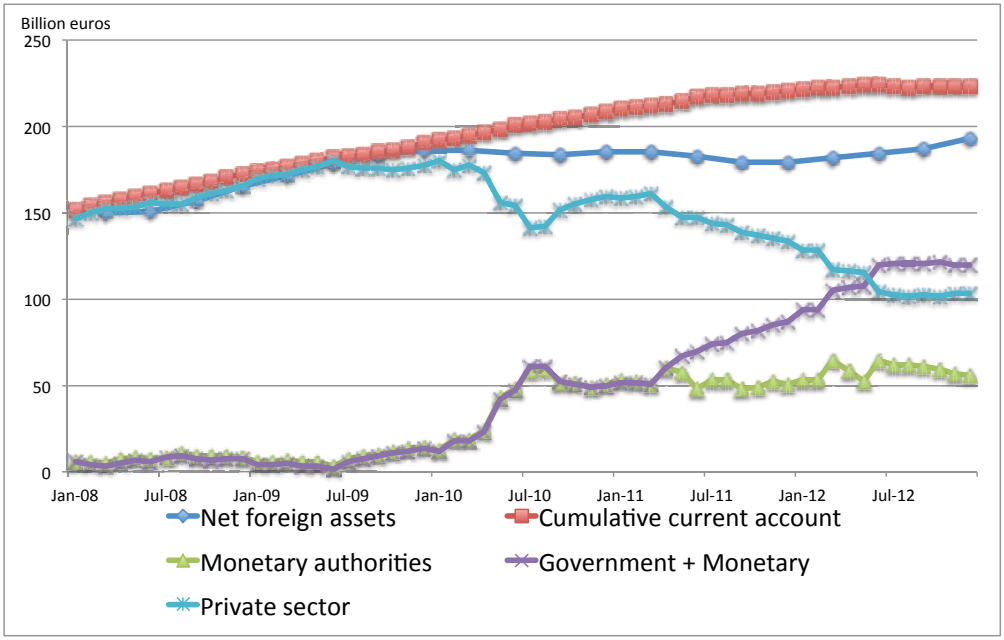
4.2 The Crash

In 2008 and 2009 most of the developed world was in a recession, making it difficult to separate the global shock from Portugal's crisis. If anything, the Portuguese economy contracted less during those 2 years than the euro area as a whole. In January 2010, however, interest rates on long-term Portuguese government bonds started rising, a few months after the same thing had happened in Greece.

Between 2003 and 2009, interest rates on Portugal's10-year bonds had hovered between 3.2 and 5.0 percent, but during 2010 they rose from 3.9 percent to 6.5 percent. Public spending also rose markedly, partly because of the automatic stabilizers, and partly because the government, which had won reelection in September 2009, implemented a campaign promise of raising public sector wages after years of zero increases. By the end of March 2011, 10-year interest rates were at 7.8 percent, and banks were reporting serious difficulties rolling over their international funding. The prime minister asked for external assistance, and a troika of the IMF, the European Commission, and the ECB approved a memorandum of understanding with the Portuguese government in May in exchange for a rescue loan. The government resigned, and elections in June led to a change in the party in power. Only by January 2013 did the 10-year interest rate again fall below 7 percent.

In terms of the model, one can think of this shock as an unexpected increase in r^f. Risk

Figure 6: Sudden Stop in Capital Flows in Portugal, 2008-12



premiums rose on most asset classes around the world after the global crisis. This effect was larger in Europe, in part because of the financial instability and political uncertainty over whether and how the sovereign bonds of the periphery countries might default (Lane 2012). As figure 5 showed, the model predicts that such a financial shock will cause a steep drop in output, as capital inflows sharply decline, affecting especially the nontradables sector. All of this occurred in Portugal starting in 2010.

Figure 6 shows the trajectory of capital flows during this period. The top two lines plot its time series (net foreign assets) and the cumulative current account balance. In 2008 and 2009 the country continued to run large current account deficits and to accumulate a growing foreign debt. Since the start of 2010, however, the foreign debt has been stable. For most of that year, positive valuation effects offset the current account deficit, but by the end of 2012 Portugal had a balanced current account and no capital inflows. That is an extraordinarily sudden stop of capital flowing into the country in the space of 2 years.

The other three lines in the figure break down these capital flows into those flowing through the central bank, those to the government, and those to the private sector. During the slump and into 2008, most capital inflows were private. During 2009, however, private capital inflows stagnated, and all of the new capital came in through the balances in TARGET2, the Eurosystem's interbank payments system. Once the troika rescue was in place, transfers from the monetary authority were replaced by loans to the government. From the

middle of 2011 onward, private flows left the country en masse, to an extent comparable to the deepest sudden-stop episodes in Latin America in the last two decades.

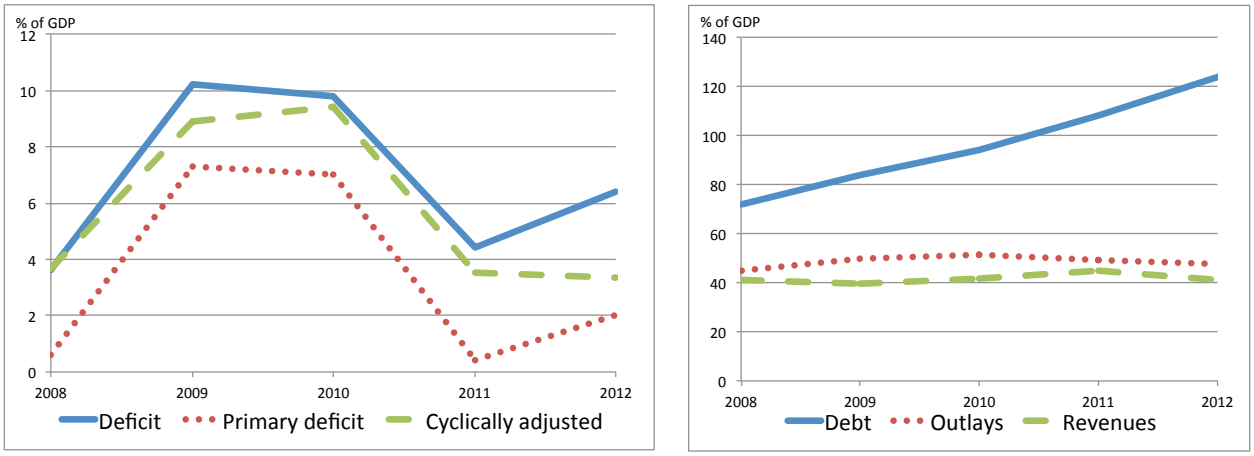
As in the Latin American cases, this sudden stop of capital inflows has resulted in a deep recession in Portugal. From its peak in 2010Q3 to the present, quarterly real GDP has fallen by 10.6 percent, according to the latest available figures (2013Q1), and the unemployment rate is at 17.7 percent. However, whereas the collapse in the Latin American countries was often followed by a quick recovery (Calvo and others 2006), the Portuguese economy shows no signs of resuming growth. The policies usually associated with these "phoenix miracles" have not been present in Portugal: there have been no significant writedowns on the external debt, and monetary policy has been tight, with no nominal depreciation of the euro or significant inflation.

4.3 Further Ingredients of the Crash: Banks, Austerity, and Wages

Because Portugal's banks were at the center of the capital flows—and in 2010 accounted for approximately half of the net foreign debt—they were the most affected by the capital reversal. As part of the troika package, three of the four largest banks have been recapitalized with public funds. Two characteristics of Portuguese banks are shared with other European banks, but not with their American counterparts. First, the principal Portuguese banks are very large relative to the size of the economy. In 2008, the largest Portuguese bank, Banco Comercial Português, had liabilities equal to 54% of GDP of the whole country (Demigurc-Kunt and Huizinga, 2010), and its share price since then fell from above 70 cents at the start of 2008 to less than 10 cents since 2012. As a result, when a severe banking crisis occurs, the ability of the already revenue-strapped government to rescue the banks comes seriously into question. Second, Portuguese banks hold large amounts of Portuguese government securities. In the December 2010 European Banking Authority stress tests, the exposure of Portuguese banks to Portuguese government debt was estimated at 23 percent of their assets. As a result of these features, sovereigns and banks in Europe are joined at the hip: the correlation between credit default swap spreads for sovereigns and banks is close to 1 (Mody and Sandri 2012).

As Maurice Obstfeld (2013) emphasizes, the euro crisis is at its heart a financial crisis. Markus Brunnermeier and coauthors (2011) argue that the sudden panics and run-ups in sovereign bond yields in Portugal and elsewhere were the consequence of a "diabolic loop" between banks and sovereigns. Fears about the solvency of a sovereign put the solvency of banks in that country at risk, since banks typically hold so much of their assets in the

Figure 7: Public Finances in Portugal, 2008-12



sovereign debt of their country. But should the banks fail, the government's net spending will increase, either directly because of the need for a bailout, or indirectly because of the recessionary impact of the banking crisis. Either way the initial fears are confirmed, and the economy may easily fall to a lower equilibrium. Reis (2013) puts forward a simple model of this mechanism.

The left-hand panel of figure 7 plots Portuguese public sector revenue and spending and the stock of public debt from 2008 through 2012; the right-hand panel does the same for the public deficit. In 2011 there was a serious consolidation of public finances, with the first reduction in the ratio of spending to GDP in more than 20 years and a primary deficit close to zero. Yet as GDP fell in 2012, the consequent fall in revenue drove an increase in the deficit, and the debt at the end of 2012 was 123.6 percent of GDP, well above the objective of 111.8 percent set out in the first review of the memorandum of understanding with the troika. Much ink has been spilled over the dilemma faced by a country in this situation: on the one hand, a country suffering a run on its debt must have a credible plan to lower its public deficit, while on the other hand implementing fiscal austerity prolongs the recession.

Structural reform was also part of the agenda. The memorandum of understanding with the troika listed 223 separate reforms for Portugal to undertake, covering most areas of government intervention. The six reviews of the program so far have agreed that most have been implemented on schedule. To take one striking example, Portugal had the 2nd-highest OECD employment protection index in 2000, the 7th highest by 2009, and with all the implemented reforms, it is forecasted to be in the 13th spot in 2012 (IMF 2013). The crisis has forced reforms that had been necessary but politically infeasible before (Fernandez-

Villaverde, Garicano, and Santos 2013).

Given the large increase in unemployment, one would expect to see a large decline in wages. Yet since the beginning of 2010, average nominal compensation per employee has fallen by less than 2 percent, and unit labor costs by 4 to 6 percent. An example of these nominal wage rigidities is illustrative: on net, one-third of the jobs in the construction sector were destroyed between 2006 and 2012. Yet although approximately 170,000 workers are now without a job, nominal wages in the sector are fixed by collective bargaining and have not fallen a single cent. Schmitt-Grohé and Uribe (2011) show that these rigidities deepen the recession following a sudden stop.

5 Conclusion and policy options

The events in the Portuguese economy since 2000 have been troubling. Like many countries before it, Portugal went through a gradual increase in capital inflows, starting in 1995 and intensifying after 2000. Although initially these capital flows led to a boom, as they had in other countries before, they triggered a slump from 2000 onward. I suggested that this happened because most of the capital inflows funded unproductive firms in the nontradables sector, causing economy-wide productivity to fall and the real exchange rate to rise, and taking resources away from the tradables sector. Meanwhile, generous past promises on old-age pensions led to continuous increases in taxes, which discouraged work and aggravated the slump. As the country quickly became financially integrated with the rest of the euro area, net foreign borrowing rose, leaving it particularly exposed to the financial crisis that came at the end of the decade. After 2010, a sudden stop in capital flows plunged the country into a crash.

What could policy have done about this? Taking as given that Portugal wanted to join the euro and achieve monetary and financial union with the rest of Europe, the account in this paper still suggests a few policy options. First, according to the model, actively fighting the creation of rents in the nontradables sector, as suggested by Bento (2010a), would have improved capital allocation. Enforcing greater competition would have been one way to do so, and a more direct approach might have been to slow down public investment in those sectors.

Second, more prudential financial regulation could have curtailed the sudden increase in foreign borrowing. One possibility would have been to impose and enforce limits on leverage in the financial sector. More generally, the model suggests that if policymakers foresee a

period of rapid financial integration, they should focus their energy on promoting financial deepening in their country.

Third, the absence of fiscal profligacy should not serve to excuse Portugal's management of its public finances. An earlier reform of old-age pensions, other cuts in spending programs, and less distortionary tax increases would have been potentially more effective ways to deal with the pensions problem.

I have emphasized throughout the paper the similarities between the events in Portugal and those occurring contemporaneously in Greece, Ireland, and Spain as well as the similarities with the sudden stops that many other countries have suffered through in the last three decades. The singularity of the Portuguese slump provides some new data that future research might use to improve our understanding of these pervasive phenomena, leading to better policy responses in the future.

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Appendix

A Data Sources

The data for the calculations in this paper come mostly from three sources: the OECD Economic Outlook, the AMECO database of the European Commission (and sometimes Eurostat directly), and the KLEMS project (`www.euklems.net`) by O'Mahony and Timmer (2009). More recent data not in those databases come directly from the Banco de Portugal and the Instituto Nacional de Estatística.

Figure 1: The Portuguese series is real GDP per capita from AMECO, the U.S. series is series GDPA in the FRED database (Federal Reserve Economic Data, from the Federal Reserve Bank of St. Louis) divided by population from the Census Bureau, and the Japanese series is from the World Bank's World Development Indicators.

Table 1: The data on interest rates are series IRL with interest on government bonds, from the OECD; all other series are from AMECO.

Table 2: The value for net foreign assets comes from the updated and extended version of dataset constructed by Lane and Milesi-Ferretti (2007) on the wealth of nations (`www.philiplane.org/EWN.html`), the current account and trade account balances are from the OECD, and the number for trade outside the European Union is from AMECO.

Table 3: The real and nominal exchange rates are calculated by the OECD. The terms of trade with respect to all trading partners are measured by Eurostat in AMECO; for the terms of trade of the euro area and the main trading partners, I use the relative price deflators of the manufacturing sector to proxy for tradables. The value-added measure for all industries and all trading partners is from Robert Johnson (`https://sites.google.com/site/robjohnson41/research`); for the euro area and the main trading partners, I use the price deflators in KLEMS for Portugal, the euro area, and Spain, Germany, and France.

Table 4: The source is KLEMS. The five main-industry codes are manufacturing (D), construction (F), real estate, renting, and business activities (K), community, social, and personal services (LtQ), and wholesale and retail trade (G).

Table 5: Total factor productivity corresponds to the TFP measures in KLEMS. For markups I again use KLEMS to calculate the log of the ratio between VA (value added) and LAB (labor compensation).

Table 6: The debt figures come from the OECD. The numbers for taxes come from the annex to the European Commission report on taxation trends in the European Union (`ec.`

europa.eu/taxation_customs/taxation/gen_info/economic_analysis/tax_structures/index_en.htm). The numbers for the categories of spending come from Eurostat via Oh and Reis (2012). The old-age pension statistics come form the OECD and Eurostat.

Figure 4: All data are from the irs.m series of the European Central Bank statistical warehouse on long-term interest rates for convergence purposes.

Figure 6: All series come from the Banco de Portugal website. I start from the net international investment position reported for December 2007. The series for net foreign assets is this quarterly series over time, the cumulative current account starts from that value and accumulates the balance in the current account. The breakdown into the three sectors is from the financial account.

Figure 7: All series are from AMECO and Eurostat, in its statistics for government finances.

Finally, the more recent numbers for the Portuguese economy reported in section 4 all come from the website of the Instituto Nacional de Estatística.

B More Details on the Model

There are three types of agents: entrepreneurs, banks, and households. I discuss each in turn, using lowercase letters to denote individual choices by entrepreneurs, capital letters to denote their aggregate, and capital letters with a hat (such as $\hat{C}$) to denote the choices of the representative household.

B.1 The Entrepreneurs' Problem

A continuum of entrepreneurs, with density $G(a)$, at date t choose $\{c_t, n_t, k_t, d_{t+1}, b_{t+1}\}$ in order to solve the following problem (see section 2.1 for variable definitions):

$$\max \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \ln(c_t)\right] \text{ subject to:} \tag{1}$$

$$p_t c_t + k_t + \frac{d_{t+1}}{r_t} - \frac{b_{t+1}}{r_t^b} = p_t^N a_{t-1} k_{t-1}^{\alpha} n_t^{1-\alpha} - w_t n_t + d_t - b_t, \tag{2}$$

$$b_t \leq \theta \left[p_t^N a_{t-1} k_{t-1}^{\alpha} n_t^{1-\alpha} - w_t n_t\right], \tag{3}$$

$$d_{t+1} \geq 0, \;\; b_{t+1} \geq 0, \;\; k_t \geq 0. \tag{4}$$

The choice of n_t has no intertemporal dimension, so we can find the optimum directly by

maximizing revenue net of labor costs. This gives

$$p_t^N a_{t-1} k_{t-1}^{\alpha} n_t^{1-\alpha} - w_t n_t = x_{t-1} k_{t-1} \tag{5}$$

$$\text{where: } x_{t-1} = \alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}} \left(\frac{p_t^N a_{t-1}}{w_t^{1-\alpha}} \right)^{\frac{1}{\alpha}} \tag{6}$$

while the demand for labor is

$$n_t = \left[\frac{(1-\alpha) p_t^N a_{t-1}}{w_t} \right]^{1/\alpha} k_{t-1}. \tag{7}$$

The entrepreneur then has three investment options available at date t: capital with return x_t, lending with return r_t, and borrowing with return r_t^b. I will later verify that $r_t \geq r_t^b$ in equilibrium. Moreover, if x_t is higher than r_t^b, clearly the collateral constraint will bind, so that investing in the firm gives a leveraged return. Therefore, the choice is whether to save in the bank, earning return r_t, or use the production technology, earning a leveraged multiple of the marginal product x_t. The return therefore is

$$R_{t,t+1}(a_t) = \max \left\{ r_t, \frac{(1-\theta)x_t}{1 - \frac{\theta x_t}{r_t^b}} \right\}, \tag{8}$$

which is larger than x_t as long as $\theta > 0$ and $r_t^b > 0$, that is, as long as the entrepreneur can profitably leverage her investment. This return on investing in capital at t for producing at $t+1$ is a function of the individual a_t and the aggregate p_{t+1}^N and w_{t+1}, all via the definition of x_t in equation 6. I use the notation $R_{t,t+1}(a_t)$ to capture this dependence.

The net worth of the entrepreneur is the right-hand side of the budget constraint in equation 2: $z_t = x_{t-1} k_{t-1} + d_t - b_t$. If $R_{t,t+1}(a_t) = r_t$, then $k_t = b_{t-1} = 0$, and $z_t = d_t$, so the entrepreneur invests all his funds in the financial market. Otherwise, if $R_{t,t+1}(a_t) > r_t$, then $d_t = 0$, and the collateral constraint binds, so $b_{t+1} = \theta x_t k_t > 0$, and investment is constrained by net worth: $x_t k_t = z_{t+1}/(1-\theta)$. The threshold a_t^*, such that entrepreneurs with productivity higher than a_t^* produce, while those below a_t^* are inactive and save in the bank, is then the solution to the following equation:

$$R_{t,t+1}(a_t^*) = r_t. \tag{9}$$

Combining these results, the consumption problem of the entrepreneur then becomes

$$\max \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t \ln(c_t)\right] \text{ subject to:} \tag{10}$$

$$z_{t+1} = R_{t,t+1}(a_t)(z_t - p_t c_t) \text{ and } z_t \geq 0. \tag{11}$$

This is a standard problem with solution:

$$p_t c_t = (1-\beta) z_t \tag{12}$$

$$z_{t+1} = R_{t,t+1}(a_t)\beta z_t. \tag{13}$$

B.2 The Banks' Problem

A representative bank at date t chooses $B_{t+1}, F_{t+1}, D_{t+1}$ to solve the problem

$$\max B_{t+1} - F_{t+1} - D_{t+1} \text{ subject to:} \tag{14}$$

$$\frac{D_{t+1}}{r_t} + \frac{F_{t+1}}{r^f} = \frac{B_{t+1}}{r_t^b}, \tag{15}$$

$$F_{t+1} \leq \phi B_{t+1}, \tag{16}$$

$$D_{t+1} \geq 0 \;\; B_{t+1} \geq 0 \;\; F_{t+1} \geq 0. \tag{17}$$

I will throughout consider equilibria where $r^f < r_t$ if $\phi > 0$, in which case the foreign financing constraint holds with equality: $F_{t+1} = \phi B_{t+1}$. Moreover, in equilibrium banks earn zero profits, so $B_{t+1} = F_{t+1} + D_{t+1}$. The remaining optimality condition for the entrepreneurs implies that

$$\frac{1}{r_t^b} = \frac{\phi}{r^f} + \frac{1-\phi}{r_t}. \tag{18}$$

It then follows that $r_t \geq r_t^b$, as I imposed on the entrepreneurs' problem.

I can then revise the expression for the effective return on entrepreneurs by substituting out r_t^b:

$$R_{t,t+1}(a_t) = \max\left\{r_t, \frac{(1-\theta)x_t}{1 - \frac{\theta\phi x_t}{r^f} - \frac{\theta(1-\phi)x_t}{r_t}}\right\} \tag{19}$$

Using this definition and the equilibrium equation (equation 9) gives the firm-selection curve discussed in the text.

B.3 Market Clearing for Loans

The other optimality condition for banks implies that

$$(1-\phi)B_{t+1} = D_{t+1}. \tag{20}$$

This is a market-clearing condition, requiring that the domestically financed loans made to active entrepreneurs equal the deposits collected from inactive entrepreneurs. Returning to the behavior of active entrepreneurs,

$$\begin{aligned} B_{t+1} &= \int_{a_t^*}^{\bar{a}} b_{t+1} dG(a_t) = \int_{a_t^*}^{\bar{a}} \frac{\theta z_{t+1}}{1-\theta} dG(a_t) \\ &= \int_{a_t^*}^{\bar{a}} \frac{\theta\beta R_{t,t+1}(a_t) z_t}{1-\theta} dG(a_t) = \frac{\theta\beta Z_t}{1-\theta} \int_{a_t^*}^{\bar{a}} R_{t,t+1}(a_t) dG(a_t). \end{aligned} \tag{21}$$

Here the first equality is the definition of aggregate loans, the second uses the binding collateral constraint and the definition of net worth, the third is the law of motion for net worth, and the fourth uses the fact that with i.i.d. productivity returns, the entrepreneur's past net worth z_t and his new return $R_{t,t+1}(a_t)$ are orthogonal. Z_t is the aggregate net worth across all entrepreneurs.

As for inactive entrepreneurs, by similar steps,

$$D_{t+1} = \int_0^{a_t^*} d_{t+1} dG(a_t) = \int_0^{a_t^*} z_{t+1} dG(a_t) = \int_0^{a_t^*} \beta r_t z_t dG(a_t) = \beta r_t Z_t G(a_t^*) \tag{22}$$

The market-clearing condition then becomes

$$\frac{(1-\theta) r_t}{\theta(1-\phi)} = \frac{\int_{a_t^*}^{\bar{a}} R_{t,t+1}(a_t) dG(a_t)}{G(a_t^*)}. \tag{23}$$

This is the market-clearing condition in the text.

Finally, the law of motion for the aggregate net worth of entrepreneurs is

$$\begin{aligned} Z_{t+1} &= \int_0^{\bar{a}} z_{t+1} dG(a_t) = \beta \int_0^{\bar{a}} R_{t,t+1}(a_t) z_t dG(a_t) \\ &= \beta Z_t \left[r_t G(a_t^*) + \int_{a_t^*}^{\bar{a}} R_{t,t+1}(a_t) dG(a_t) \right] = \left[\frac{\beta(1-\theta\phi)}{\theta(1-\phi)} \right] G(a_t^*) r_t Z_t. \end{aligned} \tag{24}$$

The first equality comes from the definition of aggregates, the second from the evolution of

individual net worth in equation 13, the third uses the independence of z_t and $R_{t,t+1}(a_t)$ as well as the definition in equation 19, and the fourth uses the market-clearing relationship in equation 23.

B.4 Households

A representative household solves

$$\max \sum_{t=0}^{\infty} \beta^t \ln\left(\hat{C}_t - \frac{\hat{L}_t^{1+\psi}}{1+\psi}\right) \text{ subject to:} \tag{25}$$

$$p_t\hat{C}_t + \hat{K}_t - \frac{\hat{F}_{t+1}}{r^f} = A\hat{K}_{t-1}^{\alpha}\hat{N}_t^{1-\alpha} - w_t\hat{N}_t - \hat{F}_t + (1-\tau)w_t\hat{L}_t + T_t, \tag{26}$$

$$\hat{F}_t \leq A\hat{K}_{t-1}^{\alpha}\hat{N}_t^{1-\alpha} - w_t\hat{N}_t. \tag{27}$$

The solution is standard. Starting with the production problem, labor demand is

$$\hat{N}_t = \left[\frac{(1-\alpha)A}{w_t}\right]^{1/\alpha} \hat{K}_{t-1}. \tag{28}$$

The collateral constraint does not distort production decisions, so the agent must earn zero profits in production; otherwise she would expand or shrink production without bounds.

The zero-profit condition is

$$r^f = \alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}} \left(\frac{A}{w_{t+1}^{1-\alpha}}\right)^{\frac{1}{\alpha}} \tag{29}$$

Note that this equation pins down the pre-tax wage as a function solely of the foreign interest rate.

Turning to the labor supply problem, the optimality condition is

$$\hat{L}_t = \left[\frac{w_t(1-\tau)}{p_t}\right]^{\frac{1}{\psi}} \tag{30}$$

Finally, for the optimal choice of consumption, because I assume that $\beta < 1/r^f$, I know that eventually the borrowing constraint will hold. Since I start from a steady state, this is true then and after, so that foreign borrowing sustains all of the capital in the tradables sector,

and consumption is equal to labor and transfer income:

$$\hat{C}_t = \frac{(1-\tau)w_t\hat{L}_t + T_t}{p_t} = \frac{w_t\hat{L}_t}{p_t}. \tag{31}$$

Here the second equality uses the government budget constraint, $\tau w_t \hat{L}_t = T_t$.

B.5 Consumption of Nontradables

Both households and entrepreneurs share the same Cobb-Douglas aggregator over the two goods with weight γ on the nontradable good. Optimal allocation of their budget comes with the following two conditions:

$$p_t^N \bar{C}_t^N = \gamma p_t \bar{C}_t \tag{32}$$

$$p_t = \gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)} p_t^{N\gamma} \tag{33}$$

where I introduce new notation for aggregate consumption, $\bar{C}_t = \hat{C}_t + \int c_t dG(a_t)$, and likewise for $\bar{C}_t^N$.

Focusing on the first of these equations, first note that for the market to clear, the amount consumed of nontradables must equal the amount produced by the entrepreneurs: $\bar{C}_t^N = Y_t^N$. In turn, because the production function is Cobb-Douglas, we know that for every active entrepreneur, $w_t n_t = (1-\alpha)p_t^N y_t^n$. Aggregating this across all entrepreneurs we get that

$$p_t^N \bar{C}_t^N = \frac{w_t N_t}{1-\alpha} = \gamma p_t \bar{C}_t = \gamma \left(w_t L_t + (1-\beta)Z_t\right). \tag{34}$$

Here the last equality uses the optimal consumption choices by entrepreneurs in equation 12 and likewise for households in equation 31.

Next I focus on the amount of labor used by entrepreneurs,

$$\begin{aligned} N_t &= \int_{a_t^*}^{\bar{a}} n_t dG(a_{t-1}) = \left[\frac{(1-\alpha)p_t^N}{w_t}\right]^{1/\alpha} \int_{a_{t-1}^*}^{\bar{a}} a_{t-1}^{1/\alpha} k_{t-1} dG(a_{t-1}) \\ &= \left[\frac{(1-\alpha)p_t^N}{w_t}\right]^{1/\alpha} \left(\frac{\beta Z_{t-1}}{1-\theta}\right) \int_{a_{t-1}^*}^{\bar{a}} \frac{a_{t-1}^{1/\alpha} R_{t-1,t}(a_{t-1})}{x_{t-1}} dG(a_{t-1}) \\ &= \left[\frac{\beta(1-\alpha)}{\alpha(1-\theta)}\right] \left(\frac{Z_{t-1}}{w_t}\right) \int_{a_{t-1}^*}^{\bar{a}} R_{t-1,t}(a_{t-1}) dG(a_{t-1}) \\ &= \left[\frac{1-\alpha}{\alpha(1-\theta\phi)}\right] \left(\frac{Z_t}{w_t}\right). \end{aligned} \tag{35}$$

The first equality uses the definition of the aggregate, the second uses the labor demand in equation 7, the third uses the binding collateral constraint for capital, the fourth uses the definition of x_t in equation 6, and the last equation uses the equilibrium conditions in equations 23 and 24.

Using this expression to replace for N_t, I then obtain the final condition:

$$\left[\frac{1}{\gamma\alpha(1-\theta\phi)} + \beta - 1\right] Z_t = w_t L_t. \tag{36}$$

B.6 A Reduced-Form Equilibrium

Recall that from equation 29, the equilibrium wage w_{t+1} is entirely pinned down by the exogenous foreign interest rate r^f. Starting with a given net worth of the entrepreneurs Z_t and an exogenous wage w_{t+1}, a reduced-form equilibrium is a collection of $\{L_{t+1}, a_t^*, r_t, p_{t+1}^N, Z_{t+1}\}$ that solve the following equations:

$$L_{t+1} = \left(\frac{w_{t+1}(1-\tau)}{\gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)} p_{t+1}^{N\gamma}}\right)^{\frac{1}{\psi}}, \tag{37}$$

$$\left[\frac{1}{\gamma\alpha(1-\theta\phi)} + \beta - 1\right] Z_{t+1} = w_{t+1} L_{t+1}, \tag{38}$$

$$Z_{t+1} = \left[\frac{\beta(1-\theta\phi)}{\theta(1-\phi)}\right] G(a_t^*) r_t Z_t, \tag{39}$$

$$R_{t,t+1}(a_t^*) = r_t, \tag{40}$$

$$\frac{(1-\theta)r_t}{\theta(1-\phi)} = \frac{\int_{a_t^*}^{\bar{a}} R_{t,t+1}(a_t) dG(a_t)}{G(a_t^*)}. \tag{41}$$

where R is defined as in equations 19 and 6.

Solving this system is relatively easy because of its particular structure. Start with finding a steady state. For a guess at the value of a^*, equation 39 gives r, equation 40 (with equations 6 and 19) gives p^N, and equation 41 verifies the guess. Equations 37 and 38 then give L and Z, respectively. The only difficulty is in solving the integral. But because this is an integral of the form $\int a^{1/\alpha}/(1-\xi a^{1/\alpha})dG(a)$, then for a uniform distribution for a, its solution is known and equal to a hypergeometric function. If instead $a^{1/\alpha}$ is uniform, then the integral is equal to a log function.

To instead find a dynamic perfect-foresight path, note that the first three equations can be used to eliminate Z_{t+1} and L_{t+1}, leaving three equations in three variables $\{a_t^*, r_t, p_t^N\}$. Equation 40 can be further used to eliminate r_t from the system, leaving two messy equations in $\{a_t^*, p_t^N\}$. Guessing a value for a_t^*, backing out the implied p_t^N, and then checking equation 41 gives a quick algorithm. It takes a few seconds to solve.

B.7 Other Variables of Interest

Once the reduced-form equilibrium has been derived, one can obtain other variables of interest. I list here only the main ones, all using results from earlier in the paper:

$$N_t = \left[\frac{1-\alpha}{\alpha(1-\theta\phi)}\right]\left(\frac{Z_t}{w_t}\right) \tag{42}$$

$$Y_t^N = (1-\alpha)w_t N_t / p_t^N \tag{43}$$

$$K_t = \left(\frac{\beta Z_t}{1-\theta}\right)\int_{a_t^*}^{\bar{a}} \frac{R_{t,t+1}(a_t)}{x_t} dG(a_t) \tag{44}$$

$$F_t = \left(\frac{\theta\phi}{1-\phi}\right) Z_t \tag{45}$$

$$\hat{N}_t = L_t - N_t \tag{46}$$

$$\hat{Y}_t = (1-\alpha)w_t \hat{N}_t \tag{47}$$

$$\hat{F}_t = \alpha \hat{Y}_t \tag{48}$$

$$\hat{K}_{t-1} = \hat{F}_t / r^* \tag{49}$$

$$C_t = \frac{w_t \hat{L}_t + (1-\beta)Z_t}{p_t} \tag{50}$$

In the figures I plot aggregate output and TFP, defined, respectively, as

$$Y_t = \hat{Y}_t + p_t^N Y_t^N \tag{51}$$

$$TFP_t = (a_t^* + \bar{a})/2 \tag{52}$$