Sudden Stops, Productivity, and the Exchange Rate*

Laura Castillo-Martinez
Duke University

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Abstract

Following a sudden stop, real exchange rates can adjust through a nominal exchange rate depreciation, lower domestic prices, or a combination of both. This paper makes three contributions to understand how the type of adjustment shapes the response of macroeconomic variables, in particular productivity, to such an episode. First, using Spanish micro data during two episodes, it documents that in a currency union unproductive firms exit more than in a floating regime. Second, it proposes a small open economy DSGE model featuring firm selection, variable markups and elastic labor supply to rationalize this finding. The model nests three mechanisms through which a sudden stop affects productivity: a pro-competitive, a cost, and a demand channel. While only the former operates when the nominal exchange rate adjusts, all three are active under a currency union. The model delivers general conditions under which the positive impact of the demand channel on productivity dominates. Third, it validates the model's aggregate predictions against a wider set of economies. In particular, it shows that the decline in productivity after a sudden stop is increasing in the flexibility of the exchange rate.

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1 Introduction

The benefits of flexible exchange rates during a balance of payment crisis have been widely discussed among generations of international macroeconomists. The arguments, however, mostly rely on an aggregate view of the economy. This contrasts with an increasing use of granular data and a stark emphasis on heterogeneity in theoretical frameworks across fields. Zooming into the micro-level response to exchange rate policy remains a pending assignment for this literature. This paper contributes towards closing the gap by pursuing an unexplored dimension of exchange rate policy: its effects on firm dynamics.

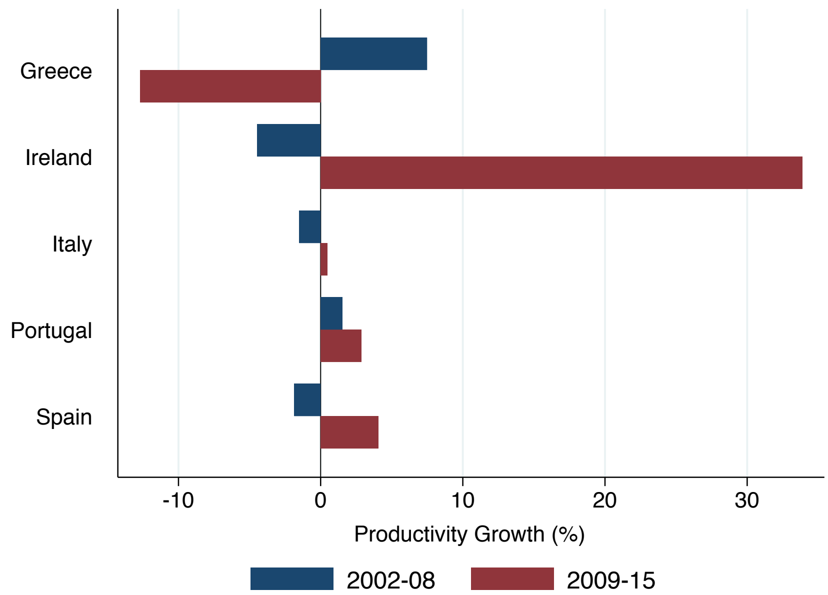
The recent European sovereign debt crisis makes for an excellent stage to rekindle this debate. As Greece admitted to have misreported the figures of its public debt in late 2009, the periphery of Europe experienced an unexpected reversal in capital flows. This phenomenon, often referred to as a sudden stop, had not yet been studied in the context of a currency union. In addition, sudden stops have been traditionally associated with declines in aggregate total factor productivity (TFP). However, with the exception of Greece, the periphery of Europe experienced a productivity improvement as shown in Figure 1. It is well known that measuring TFP is particularly challenging in the aggregate and is often subject to compositional bias. Thus, in looking for explanations to this puzzling observation, firm-level heterogeneity emerges as a key element to consider when addressing the following questions: what is the relationship between sudden stops, productivity and the exchange rate regime? How does accounting for firm dynamics complement our understanding of fixed versus floating regimes?

This paper studies how the type of real exchange rate realignment shapes the response of macroeconomic variables to a sudden stop in the presence of firm heterogeneity. Using Spanish microdata during two balance of payment crises, it is the first paper to document differences in firm entry and exit across exchange rate regimes. An internal devaluation, as opposed to a nominal depreciation, is associated with greater exit of unproductive firms, contributing to TFP growth through a so-called cleansing effect. The paper rationalizes these patterns by incorporating firm dynamics to an otherwise standard small open economy model. The novel link between consumer labor income and firm profitability is crucial in explaining why firm exit is larger when wages fall. The model's predictions apply to a wider set of countries as shown by the event study discussed at the end of the paper. This exercises looks at aggregate data by binning sudden stop episodes by the prevalent exchange rate regime.

Section 2 starts by inspecting micro evidence from the Spanish manufacturing sector. More specifically, I exploit survey firm-level data during the 2010-13 European sovereign debt crisis and contrast it to an earlier sudden stop that hit Spain in 1992-93: the Exchange Rate Mechanism crisis. Parallels in the onset but divergence in the observed cyclicality of productivity make for a relevant comparison.

The joint analysis of these episodes uncovers the following empirical patterns. First, changes

FIGURE 1: PRODUCTIVITY GROWTH IN PERIPHERAL EUROPE 2002-2015



Notes: This graph plots the overall change in aggregate TFP for Greece, Ireland, Italy, Portugal and Spain for the 2002-08 and the 2009-15 periods. The latter coincides with the European sovereign debt crisis and is the period of interest, while the former is depicted for comparison. The data used is collected from the AMECO database.

in productivity are concentrated on the lower tail of the firm productivity distribution in both cases. Second, while productivity declines at the firm-level during both crises, the exit of unproductive firms contributes substantially more to positive TFP growth in the 2010-13 sudden stop. Third, a formal test for cleansing shows that the negative (positive) correlation between firm-level productivity and propensity to exit (factor growth) is strengthened in 2010-13 but not during the 1992-93 sudden stop. Fourth, there is evidence that firms charge price markups which are firm-specific and time-varying. The data shows these tend to be higher among more productive firms and lower in times of higher aggregate productivity, suggesting there is a link between changes in competition and aggregate productivity.

Arguments based on disparities in the size of the construction bust, the uneven disruption of credit and opposing trends in the misallocation of (solely) capital empirically fail to fully explain these findings. There is, however, an obvious difference across episodes that cannot be ruled out: the response of exchange rate policy. While during the earlier sudden stop, the national currency, the *peseta*, depreciated on multiple occasions; during the latter, Spain was a member of a currency union and could only regain competitiveness by lowering wages. The rest of the paper is devoted to exploring this distinctness.

Based on the previous evidence, section 3 develops a small open economy model with a micro-structure that builds on Melitz and Ottaviano (2008) to study the macroeconomic effects of a sudden stop.[1] The use of quasi-linear quadratic preferences and firm heterogeneity in productivity generates firm selection into production and endogenous variable markups, as observed in the data. I extend this framework to include leisure in the utility function, thereby explicitly modeling the consumer's labor supply decision. This means wages are allowed to respond to shocks, which is absent in the original framework but essential in studying internal devaluations. Moreover, this provides a new channel through which the wage level and individual firm profits interact.

To allow a role for policy, I introduce nominal rigidities in the wage-setting process. The central bank chooses the nominal exchange rate as its main policy tool. I focus on two extreme regimes: a currency union, characterized by a credible commitment to keep the nominal exchange rate constant; and a strict wage inflation targeting regime, where the flexible wage equilibrium is always implemented. A sudden stop is defined as a two-fold shock to the domestic economy. On the one hand, it involves an increase in the risk premium component of the interest rate that consumers pay when borrowing. By increasing the cost of borrowing abroad, the domestic economy is forced to deleverage internationally and increase net exports through a real exchange rate depreciation. On the other hand, it simultaneously features a decline the productivity level of all firms, which leads to a contraction of domestic output despite the reversal in the current account.

Section 4 discusses the effects of a sudden stop shock on aggregate productivity as predicted by the model. The key insight is that aggregate productivity is proportional to a domestic productivity threshold. The threshold represents the minimum productivity level at which a firm can generate positive profits and, thus, select into the domestic market. It therefore suffices to understand how the threshold moves after a sudden stop to learn about its effect on aggregate productivity.

In equilibrium, the domestic threshold is determined by the number of active firms in the market and the wage level. Therefore, there are three endogenous mechanisms through which a shock can affect productivity. First, the threshold increases with the number of active firms, as greater competition lowers profit margins for all firms and, thus, requires a higher level of productivity to remain profitable. This is the pro-competitive channel. Second, higher wages increase the costs of production for all firms, lowering again their profit margin and calling for a higher productivity level. This is the cost channel. Third, higher wages also increase the demand for overall consumption by increasing households' labor income. This, instead, increases the firm profit margin and relaxes the productivity requirement. This is the demand channel.

The effect of a sudden stop on the domestic productivity threshold will hinge on the relative strength of these conflicting forces. This, in turn, depends on how the real exchange rate adjusts.

[1] A sudden stop is essentially a real exchange rate shock. To some extent, it is isomorphic to a specific trade policy mix: a simultaneous increase in export subsidies and import tariffs. I, thus, build on the New New Trade Theory, which has long studied the effects of trade liberalization on aggregate productivity through firm selection, to understand the impact of a sudden stop.

More precisely, on whether it takes place through the depreciation of nominal exchange rates or a lower wage level. For a simplified version of the model that can be solved analytically, I show that if the nominal exchange rate bears the full brunt of the adjustment, then only the pro-competitive channel is active, as fewer firms import and productivity falls unambiguously. In contrast, when the nominal exchange rate is fixed, the wage adjusts completely and all three channels operate, resulting in a quantitatively ambiguous overall effect. The simplified model delivers conditions under which the demand channel dominates, allowing a sudden stop to generate a productivity improvement in a currency union.

The rest of section 4 studies the properties of the full model through a numerical simulation exercise. I calibrate parameters using Spanish macroeconomic data as well as the firm-level evidence presented in section 2. Plotting the impulse response function of aggregate TFP confirms that the previous analytical results hold more generally: productivity falls under a floating arrangement and increases in a currency union following a sudden stop. This is not only robust to alternative parameterizations of the model, but also to a range of extensions that includes featuring capital as the second factor of production, allowing for imported intermediate inputs and considering a long-run version of the model, all of which are presented in section 5.

The model is able to match the observed differences in the contribution of firm dynamics to overall productivity growth portrayed in section 2. The procyclicality of productivity at the firm-level (the intensive margin) impels the aggregate TFP decline in the first case, whereas a sizable cleansing effect (the extensive margin) is the main driver of the efficiency improvement in the second. In addition, the model generates the other stylized facts previously documented by the literature: a contraction in output, a reversal in the current account and a real exchange rate depreciation.

Section 6 explores the external validity of the paper by providing systematic evidence on the behavior of macroeconomic variables during a sudden stop for a wider set of economies during the 1990-2015 period. Using a standard criterion to identify sudden stops that captures both the episodes discussed previously in the literature as well as the recent Southern-European cases, I first confirm the established fact that TFP falls on average. Next, I show that when binning episodes by prevalent exchange rate regime, a new pattern emerges: the decline in productivity increases in the flexibility of the exchange rate as captured by the model. This is robust to alternative exchange rate classifications, detrending methods and controlling for crisis and country characteristics.

In comparing the response of other macroeconomic variables across regimes two more regularities provide additional empirical support for the working of the model. First, in a currency union there is a larger decline in employment in both absolute and relative to output terms. Second, there is also a greater decline in imports relative to the increase in exports, suggesting the increase in aggregate TFP comes at the expense of a greater domestic contraction.

Relation to the literature This paper contributes to several strands of the literature at the intersection of international finance, trade theory and firm dynamics.

First, it focuses on sudden stops, as defined by Calvo (1998), abrupt and unexpected reversals in foreign capital inflows. It follows the empirical research that documents regularities among historical sudden stop episodes including Calvo, Izquierdo and Mejía (2004), Guidotti et al. (2004), Calvo and Talvi (2005) and Kehoe and Ruhl (2009) and adds to the discussion by revisiting the established stylized facts when episodes are binned by the flexibility of the nominal exchange rate. I document the fall in productivity is increasing in the relative size of the nominal adjustment.

On the theoretical side, several articles propose amendments to the standard open economy neoclassical model in order to reconcile theoretical predictions with the observed behavior of macroeconomic variables. For example Meza and Quintin (2007) allow for endogenous factor utilization, Christiano, Gust and Roldos (2004), Neumeyer and Perri (2005) and Mendoza (2006) introduce advanced payments of inputs and Ates and Saffie (2016) incorporate endogenous technical change. My formalization of a sudden stop is somewhat close to Mendoza (2010), which features both a risk premium and productivity shock, although I abstract from financial frictions and generate amplification through selection into production.[2]

The second strand of the literature to which this paper closely relates is trade models of heterogeneous firms à la Melitz (2003).[3] My framework builds on Melitz and Ottaviano (2008) in featuring endogenous markups but departs along three dimensions. First, I explicitly model a labor supply choice, incorporating a new channel that affects firm entry decisions. Second, I allow for transition dynamics by embedding the steady-state version in a DSGE setting.[4] Third, I introduce nominal rigidities and, thus, discuss the effects of monetary policy. [5]

Finally, this paper is connected to the literature that studies the contribution of reallocation to TFP growth. In particular, I provide empirical support for Caballero and Hammour (1994)'s cleansing hypothesis and discuss the conditions under which its magnitude is likely to be relevant in the context of a current account shock.[6] Moreover, this work adds to the recent set of papers that link declining TFP and enhanced misallocation with capital inflows; see Reis (2013), Benigno and Fornaro (2014) and Gopinath et al. (2017) among others. While their focus is on an

[2] Ates and Saffie (2016) and Monacelli, Sala and Siena (2018) also account for firm dynamics in the study of the productivity costs of capital flows. The focus of the former is on the long run effects of entry distortions generated by an interest rate shock and how financial selection cushions the fall in endogenous productivity. The latter studies the interaction of real exchange rate movements and funding costs in encouraging the entry of unproductive firms following an interest rate shock in emerging markets.

[3] For a review of the literature, refer to Melitz and Redding (2014).

[4] Ghironi and Melitz (2005) are the first to consider firm dynamics in an open economy setting. To gain tractability, however, they assume that all firms that enter the market generate positive profits and, thus, firm exit is exogenous.

[5] Bilbiie, Ghironi and Melitz (2008) and Bilbiie, Fujiwara and Ghironi (2014) introduce price adjustment costs in a DSGE model with endogenous entry and product variety to study optimal monetary policy. They consider, however, a closed economy.

[6] The cleansing hypothesis is an interpretation of Schumpeter (1939)'s creative destruction argument that emphasizes the role of reallocation among new and incumbent firms at a business cycle frequency.

earlier period, I show that the negative relationship between productivity and flows holds when capital retrenches and propose a complementary explanation for changes in measured misallocation: variable markups.

2 Spain: A Tale of Two Sudden Stops

In unraveling what might be behind the aggregate patterns summarized by Figure 1, it is useful to look at more disaggregated data. In exploring the singularity of this episode, it is convenient to set it against a comparable sudden stop that features a TFP decline. I do both by exploiting firm-level data from two sudden stops in Spanish recent economic history: the 1992-93 Exchange Rate Mechanism (ERM) crisis and the 2010-2013 European sovereign debt crisis.

There are clear parallels between the two episodes regarding the onset. Both were preceded by periods of increasing capital inflows, declining international competitiveness and widening current account deficits. Economic growth was fueled by the construction sector, with steep increases in property prices and crawling private debt. Public finances, on the other hand, were in a similar good shape.

Foreign capital inflows abruptly reverted following a confidence crisis affecting the European integration project: the negative outcome of the Danish referendum on the Maastricht Treaty in the first case, and the Greek announcement of substantial upward revisions in the government budget deficit more recently. The flight of international investment led to an urgent correction of misaligned real exchange rates in order to expand net exports. As growth stalled and unemployment rose, austerity measures were put in place in order to curb the rising public deficits generated by automatic stabilizers. In addition, structural reforms aimed at increasing the flexibility of the labor market were passed during both episodes.[7,8]

The response of exchange rate policy to these events, however, diverged significantly. While the *peseta* was devalued in three occasions during the 1992-93 crisis, Spain already shared a common currency with its largest trading partners since 2002 and underwent a process of internal devaluation.[9] I take these episodes as representative of sudden stops under floating arrangements and currency unions, respectively, and use firm-level data to explore what is driving the observed

[7]There are two stark differences regarding these two sudden stops. First is the magnitude of the shock: Spain's current account surplus as a share of GDP moved from -3.5% to -1.2% between 1991 and 1994 versus -4.3% to 1.0% between 2009 and 2014. However, the duration was longer in the second episode, such that, per year, the reduction was around 1.1% during both episodes. Second, the latter is an example of a twin crisis, defined as a simultaneous crisis in banking and currency, while the former is not. I partially address this concern by looking at the level of leverage of firms at the end of the section.

[8]For a more detailed discussion on the comparability of these two sudden stops see Online Appendix A.1.

[9]In 1992, the *peseta* was first devalued by 5% on September 17th, known as Black Wednesday, when the pound and the lira abandoned the ERM altogether. A further 6% was devalued on November 23$^{\text{rd}}$, with a third devaluation taking place in May 1993.

aggregate TFP pattern.[10,11]

2.1 Data

I use firm-level data from the Survey on Business Strategies (Encuesta sobre Estrategias Empresariales, ESEE, in Spanish) managed by the SEPI Foundation, a public entity linked to the Spanish Ministry of Finance and Public Administrations. The ESEE surveys all manufacturing firms operating in Spain with more than 200 workers and a sample of firms between 10 and 200 workers, providing a rich panel dataset with over 1,800 firms for the period 1990-2014. It covers around 20 percent of output in Spanish manufacturing and provides information on each firm's balance sheet together with its profit and loss statement.

The main advantage of ESEE, especially over the ORBIS dataset compiled by Bureau van Dijk Electronic Publishing (BvD), is that it closely captures the extensive margin of production.[12] This is particularly true for the exit of firms as the dataset clearly differentiates between firms that decide not to collaborate in a given year, firms that exit the market and firms that are affected by a split-up, a merger or an acquisition process. In addition, firms that resume production or collaboration with the survey are re-included in the sample and properly recorded. As for entry, new firms are incorporated every year in order to minimize the deterioration of the initial sample. These include all entrants with more than 200 workers and a random selection representing 5% of those with 10 to 200 workers.[13]

There are other advantages of the ESEE dataset that are also worth highlighting. It is the only dataset with reliable financial information going back as early as the beginning of the 1990s, allowing me to study the 1992-93 episode. It also provides firm-level records of the value of exports which is most often subject to stringent confidentiality rules in Spain. Finally, the ESEE dataset is intended for research purposes, with effort devoted to ensure consistency and accuracy during the data collection process. At the same time, there are a number of caveats regarding the representativeness of the ESEE data that need to be addressed. I discuss concerns on size distribution,

[10]It can be argued that Spain does not strictly classify as a floating exchange rate regime in 1992-93 as it remains a member of the ERM, a multilateral party grid of exchange rates established in 1979. However, the repeated realignments of its central rate against the *deutsche mark* and the substantial widening of the exchange rate fluctuation bands meant that the overall devaluation of its currency was even larger than that of floating currencies such as the pound. In order words, despite the formal membership of the ERM, the exchange rate effectively behaved as flexible.

[11]Figure A.1 revisits the evolution of aggregate TFP in Spain using all popular sources available. While depending on the source one might conclude that since 2009 TFP clearly increased, remained flat or declined slightly in absolute terms, TFP performance improved by all metrics when compared to its previous trend. As this paper focuses on business cycle fluctuations as opposed to long-term trends, the latter is the relevant measure to consider.

[12]The other existing firm-level dataset, as used in García-Santana et al. (2020), is the Central Balance Sheet Data (Central de Balances Integrada, CBI, in Spanish) owned by the Bank of Spain and only accessible to in-house economists. This alternative dataset, however, is put together using the same source of data that constitutes the Spanish input for ORBIS, annual financial statements that firms are obliged to submit to the Commercial Registry, and, thus, is subjected to the same limitations. Almunia, López-Rodríguez and Moral-Benito (2018) provide extensive details.

[13]Therefore, for the rest of the analysis entrants are defined as firms trespassing the 10 worker threshold for the first time.

coverage and entry measures in Section 2.4. In addition, an analysis on discrepancies with results reported in other papers using alternative micro-data sources can be found in Online Appendix A.3.

Details on the cleaning procedure and the deflating of nominal variables are relegated to Online Appendix A.2. I estimate industry output elasticities for capital and labor using Ackerberg, Caves and Frazer (2015)'s algorithm and then compute firm-level productivity as a Solow residual.[14]

2.2 Results

Aggregate TFP, defined as the employment-weighted average of firm-level TFP, decreased by 10.87% during the 1992-1993 episode while increased by 10.02% in the 2010-2013 period.[15] The granularity of the data allows for a more detailed investigation regarding the drivers of productivity.

The Lower Tail

I first document changes in the distribution of firm-level productivity before and after each of the crises. A visual inspection of the kernel probability distribution estimate of log TFP before and after each of the two sudden stops confirms there is ample heterogeneity in TFP levels among firms in any given year as already highlighted by the literature. More surprisingly, the shape of the distribution is similar and remains unchanged throughout both crisis periods, with no major shifts. In fact, the lower tail concentrates most, if not all, of the action: it lengthens as TFP decreases in the former crisis while shortens as TFP increases in the latter case.

To see this graphically, Figure 2 presents the percentage change in average productivity for each percentile of the productivity distribution during the two sudden stops. On average, the difference in the change in productivity across episodes, the gap between the red and blue lines, is roughly constant across the entire distribution, with the notable exception of the 5% percentile where TFP decreases by 44% during 1991-1993 while increases by 8% during 2009-2013. Although the error bands are admittedly wide in both cases, the difference relative to other percentiles is large enough to remain relevant - the gap is three times the average.

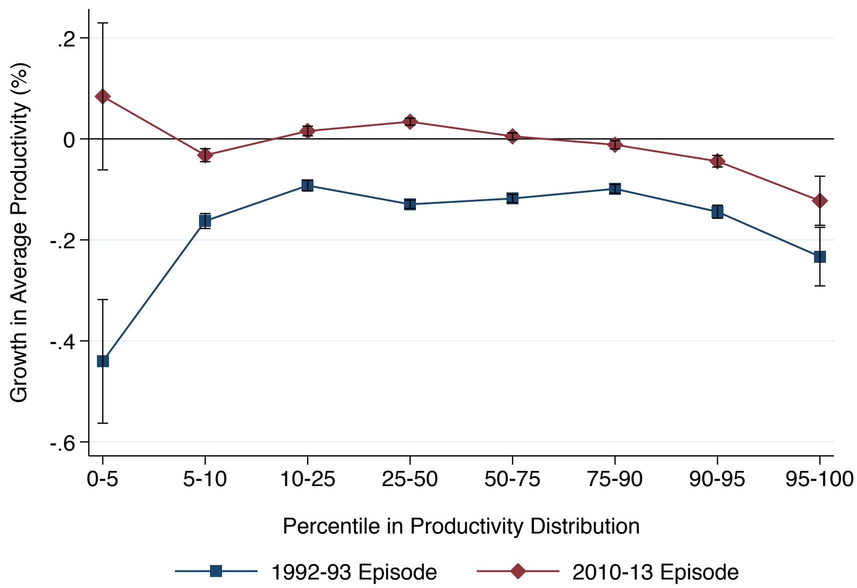
Estimated moments of the distribution support the predominant role of the lower tail with higher-order moments experiencing the largest swings.[16] During the 1992-93 crisis firms display

[14]See Online Appendix A.4 for a more detailed review of production function estimation techniques.

[15]I consider employment, as opposed to value added, weights when aggregating TFP for two reasons. First, I will be presenting a theoretical model with labor as the only factor of production where employment shares are the appropriate weight. Second, large firms in terms of employment are overstated in my sample, as explained above, and, thus, employment weights are consistent with the interpretation of my results as a lower bound. Results using value added weights, however, are reported in Online Appendix A.7.

[16]Refer to Table A.1 for further details.

FIGURE 2: PRODUCTIVITY GROWTH ACROSS THE PRODUCTIVITY DISTRIBUTION



Notes: This graph plots the growth in average TFP by percentile of the productivity distribution. It compares the average TFP of firms in a given percentile before and after each of the two sudden stops. As this is an unbalanced panel, firms are allowed to change percentiles and even exit the sample during the transition. The corresponding base and end years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. To account for variability, the vertical lines represent error bands. The data used is collected from the ESEE dataset.

lower productivity on average and the dispersion of log TFP increases. The increase in dispersion, however, is asymmetric. The distribution of unproductive firms expands while that of productive firms changes little with the coefficient of skewness declining from -0.40 to -1.24. Moreover, increasing kurtosis, 7.04 versus 10.42, is associated with fatter tails as the probability mass moves away from the shoulders of the distribution. Although the behavior of TFP exactly reverses during the 2010-2013 crisis - productivity increases while dispersion drops - it is still the tails, and especially, the lower tail, that changes the most. In this case, skewness increases from -2.37 to -0.89 while kurtosis shrinks from 27.92 to 7.13.

Decomposing TFP Growth

While the above findings support a narrative of shifting productivity cutoffs, there is yet room for skepticism. It is often the case that firms at the lower end of the productivity scale are small in size and, thus, have negligible effects on the aggregate. A more formal test of growth patterns requires considering weighted measures. Moreover, it should aim at disentangling the role of incumbent, entering and exiting firms in shaping TFP changes.

I study this by performing a TFP growth decomposition exercise using the formulation pro-

TABLE 1: DECOMPOSITION OF PRODUCTIVITY GROWTH

	Sudden Stops	
	1992-1993	2010-2013
Productivity Growth (%)	-10.87	10.02
Contribution to Productivity Growth		
Incumbents' Contribution	**-11.20**	**3.05**
Within-firm Contribution	-9.69	-2.41
Between-firm Contribution	0.47	3.75
Cross-term Contribution	-1.98	1.71
Net Entry Contribution	**0.33**	**6.96**
Entrants' Contribution	-0.77	-0.72
Exiters' Contribution	1.10	7.68

Notes: Productivity growth refers to accumulated TFP growth for the stated period. Base and final years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. Contribution of incumbents and net entrants add up to productivity growth. Contribution of within-firm, between-firm and cross-term components add up to incumbents' contribution. Contribution of entrants and exiters add up to net entry contribution. The formal decomposition is given by:

$$\Delta Z_t = \sum_{i \in C} s_{i,t-1} \Delta Z_{i,t} + \sum_{i \in C} Z_{i,t-1} \Delta s_{i,t} + \sum_{i \in C} \Delta s_{i,t} \Delta Z_{i,t} + s_t^N \left(Z_t^N - Z_t^C \right) - s_{t-1}^X \left(Z_{t-1}^X - Z_{t-1}^C \right) ,$$

where $s_{i,t}$ is the employment share and $Z_{i,t}$ is the productivity level of firm i in period t and C, N, X denote incumbents, entrants and exiters respectively. More details can be found in Online Appendix A.5. The data used is collected from the ESEE dataset.

posed by Dias and Marques (2018), which I derive in Online Appendix A.5. Results for the two sudden stops are summarized in Table 1. The decline in TFP in the 1992-1993 crisis is entirely driven by incumbents. In fact, net entry contributes to positive growth, although the magnitude is small. Among incumbents, there is some reallocation of market shares towards more productive firms. However, it is far from enough to overcome the pronounced fall in within-firm productivity and the cross-term.

In contrast, the increase in TFP experienced during 2010-2013 is largely driven by net entry, in particular, by unproductive firms exiting the sample. The size of the effect is remarkable, especially given that small and medium firms are underrepresented in the sample. Delving deeper into the characteristics of exiting firms shows that during the 2010-2013 episode, firms that exit the market were, on average, bigger in terms of labor market share (7.01% versus 2.78) and three times as unproductive in relation to incumbents (27.16% versus 9.17%) than their 1992-1993 counterparts. Moreover, the annualized exit rate more than doubled from 4.47% to 9.19%.[17] In other words, there is more and better exit.

Back to Table 1, the contribution of incumbents, although half as important, is also noteworthy.

[17]The corresponding averages for the entire sample are the following: the annualized exit rate is 7.71%, the employment share of exiting firms is 6.43% and the difference in TFP between exiting firms and incumbents is 14.09%.

It is still the case that, on average, the productivity of incumbents is procyclical, yet the positive effect of the between and cross terms dominate overall. The increase in market share reallocation and a stronger correlation between productivity and market share changes at the individual firm, together with the positive contribution of exiting firms, is consistent with a cleansing effect of the 2010-13 sudden stop which is absent in the 1992-93 episode. The cleansing hypothesis, as discussed by Caballero and Hammour (1994), argues that crises are periods of accelerated productivity-enhancing reallocations, especially as resources are freed by the exit of unproductive firms. I turn to formally testing the firm-level implications of this interpretation in what follows.[18]

The Cleansing Hypothesis: A Formal Test

According to the literature, there is a tight connection between firm exit, input growth and productivity: models of firm dynamics predict that exit is more likely among low productivity firms whereas high productivity firms are expected to grow by more every period. The cleansing hypothesis suggests that recessions accelerate these dynamics. One should therefore observe a stronger correlation between survival, labor growth and productivity levels during crises. To test whether this is the case for the two sudden stop episodes considered, I adjust the empirical specification proposed by Foster, Grim and Haltiwanger (2016) and run the following set of regressions:

$$y_{i,t+1} = \lambda_{t+1} + \beta\, TFP_{it} + \gamma\, ss^1_{t+1} * TFP_{it} + \theta\, ss^2_{t+1} * TFP_{it} + X'_{i,t}\,\omega + \epsilon_{i,t+1}\,,$$

where $y_{i,t+1}$ stands for a set of dependent variables. It is a dummy variable with value one when a firm reports activity in period t and no activity in period $t+1$ in the exit specification. It is a quantitative variable measuring labor growth between t and $t+1$ in the regressions for input growth. The regressor ss^1_{t+1} is a dummy variable for the 1992-93 sudden stop, ss^2_{t+1} is a dummy variable for the 2010-13 sudden stop and TFP_{it} captures the log of firm-level productivity. To abstract from underlying trends, the above specification includes year effects as given by λ_{t+1}. In addition, $X_{i,t}$ controls for firm characteristics. For the baseline specification, I follow Foster, Grim and Haltiwanger (2016) in considering firm size effects.[19] However, the role of other firm characteristics is also explored in the section that follows.

For the exit specification, the relationship between survival probability and productivity is expected to be positive and, thus, $\beta < 0$. Under the cleansing hypothesis, this correlation should strengthen during a sudden stop episode and one would anticipate $\gamma < 0$ and $\theta < 0$. For the input growth specification, the exact opposite applies.

Results of these regressions are summarized in Table 2. The first column shows the relationship

[18] A valid concern is that if firms are forward-looking, they might backload the decision to exit, and, thus, the duration of a crisis might be an important driver of results. I refer the reader to Online Appendix A.7, where I show that exit in the 2010-13 episode is not concentrated on the later years.

[19] For firm size effects, I use a categorical variable: firm size class =1 if firm employment < 20; =2 if $20 \leq$ firm employment ≤ 50; =3 if $50 \leq$ firm employment ≤ 200; =4 if firm employment > 200.

TABLE 2: REALLOCATION AND PRODUCTIVITY

	Exit	Labor Growth (Incumbent & Exiters)	Labor Growth (Incumbents Only)
	(1)	(2)	(3)
TFP_{it}	-0.020***	0.022***	0.018***
	(0.003)	(0.003)	(0.003)
$ss^1_{t+1} * TFP_{it}$	-0.004	-0.003	-0.004
	(0.014)	(0.006)	(0.008)
$ss^2_{t+1} * TFP_{it}$	-0.038***	0.016*	0.010*
	(0.010)	(0.008)	(0.005)
Observations	36,261	32,268	28,275
Year FE	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes

Notes: Regression for exit is a linear probability model where exit=1 if the firm reports positive activity in period t and no activity in period $t+1$. Labor growth is measured from period t to period $t+1$. TFP_{it} is the log firm-level TFP at time t, ss^1_{t+1} is a dummy equal to one for years 1992-1993 and ss^2_{t+1} is a dummy equal to one for years 2010-2013. Firm size classes in period t are used to control for firm size effects. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

between productivity and the probability of exit. Consistent with earlier findings, firms that exit the market tend to feature lower productivity levels. Focusing on the interaction terms, there is evidence of a cleansing effect only during the second episode. In terms of quantitative significance, the predicted difference in probability of exit between a firm one standard deviation below and a firm one standard deviation above average is about 2 percentage points in normal times but almost 7 percentage points during the latter sudden stop.

The second and third columns support further the predictions of the cleansing hypothesis for the 2010-13 episode. First, note that there is a positive impact of productivity on labor growth as predicted by the literature. Of greater interest, this correlation is even higher during the second sudden stop. In fact, the predicted difference in labor growth between a firm one standard deviation above and a firm one standard deviation below average increases from 2.6 (2.1) percentage points in normal times to 4.5 (3.3) percentage points in 2010-2013 according to coefficients reported in the second (third) column.

2.3 Alternative Explanations

Though so far the focus has been on the marked divergence in the exchange rate policies implemented during the two sudden stops, there are a number of additional dimensions along which the Spanish economy differed in 1992 versus 2010 that could also explain the contrast in firm dynamics documented in the previous section. While it is unfeasible to fully rule out all alter-

TABLE 3: FIRM EXIT AND PRODUCTIVITY WITH ADDITIONAL CONTROLS

	(1)	(2)	(3)	(4)	(5)
TFP_{it}	-0.020***	-0.021***	-0.015***	-0.019***	-0.016***
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
$ss^1_{t+1} * TFP_{it}$	-0.004	-0.003	-0.007	-0.004	-0.007
	(0.014)	(0.015)	(0.013)	(0.015)	(0.015)
$ss^2_{t+1} * TFP_{it}$	-0.038***	-0.036***	-0.029***	-0.035***	-0.026***
	(0.010)	(0.010)	(0.009)	(0.009)	(0.008)
$cons_i$		-0.165***			-0.150**
		(0.055)			(0.056)
$ss^1_{t+1} * cons_i$		0.080			0.069
		(0.085)			(0.090)
$ss^2_{t+1} * cons_i$		0.191***			0.152*
		(0.058)			(0.076)
$leverage_{it}$			0.133***		0.131***
			(0.021)		(0.020)
$ss^1_{t+1} * leverage_{it}$			-0.015		-0.013
			(0.079)		(0.077)
$ss^2_{t+1} * leverage_{it}$			0.054		0.051
			(0.040)		(0.038)
$importer_{it}$				-0.010**	-0.008**
				(0.004)	(0.004)
$ss^1_{t+1} * importer_{it}$				-0.010	-0.016
				(0.019)	(0.020)
$ss^2_{t+1} * importer_{it}$				-0.027**	-0.018
				(0.011)	(0.011)
Observations	36,261	36,261	34,307	36,261	34,307
Year FE	Yes	Yes	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes	Yes	Yes

Notes: All regressions are linear probability models where exit=1 if the firm reports positive activity in period t and no activity in period $t+1$. TFP_{it} is the log firm-level TFP at time t, ss^1_{t+1} is a dummy equal to one for years 1992-1993 and ss^2_{t+1} is a dummy equal to one for years 2010-2013. $cons_i$ measures the exposure of firm i to the construction sector according to the sector it operates in. $leverage_{it}$ is captured by the debt-to-assets ratio. $importer_{it}$ is a dummy equal to one if the firm reports any positive imported value. Firm size classes in period t are used to control for firm size effects. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

native explanations, this section explores to what extent they might be driving the results. More specifically, I investigate the role of the construction sector, the simultaneity of a banking crisis, expenditure switching effects of a real depreciation and resource misallocation trends.

Table 3 augments the above empirical model for exit by adding relevant firm-level controls and interactions to test whether the coefficients of interest, especially θ, remain significant and stable when considering alternative explanations. To ease comparison, the first column of Table 3 reiterates results for the baseline specification.

The second column examines the burst of the 2000s property bubble in 2008. As the ESEE abstracts from construction sector altogether, I build a measure of exposure of manufacturing firms to construction using the two-digit industry Leontief inverse matrix coefficients reported by the OECD in the 2007 input-output tables for Spain. Results show that while having a tighter link to the construction sector shields firms from exit in normal times, this correlation is entirely reversed during the second sudden stop. Importantly, however, the significance and magnitude of the productivity coefficients is unchanged, suggesting the developments in the housing market are not a main driver. As a robustness check, nevertheless, I repeat the analysis restricting the sample to firms that do not operate in one of the five sectors with the highest exposure to construction to find that main conclusions hold.[20]

Another important difference across the two sudden stops is that during the latter, Spain simultaneously experienced a banking crisis. While the standard logic of this argument works in the wrong direction: highly leveraged firms, with a higher propensity to exit during a credit crunch, feature higher productivity levels; the third column of Table 3 considers the role of leverage explicitly. In particular, the empirical model is augmented to account for the debt to assets ratio and the corresponding interactions. On the one hand, leverage is positively correlated with exit overall, with no significant effect during any of the sudden stops. On the other, the productivity results remain mostly unchanged. In the Online Appendix, Table A.4 reports additional firm-level controls aimed at capturing the firm's financial soundness such as the average cost of long-term debt, sales growth and the return on equity (ROE) ratio. In sum, results are not mainly driven by a greater disruption of credit in 2010-13.

Other well-known effects of a real exchange rate depreciation include (i) an expenditure switching effect on imported intermediate inputs and (ii) balance sheet effects resulting from liability currency mismatches. While in the absence of a model it is ex-ante unclear whether these effects should be different across episodes, most economists tend to expect a greater impact whenever the currency depreciates. This would involve more exit in the first episode, which does not hold in the data. Although the ESEE dataset does not provide information on debt denomination, the fourth column of Table 3 provides some evidence on the role of imported intermediate inputs by featuring the import status of the firm. As theory predicts importers have a lower propensity to exit. Interestingly, this correlation is reinforced during the most recent episode. As in previous columns, however, the productivity coefficients remain significant and stable.

Finally, I evaluate a popular complementary channel through which reallocation contributes to productivity growth - increased allocative efficiency. Following Hsieh and Klenow (2009), the degree of dispersion of firm-specific distortions is informative of the degree of misallocation in the economy. As distortions are unobservable in practice, I use marginal revenues products as proxies. Periods of higher TFP should be associated with periods of lower marginal revenue product dispersion and differences in the results for capital and labor can be interpreted as evidence of the different types of wedges that might prevail.[21]

In this spirit, I estimate the within-sector standard deviations of marginal revenue products of capital (MRPK) and labor (MRPL) before and after each sudden stop for each two-digit indus-

[20]Results available upon request.

[21]See Online Appendix A.6 for a review of the argument and further details on how to construct these measures.

TABLE 4: MARKUPS AND PRODUCTIVITY

	(1)	(2)	(3)	(4)
Firm-level TFP	0.994***	0.992***	0.964***	0.960***
	(0.003)	(0.003)	(0.008)	(0.008)
Aggregate TFP	0.022	-0.000		
	(0.020)	(0.016)		
Industry TFP			-0.882***	-0.879***
			(0.048)	(0.049)
Observations	36,261	36,261	36,261	36,261
R-squared	0.933	0.937	0.856	0.859
Industry FE	Yes	Yes	No	No
Export status	No	Yes	No	Yes

Notes: This table reports the results of a cross-section regression of firm-level markups on different measures of productivity: at the firm level, at the industry level and at the economy level. All variables are measured in logs. Export status is a dummy equal to one whenever a firm reports a positive exporting revenue. Standard errors (in parentheses) are clustered by industry; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$. The data used is collected from the ESEE dataset.

try. In most sectors, dispersion increases during the first episode and decreases by the end of the latter.[22] Importantly, this pattern holds for both capital and labor, suggesting that while there are changes in the distortions over time, such distortions affect both factors of production simultaneously or, in Hsieh and Klenow (2009) lingo, it is changes in the output (and not the capital to labor ratio) wedge that are driving TFP movements.[23]

An alternative interpretation of this result, which implies moving away from the CES assumption, suggests the presence of firm-specific markups that are time-varying. I explore this possibility by computing markups at the firm level as the ratio of the output elasticity of labor to the labor share following De Loecker and Warzynski (2012)'s cost minimization approach. I find that the dispersion of firm-specific markups is substantial; the standard deviation is 0.47 and changes over time.[24]

To study its relationship with productivity, I regress firm-specific markups on firm-level and

[22]Take the biggest industry in the dataset, "Vehicles", as an example. For the 1992-93 sudden stop the standard deviation for capital (labor) was 0.947 (0.342) the year before the crisis; it increased to 1.037 (0.439) by the end of the crisis. For the 2010-13 sudden stop the standard deviation for capital (labor) was 1.098 (0.704) the year before the crisis; it however decreased to 0.977 (0.368) by the end of the crisis. To derive an economy-wide measure of the standard deviation, I then aggregate standard deviations at the industry level using time-invariant employment weights. Results, which are similar to those for "Vehicles", are summarized in Table A.5.

[23]While Gopinath et al. (2017) and García-Santana et al. (2020) have shown that increasing capital misallocation is responsible for the slowdown of productivity growth prior to the 2010-2013 crisis, these results rule out the possibility that it is the undoing of this phenomenon what drives the most recent improvement.

[24]To calculate these numbers, I estimate standard deviation at the industry level and then compute an employment weighted average across industries.

aggregate TFP measures. Results are presented in Table 4. Columns (1) and (2) focus on a economy-wide measure of aggregate productivity while columns (3) and (4) restrict attention to productivity aggregated at the industry level. More productive firms set higher markups on average. This is consistent with most models of variable markups. In addition, lower markups are associated with higher levels of aggregate productivity at the industry level although the effect vanishes at a higher level.

2.4 Caveats and Robustness

This section highlights three well-known limitations of the ESEE dataset. The goal is to understand how each of them might be impacting the above results and to propose ways of addressing them. First, large firms are over-represented in the sample. While, this should bias results against a relevant role of exit, I construct population weights to improve the representativeness of the sample. Unfortunately, the Spanish Census is not available to researchers and, thus, I do not have access to the full population of firms in order to estimate appropriate propensity scores.[25] As a second best, I use the dynamic sampling weights provided by the ESEE. The new weighted sample performs significantly better in two key aspects. First, it matches more closely the actual firm size distribution as reported by Eurostat (Figure A.4). Second, it captures the capital misallocation trend in the pre-crisis period documented by Gopinath et al. (2017) (Figure A.5).[26] Online Appendix A.7 explains further details and shows that results fully go through when using this new weighted sample.

Second, the coverage of the ESEE dataset is limited. I mitigate this concern in two different ways. On the one hand, I redo the analysis using data from ORBIS, which has substantially better coverage for recent years. Online Appendix A.7 confirms that main results hold for the 2010-13 episode, since the data is only available from the late 1990s. I take these results as evidence that the ESEE dataset is representative of the ORBIS dataset (and, thus, of the world of Spanish manufacturing firms) for the purposes of this paper, at least, for the second episode. Given that the ESEE data collection process is consistent over time, there is no obvious reason to believe results for the earlier episode are not equally representative. On the other hand, I show that while the coverage of the ESEE data relative to different releases of the EU KLEMS data for the Spanish manufacturing sector is indeed modest, it is also fairly constant over time.[27]

Third, actual firm entry is captured with some delay in the ESEE data given the size threshold of data collection. As long as the size threshold is constant over time, which is the case, the impact on results is modest and the behavior of sample entrants is informative of that of true entrants.

[25]Selection issues might therefore remain. Note, however, that as long as these are systematic over time, the exercise of comparing two different periods should plaque their impact.

[26]It has been previously established that it is essential to have small firms in the sample to capture factor misallocation.

[27]Refer to Table A.13 for further details.

More importantly, entry is not the main object of study in this paper. However, as a robustness, Table A.14 redoes the TFP decomposition exercise by shutting off the contribution of entrants.

In sum, the above findings call for a theory of sudden stops that features heterogeneously productive firms, selection into production and variable firm-specific markups. All of these elements, together with the exchange rate dimension, are featured in the theoretical framework that I develop next.

3 A Small Open Economy with Firm Dynamics

Consider an infinite-horizon small open economy. Time is discrete and indexed by t. The economy is populated by a representative household that consumes goods and leisure and engages in financial transactions with foreign investors. There is also a large number of differentiated firms that produce consumption goods using labor supplied by the household, and a monetary authority that sets the nominal exchange rate as the policy instrument.

3.1 A Representative Household

The representative household derives utility from leisure and the consumption of a set of differentiated goods, indexed by $\omega \in \Omega$, and supplies differentiated types of labor input, indexed by $i \in (0, 1)$. The lifetime utility is given by:

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t U \left(q_t(\omega), L_t^i \right) \right], \tag{1}$$

where $\mathbb{E}_t$ is the expectation operator conditional on the information set available at time t, β is the discount factor, $q_t(\omega)$ is the consumption level of variety ω and L_t^i is the labor supply of type i. The period utility function is based on Melitz and Ottaviano (2008):

$$U \left(q_t(\omega), L_t^i \right) = \alpha \int_{\omega \in \Omega} q_t(\omega)\, d\omega - \frac{1}{2} \gamma \int_{\omega \in \Omega} q_t(\omega)^2\, d\omega - \frac{1}{2} \eta \left(\int_{\omega \in \Omega} q_t(\omega)\, d\omega \right)^2 - \int_0^1 L_t^i\, di,$$

where demand parameters α, γ and η are strictly positive.

Melitz and Ottaviano (2008) preferences are appealing for three reasons. First, they capture love of variety through γ, which determines the level of product differentiation between consumption goods. As γ increases, consumers place higher weight on the distribution of consumption across varieties. Second, the quadratic form gives rise to a linear demand function which ensures the existence of a choke price and an extensive margin of production even in the absence of fixed costs of production. Third, they generate endogenous variable markups, which capture the effect of market competition on firm sales (the so-called pro-competitive effect) as opposed to standard CES preferences.

Melitz and Ottaviano (2008) preferences also depict a second consumption good, which is homogeneous and assumed to be the numeraire, with a linear production technology that pins down the wage in the economy. As endogenous fluctuations in the wage level are relevant in this analysis, this feature of the original functional form is inconvenient. Moreover, in the context of an internal devaluation, it is also interesting to capture any changes in demand patterns that may arise from movements in wages. My approach is to explicitly model the labor supply decision by assuming preferences that are linear in leisure.[28,29] The demand parameters α and η therefore measure the substitutability between the consumption of differentiated goods and leisure.

The budget constraint of the representative agent in terms of domestic currency can be written as:

$$\int_{\omega \in \Omega} p_t(\omega)\, q_t(\omega)\, d\omega + \epsilon_t B_t = \int_0^1 W_t^i L_t^i \, di + \Pi_t + \epsilon_t R_{t-1} B_{t-1}\,, \tag{2}$$

where $W_t^i L_t^i$ is the income derived from supplying differentiated labor input i, Π_t is profit received from firms and ϵ_t denotes the nominal exchange rate, defined as units of domestic currency needed to buy one unit of foreign currency.

The representative household can only engage in financial transactions with foreign investors by trading in risk-free foreign denominated nominal bonds B_t, which pay a debt elastic rate of return:

$$R_t = R^* + \phi\left(e^{\bar{B}-B_t} - 1\right) + \xi_t\,, \tag{3}$$

where R_t^* is the world interest rate and $\bar{B}$ is the steady state level of debt.[30,31] The only source of uncertainty so far is ξ_t, which is interpreted as a country risk premium shock, similar to that of Garcia-Cicco, Pancrazi and Uribe (2010), and assumed to follow an AR(1) process. A sudden stop in the model involves a positive realization of ξ_t: an unexpected increase in the cost of international borrowing that forces the domestic economy to deleverage internationally by expanding net exports.

Labor supply is differentiated. There is a unit continuum of labor types. Firms can aggregate labor types according to $L_t = (\int_0^1 L_t^{i\,\frac{\theta-1}{\theta}} di)^{\frac{\theta}{\theta-1}}$, where θ measures the elasticity of substitution. I assume that the representative household supplies all the differentiated labor inputs as in Woodford

[28] Given the quasi-linear functional form, there is no income effect for differentiated varieties. However, changes in wages will affect demand through the substitution effect.

[29] Linearity in leisure is not an essential assumption for the purposes of this analysis. It can be easily relaxed without major impact on results. In fact, a truly quantitative exercise would require a finite elasticity of labor supply.

[30] Featuring a debt-elastic interest rate ensures a stationary solution to the model after detrending following Schmitt-Grohé and Uribe (2003). While I take this specification in reduced form, it can be micro-founded in models of limited international financial intermediation in the spirit of Gabaix and Maggiori (2015).

[31] Households are not allowed to trade in domestic bonds in the baseline model for the sake of simplicity. However, extending the model to include domestic bonds would be trivial as these would be in zero net supply.

(2011).[32] Suppose, for example, that each member of the household specializes in one occupation. The representative household has monopoly power to set the wage for each labor type, W_t^i.

Each period the household chooses $q_t(\omega)$, B_t, L_t^i and W_t^i to maximize the expected present discounted value of utility, equation (1), subject to the budget constraint, equation (2), and the demand for type i labor input, which is given by:

$$L_t^i = \left(\frac{W_t}{W_t^i}\right)^{\theta} L_t \,.$$

Optimality conditions Given quadratic preferences, it may be the case that not all differentiated goods are demanded by the household. However, when a particular good ω is consumed, its inverse demand is determined by:

$$\alpha - \gamma q_t\left(\omega\right) - \eta Q_t = \lambda_t p_t\left(\omega\right) \,, \tag{4}$$

where $Q_t \equiv \int_{\omega\in\Omega} q_t\left(\omega\right) d\omega$ is the consumption level over all varieties and λ_t is the time t Lagrangian multiplier. Consumption of a given variety decreases with price, the marginal utility of wealth and total consumption.

The optimal decision for the purchase of the foreign asset, B_t, delivers a standard Euler equation:

$$\lambda_t = \beta R_t E_t\left[\frac{\epsilon_{t+1}}{\epsilon_t}\lambda_{t+1}\right] \,. \tag{5}$$

A higher interest rate and expectations of nominal exchange rate depreciation both increase the cost of borrowing internationally and, thus, encourage consumer savings.

Solving for the optimal wage for labor type i gives:

$$W_t^i = \frac{\theta}{\theta-1}\frac{1}{\lambda_t} \,. \tag{6}$$

Intuitively, higher wages increase household's wealth everything else equal. Given diminishing marginal utility, the Lagrangian multiplier falls. Equation (6) also implies that the optimal flexible wage is equalized across labor types *i.e.* $W_t^{flex} = W_t^i$.

Finally, note that the representative household will be willing to satisfy firms' labor demand as long as:

$$\frac{W_t}{P_t} \geq \frac{1}{\left(\alpha - \eta Q_t\right) N_t - \gamma Q_t} \,,$$

where N_t is the number of active firms in the domestic market.

[32] This is equivalent to assuming that each household specializes in the supply of one type of labor input as long as there are equal number of households supplying each type.

3.2 Firms

There is a continuum of measure M of domestic firms, each deciding whether to produce a differentiated variety ω.[33] Labor is the only factor of production and the unit cost is a concave function in the factor price *i.e.* $C_t(z) = \frac{W_t^\sigma}{Z_t z}$, where $0 < \sigma \leq 1$ is the labor income share.[34] Firm productivity has a common stochastic shifter, Z_t, which follows an AR(1) in logs and a constant firm-specific component, z, which is drawn from a Pareto distribution $1 - G(z) = \left(\frac{1}{z}\right)^k$ with shape parameter k and minimum level equal to one.[35]

The main focus of the paper is the short-run and, as such, cross-country reallocation of firms is not allowed.[36] This implies that the number of potentially active firms in the economy, M, is fixed and there is no free entry condition. Firms only choose whether to produce or not in each period based on the profitability for the corresponding period.

Firms can sell their varieties in both the domestic and the export market. Markets are segmented and selling abroad requires incurring a per-unit trade cost $\tau > 1$. While domestic demand for variety z, $q_t^H(z)$, is given by equation (4), the foreign demand for a domestic variety z, $q_t^{*F}(z)$, is given by:

$$q_t^{*F}(z) = A - Bp_t^{*F}(z), \tag{7}$$

where A and B are exogenous given a small-open economy setting. In the spirit of Demidova and Rodriguez-Clare (2009), I show in Online Appendix B.2 that this small open economy is a special case of the two economy framework where the share of potentially active firms in Home, $n = \frac{M}{M+M^*}$ approaches zero.[37]

[33] The same is true for the foreign economy: there is a continuum of measure M^* potentially active foreign firms.

[34] To rationalize this functional form, suppose there is a second factor of production, which is inelastically supplied by households and the production function is Cobb-Douglas. If the price of this second input, κ, is assumed to be constant, the marginal cost is given by $C_t = \left(\frac{W_t}{\sigma}\right)^\sigma \left(\frac{\kappa}{1-\sigma}\right)^{1-\sigma}$. In section 5.1 I relax this assumption and show that explicitly considering two factors of production does not change the model's predictions in any substantial way.

[35] For completeness, the assumption is that $Z_t^* = 1 \; \forall t$

[36] Note that this is only true for the baseline set-up. In section 5.3, I allow for firm entry and study long-run implications instead.

[37] In the limit z^{*F} is unaffected by changes in Home, the term A includes the price index, the number of consumed varieties and the marginal utility of wealth in Foreign while the term B is proportional to the marginal utility of wealth in Foreign.

Optimality conditions The profit maximization problem delivers the following set of first-order conditions:

$$q_t^H(z) = \max\left\{\frac{\lambda_t}{\gamma}\left[p_t^H(z) - \frac{W_t^\sigma}{zZ_t}\right], 0\right\},$$
$$q_t^F(z) = \max\left\{\frac{\lambda_t}{\gamma}\left[p_t^F - \frac{\tau\epsilon_t\left(W_t^*\right)^\sigma}{z}\right], 0\right\},$$
$$q_t^{*F}(z) = \max\left\{B\left[p_t^{*F}(z) - \frac{\tau W_t^\sigma}{\epsilon_t zZ_t}\right], 0\right\},$$

where the expressions for domestically-consumed domestically-produced, henceforth domestic goods, $q_t^H(z)$, and exported goods, $q_t^{*F}(z)$, are given by the optimization of domestic firms while the expression for imported goods, $q_t^F(z)$, results from the optimization of foreign firms.

The labor demand for a domestic firm with productivity level z is given by the firm's cost minimization problem and reads:

$$L_t(z) = \frac{\sigma}{W_t^{1-\sigma}}\frac{q_t(z)}{zZ_t}, \tag{8}$$

where $q_t(z)$ will be either $q_t^H(z)$ or $q_t^{*F}(z)$ depending on whether the labor input hired is used to serve the domestic or the export market.

3.3 Aggregation and Market Clearing

I aggregate firm-level variables and impose market clearing conditions as building blocks to define the competitive equilibrium.

Productivity thresholds Given that firm-level productivity follows a Pareto distribution, the aggregate productivity level for a given market is summarized by a productivity threshold.[38] This is simply the productivity level of the marginal firm that is indifferent between producing or not for a specific market.

On the supply side, the zero profit condition holds for the marginal firm: it optimally sets its price equal to its marginal cost. For example, for the domestic good $\bar{p}_t^H = \frac{W_t^\sigma}{z_t^H Z_t}$. On the demand side, the linearity of consumer's demand gives rise to a choke price. This is the maximum price that can be charged for a given variety; anything beyond which drives demand down to zero. Following the previous example, $\bar{p}_t^H = \lambda_t^{-1}(\alpha - \eta Q_t) = (\gamma + \eta N_t)^{-1}(\alpha\frac{\gamma}{\lambda_t} + \eta P_t)$. By combining

[38] See section 4 for the formal proof.

these two sets of conditions, the equilibrium thresholds can be expressed as:

$$z_t^H = \frac{\gamma + \eta N_t}{\alpha\gamma\frac{1}{\lambda_t} + \eta P_t} \frac{W_t^\sigma}{Z_t}, \tag{9}$$

$$z_t^F = \frac{\gamma + \eta N_t}{\alpha\gamma\frac{1}{\lambda_t} + \eta P_t} \tau\epsilon_t (W_t^*)^\sigma, \tag{10}$$

$$z_t^{*F} = \frac{B}{A} \frac{\tau W_t^\sigma}{\epsilon_t Z_t}, \tag{11}$$

where z_t^H is the productivity threshold for domestic firms serving the domestic market, z_t^F is the importer threshold and z_t^{*F} is the exporter threshold. Given the small open economy set-up, the productivity threshold for foreign firms serving the foreign market, z_t^{*H} is exogenously determined and irrelevant for the analysis.

All firm-level variables can then be written in terms of these thresholds. In particular:

$$p_t^H(z) = \frac{1}{2}\frac{W_t^\sigma}{Z_t}\left(\frac{1}{z_t^H} + \frac{1}{z}\right), \quad q_t^H(z) = \frac{1}{2}\frac{\lambda_t}{\gamma}\frac{W_t^\sigma}{Z_t}\left(\frac{1}{z_t^H} - \frac{1}{z}\right),$$

$$p_t^F(z) = \frac{1}{2}\tau\epsilon_t (W_t^*)^\sigma \left(\frac{1}{z_t^F} + \frac{1}{z}\right), \quad q_t^H(z) = \frac{1}{2}\frac{\lambda_t}{\gamma}\tau\epsilon_t (W_t^*)^\sigma \left(\frac{1}{z_t^F} - \frac{1}{z}\right),$$

$$p_t^{*F}(z) = \frac{1}{2}\frac{\tau}{\epsilon_t}\frac{W_t^\sigma}{Z_t}\left(\frac{1}{z_t^H} + \frac{1}{z}\right), \quad q_t^{*F}(z) = \frac{B}{2}\frac{\tau}{\epsilon_t}\frac{W_t^\sigma}{Z_t}\left(\frac{1}{z_t^H} - \frac{1}{z}\right),$$

which are derived by combining the optimality conditions from the representative household and the firms and the corresponding definition of choke prices.

Number of firms The number of active firms in the domestic market, N_t is the sum of domestic firms that serve the domestic market, N_t^H, plus the number of foreign importers, N_t^F. Given the number of existing firms in both markets, M and M^*, and the Pareto distribution assumption, the number of active firms is given by:

$$N_t = M\left(\frac{b}{z_t^H}\right)^k + M^*\left(\frac{b}{z_t^F}\right)^k, \tag{12}$$

where $\left(\frac{b}{z^H}\right)^k$ is the probability that an incumbent has a productivity level above the cutoff and, thus, generates positive profits. Note that because each firm specializes in a particular variety, N_t is also the number of differentiated varieties available for consumption in the small open economy.

Average price The average price captures the prices of all goods consumed domestically, that is, prices of domestically produced goods consumed domestically and import prices:

$$\frac{P_t}{N_t} = \frac{N_t^H}{N_t} \int_{z_t^H}^{\infty} p_t^H(z) \frac{g(z)}{1 - G(z_t^H)}\, dz + \frac{N_t^F}{N_t} \int_{z_t^F}^{\infty} p_t^F(z) \frac{g(z)}{1 - G(z_t^F)}\, dz\,.$$

Combined with the optimal price expressions and the number of active firms in equilibrium, given by equation (12), the above definition is considerably simplified to read:

$$\frac{P_t}{N_t} = \frac{2k+1}{2k+2} \frac{W_t^{\sigma}}{z_t^H Z_t}\,. \tag{13}$$

The average price is determined by the average effective marginal cost, which follows from the individual firm's optimization problem. Firms charge higher prices whenever their cost of production increase. This is the case when the wage level is high but also when the individual productivity level is low. As the average productivity level in the economy depends positively on the domestic threshold, the average price decreases in z_t^H.

Wage level I introduce nominal rigidities in the form of sticky wages à la Calvo (1983).[39] Each labor type is able to reset its wage with a probability μ each period. Thus, the labor type that adjusted its wage s periods ago would have chosen,X_{t-s}, such that:

$$log(X_{t-s}) = (1 - \beta(1-\mu)) \sum_{j=0}^{\infty} (\beta(1-\mu))^j\, \mathbb{E}_{t-s} \left(log(W_{t+j-s}^{flex}) \right)\,, \tag{14}$$

where W_t^{flex} is the optimal flexible wage as defined by equation (6). This is a weighted average of the current and the expected future optimal wages as of time s. Expectations farther in the future are given a lower weight not only because of discounting, but because there is a lower probability of the wage prevailing.

Given that the probability of updating is independent across labor types, the aggregate wage is simply:

$$log(W_t) = \mu \sum_{j=0}^{\infty} (1-\mu)^j log(X_{t-s-j})\,, \tag{15}$$

which combined with equations (6) and (14) yields a version of the wage Phillips curve,

$$\Delta log(W_t) = \beta\, \mathbb{E}_t\, \Delta log(W_{t+1}) + \frac{\mu(1-\beta(1-\mu))}{1-\mu} \left(log\left(\frac{\theta}{1-\theta}\right) - log(\lambda_t) - log(W_t) \right) \tag{16}$$

[39]The model could alternatively feature Rotemberg wage adjustment costs or sticky information à la Mankiw and Reis (2002) in the wage setting process. Note, however, that the model cannot feature downward wage rigidities as in Schmitt-Grohé and Uribe (2016). This would imply that wages are not set by households (or unions in their names), thus, preventing movements in wages to have an effect on demand, a key channel in this paper.

Labor market clearing To ensure that the labor market clears in equilibrium, aggregate labor demand must equal aggregate labor supply. To aggregate domestic individual labor demand given by equation (8), I sum across all active domestic firms using the Pareto distribution assumption. Labor market clearing then boils down to:

$$L_t = \frac{k}{(k+1)(k+2)} \frac{\sigma}{W_t} \left(\frac{W_t^{\sigma}}{Z_t} \right)^2 M \left[\frac{\lambda_t}{\gamma} \left(z_t^H \right)^{-(k+2)} + B \frac{\tau^2}{\epsilon_t} \left(z_t^{*F} \right)^{-(k+2)} \right] . \tag{17}$$

The balance of payments condition Combining some of the equilibrium conditions above, together with the domestic firms' aggregate profit equation and the consumer's budget constraint gives the aggregate resource constraint of the economy, which, in an open-economy setting, is simply the balance of payments condition. In other words, it states that the current account must be equal to the capital account in equilibrium:

$$EX_t - IM_t + \epsilon_t B_{t-1}(R_{t-1} - 1) = \epsilon_t \left(B_t - B_{t-1} \right) , \tag{18}$$

where EM_t and IM_t, the total export and import revenues in domestic currency terms, are given by:

$$IM_t = N_t^F \int_{z_t^F}^{\infty} p_t^F(\omega)\, q_t^F(\omega) \frac{g(z)}{1 - G(z_t^F)}\, dz = \frac{b^k}{2(k+2)} M^* \frac{\lambda_t}{\gamma} \frac{\left(\tau \epsilon_t \left(W_t^* \right)^{\sigma} \right)^2}{2} \left(z_t^F \right)^{-(k+2)} , \tag{19}$$

$$EX_t = \epsilon_t N_t^{*F} \int_{z_t^{*F}}^{\infty} p_t^{*F}(\omega)\, q_t^{*F}(\omega) \frac{g(z)}{1 - G(z_t^{*F})}\, dz = \frac{b^k}{2(k+2)} M \frac{B}{\epsilon_t} \left(\frac{\tau W_t^{\sigma}}{Z_t} \right)^2 \left(z_t^{*F} \right)^{-(k+2)} . \tag{20}$$

3.4 Exchange Rate Policy

To pin down the nominal variables of the model, I need to determine exchange rate policy. Suppose the central bank implements monetary policy by setting the nominal exchange rate. I consider two exchange rate regimes characterized by different targeting rules. First, consider a currency union. This is equivalent to assuming that the central bank can perfectly commit to a currency peg in which $\epsilon_t = 1$ at every period t.

Second, assume a policy of strict zero wage inflation targeting. This rule simply offsets all the distortions originating from nominal rigidities in the economy by implementing the flexible wage equilibrium, which is given by equation (6). Any movements in the real exchange rate will translate one-to-one into movements in the nominal exchange rate. This is the equivalent to a floating arrangement in this framework.[40]

[40] The exchange rate policy defined here can be easily generalized by assuming a rule such that:

$$\left(\Pi_t^w \right)^{\phi_W} \left(\epsilon_t \right)^{1-\phi_W} = 1 , \tag{21}$$

3.5 Equilibrium

I am now ready to define a rational expectations equilibrium as a set of stochastic processes $\{z_t^H, z_t^F, z_t^{*F}, IM_t, EX_t, L_t, N_t, B_t, R_t, P_t, \lambda_t, W_t\}_{t=0}^{\infty}$ satisfying equations (3), (5), (9)-(13) and (16)-(20) given the exogenous process $\{\xi_t, Z_t\}_{t=0}^{\infty}$, initial conditions $\{R_{-1}, B_{-1}, W_{-1}\}$ and the central bank's policy $\{\epsilon_t\}_{t=0}^{\infty}$. The foreign wage, W_t^*, is normalized to one.

Online Appendix B.3 discusses the existence and uniqueness of the non-stochastic steady state.

4 Sudden Stops and Productivity

In order to study the effects of a sudden stop on aggregate productivity in this framework, I first define the variable of interest and discuss the channels through which a shock can potentially affect productivity. I then restrict attention to a version of the model, which delivers an analytical solution. Finally, I simulate the model numerically and show that the results hold more generally.

4.1 Aggregate Productivity

The variable of interest is domestic aggregate productivity, which is given by:

$$Z_t^H = N_t^H \int_{z_t^H}^{\infty} \Omega(z)\, z\, Z_t \,\frac{g(z)}{1 - G(z_t^H)}\, dz\,,$$

where $\Omega(z)$ is the weight used in the aggregation. It must satisfy:

$$N_t^H \int_{z_t^H}^{\infty} \Omega(z)\, \frac{g(z)}{1 - G(z_t^H)}\, dz = 1\,.$$

Aggregate productivity is often computed as: (i) the unweighted average, $\Omega(z) = \frac{1}{N_t^H}$; (ii) the output-weighted average, $\Omega(z) = \frac{q(z)}{Q_t^H}$; or (iii) the revenue-weighted average, $\Omega(z) = \frac{r(z)}{R_t^H}$. [41] The following Lemma establishes that $z_t^H Z_t$ is the key statistic for measuring aggregate productivity independent of the weights used in the aggregation.

where $\Pi_t^w = \frac{W_t}{W_{t-1}}$ is wage inflation and $0 \leq \phi_w \leq 1$ is the weight that the monetary authority puts on wage stabilization. A currency union and a strict wage inflation target are the two extreme versions of this rule, with ϕ_w set equal to zero and one, respectively.

[41] Q_t^H is total domestic output given by:

$$Q_t^H = N_t^H \int_{z_t^H}^{\infty} q(z)\, \frac{g(z)}{1 - G(z_t^H)}\, dz\,,$$

and R_t^H is total domestic revenue given by:

$$R_t^H = N_t^H \int_{z_t^H}^{\infty} r(z)\, \frac{g(z)}{1 - G(z_t^H)}\, dz\,.$$

Lemma 1. *Domestic aggregate productivity, Z_t^H, is an increasing function of the domestic productivity threshold, z_t^H and the common shifter, Z_t.*

Proof. See Appendix □

In other words, changes in productivity in this model are partly governed by firms' entry and exit dynamics. This is in contrast to alternatives in the literature that either model productivity exclusively as an exogenous shock to the economy, allow for variable capacity utilization or consider R&D decisions.

4.2 Pro-competitive, Cost and Demand Channels

For a given realization of the common shifter, the productivity threshold is determined by the number of firms in the market, the cost of production and the level of consumer demand; all three are potentially subject to change during a sudden stop episode. Let $\hat{X}_t$ define the log deviation of a some variable X_t and $\bar{X}$ be its value at steady state.

Proposition 1. *In equilibrium:*

$$\hat{z}_t^H + \log Z_t = \underbrace{\frac{1}{2k+2}\frac{\eta}{\alpha\gamma}\frac{\bar{N}\bar{\lambda}\bar{W}^{\sigma}}{\bar{z}^H}\hat{N}_t}_{\textit{Pro-competitive}} + \underbrace{\sigma\hat{W}_t}_{\textit{Cost}} + \underbrace{\hat{\lambda}_t}_{\textit{Demand}} .$$

Proof. See Appendix □

The intuition follows next. In the first place, a larger number of active firms in the market, $\hat{N}_t > 0$, implies greater competition. Given the preferences considered, enhanced competition lowers individual firm demand. This forces less productive firms out of the market as profit margins are reduced at every level of productivity. This *pro-competitive effect* was first introduced by Melitz and Ottaviano (2008), which focuses on competition in the goods market.

Second, a higher wage, $\hat{W}_t > 0$, lowers the firm's profit margin by increasing the cost of producing.[42] Once again, a higher productivity level is then required for firms to remain profitable and select into production, therefore, aggregate productivity increases. This is what I denote the *cost effect*, which is the underlying mechanism in the canonical Melitz (2003) model, which focuses on competition in the labor market.

Finally, higher aggregate demand from consumers, $\hat{\lambda}_t < 0$, raises individual firm demand at all productivity levels and loosens the minimum productivity requirement. Less productive firms have a higher chance of entering or surviving in the market. This final channel, a novelty of this

[42]Note that the focus here is on nominal instead of real wages and costs. The underlying reason is that Melitz and Ottaviano (2008) preferences do not give rise to an ideal price index that provides a clear mapping from nominal to real variables.

model, is referred to as the *demand effect*.[43] It results from featuring leisure in the consumer's utility function.

4.3 An Analytical Result

Before proceeding to the full characterization of the model's solution, it is useful to build intuition by providing some analytical results. In order to do this, I simplify the dynamics of the model in the following way. First, suppose the common productivity shifter remains constant, i.e., $Z_t = 1$ for all t. Second, consumers are no longer allowed to issue bonds but are instead required to pay a lump-sum tax to foreigners.[44] To ease the algebra, suppose the lump-sum tax is a fraction of total import revenues such that the balance of payment condition now reads:

$$\frac{EX_t}{IM_t} = (1 + \Delta_t)\,, \tag{22}$$

where Δ_t is white noise. For now, let's assume a sudden stop is simply a positive realization of Δ_t. This will force an expansion of net exports and an improvement in international competitiveness. The following proposition considers its effect on productivity under the two alternative exchange rate regimes.

Proposition 2. *Given a sudden stop,*

1. *In a floating arrangement, only the pro-competitive channel operates and productivity falls:*

$$\hat{N}_t < 0,\ \hat{W}_t = 0 \ \textit{and}\ \ \hat{\lambda}_t = 0 \ \textit{so that}\ \ \hat{z}_t^H < 0\,.$$

2. *In a currency union, all three channel operate and the change in productivity is ambiguous:*

$$\hat{N}_t < 0,\ \hat{W}_t < 0 \ \textit{and}\ \ \hat{\lambda}_t > 0 \ \textit{so that}\ \ \hat{z}_t^H \gtrless 0\,.$$

Proof. See Appendix □

First, suppose that the nominal exchange rate depreciates one-to-one with the real exchange rate, *i.e.* ϵ_t increases. Under this assumption, the cost and the demand effect are muted as the wage level remains unchanged. There is a fall, however, in the active number of firms in the domestic economy as the number of importers declines due to the expenditure switching effect. There is an unambiguous fall in productivity as a result of this negative pro-competitive force.

[43] There is an implicit demand effect in the baseline Melitz (2003) model too. However, the assumption of fixed production costs introduces an additional fixed cost channel (on top of the variable cost channel here considered) that exactly offsets the demand effect.

[44] The full model has three state variables, B_{t-1}, R_{t-1} and W_{t-1}, which govern the dynamics. This simplification allows me to abstract from two of them.

Suppose instead that the aggregate wage adjusts completely: W_t falls while the nominal exchange rate remains unchanged. Under this alternative scenario, the negative pro-competitive effect prevails as there is still a decline in importing firms. The change in wages, in addition, leads to a negative cost effect, production of goods is cheaper, and a negative demand effect, households consume less.[45] In other words, all three channels are operating.

In sum, the change in productivity after a sudden stop is ambiguous in the currency union and depends on parameter values. It is possible, nonetheless, to show under which parameterization, the demand effect dominates and productivity increases.

Corollary 1. *Following a sudden stop in a currency union, a sufficient condition for* $\hat{z}_t^H > 0$ *is that*

$$\frac{1}{2} < \mu(1-\beta(1-\mu))\sigma(1+k) < 1\,.$$

Proof. See Appendix □

There are three key parameters for this condition to hold: the share of labor income, σ, the degree of wage rigidities, μ, and the shape parameter of the productivity distribution, k. The share of labor income governs the mapping between the wage level and the unit cost. As σ increases, labor represents a greater share of the optimal input bundle and falling wages cheapen production costs by more. This reinforces the cost effect of a sudden stop. In the Melitz (2003) model, the cost channel is at its strongest featuring a production function which is linear in labor, $\sigma = 1$.

The degree of wage rigidities determines the size of the demand effect. A sudden stop here is simply an improvement in the domestic economy's competitiveness through a decline in the wage level. As the level of wage stickiness increases and fewer labor-types are allowed to adjust, the decline in the optimal wage, W_t^*, that is required to achieve the desired overall wage adjustment is larger. This leads to a larger decrease in today's consumer wealth and, thus, a stronger demand effect of a sudden stop.[46]

The shape parameter measures the concentration of firms at the lower end of the productivity distribution. This represents the inverse of dispersion in firm-level productivity. As firms only differ in their productivity levels, if k increases, they become more homogeneous and, thus, more reliant on their relative cost advantage to survive. This implies that changes in the economy's international competitiveness will lead to larger swings in the number of importers, thus, increasing the size of the pro-competitive effect.

Two questions remain unanswered. First, is the above requirement satisfied under a reasonable parameterization? Second, do results hold in the fully-fledged version? While the following

[45] Recall that a negative demand effect is represented by a positive change in $\hat{\lambda}_t$.

[46] The forward looking behavior of consumers further slows down the adjustment of the wage level: the fraction μ of labor types that adjust take into account that there is a possibility that they will keep the new wage in the future, where they expect no more shocks will materialize. While they discount the future at rate β, this prevents them from fully adjusting today, which explains the additional $(1-\beta(1-\mu))$ term.

TABLE 5: MODEL GENERATED QUALITATIVE DECOMPOSITION OF PRODUCTIVITY GROWTH

	Exchange Rate Regime	
	Floating Arrangement	Currency Union
Productivity Growth (%)	↓	↑
Contribution to Productivity Growth		
Incumbents' Contribution	**↓**	**↑**
Within-firm Contribution	-	-
Between-firm Contribution	↓	↑
Cross-term Contribution	-	-
Net Entry Contribution	**↓**	**↑**
Entrants' Contribution	↓	-
Exiters' Contribution	-	↑

Notes: This table reproduces the productivity growth decomposition exercise in section 2 but through the lens of the model described in section 3. It builds on the analytical results discussed in section 4.3, which are qualitative. Online Appendix B.4 provides more details on the model derivations.

section discusses how to calibrate and numerically solve for the general model, I first explore how far can the current modeling of a sudden stop takes us in generating the micro-patterns observed in the two Spanish episodes.

A Qualitative Decomposition of Productivity

Table 5 reports the model predictions regarding the TFP growth decomposition exercise described in section 2.2. The previous results show that under the above parameter restriction, a positive shock to Δ_t leads to an increase (decrease) in productivity in a currency union (floating arrangement), which is summarized in the first row of Table 5. The subsequent rows show that the overall pattern is driven by both net entrants and incumbents.

Regarding the extensive margin, the model matches the positive contribution of net entry in a currency union while it predicts a counterfactual negative contribution in a floating arrangement. Decomposing net entry further shows that this is driven by a particular feature of the model that prevents entry and exit occurring at the same time. While the model generates a negative contribution of entrants in the floating arrangement in line with the data; it fails to fully offset it with a positive contribution of exiters. This caveat is not as important in the currency union regime because empirically it is exit, which the model is able to capture, that quantitatively dominates the overall contribution of net entry.

Regarding the intensive margin, the contribution of incumbent firms is exclusively driven by the reallocation of market shares. The exit of unproductive firms in a currency union frees up resources which are, at least partly, reallocated towards more productive survivors. The exact opposite holds in a floating arrangement. The model is silent about the within-firm and cross-term contribution because, so far, there is no firm-level productivity growth.

In sum, the current framework provides a fair representation of productivity patterns in a currency union but does not in a floating arrangement. This is not surprising as the empirical evidence concluded that the 2010-2013 increase in TFP was driven by a composition effect, which the model embraces, while the 1992-93 decline in TFP responded to a level adjustment, which is absent by construction. To improve performance, in what follows I will augment the definition of a sudden stop to allow for changes in firm-level productivity.

4.4 Numerical Simulation

As the full model cannot be solved analytically, I explore its properties by generating impulse response functions. To this end, I discuss how I model a sudden stop shock and calibrate parameters. Given the corollary result discussed above, I study the sensitivity of results to alternative calibrations. Finally, I quantify the contribution of the extensive vs. intensive margin to TFP growth as generated by the model.

Modelling a Sudden Stop Shock

The previous section depicts a sudden stop as an ad-hoc current account shock. In the full model, which allows for international borrowing, the natural extension is a positive realization of the risk premium shock ξ_t: an exogenous increase in the rate at which the economy borrows abroad, which forces international deleveraging and an expansion of net exports. However, I now augment the definition of a sudden stop to include a simultaneous decline in the common shifter of firm productivity Z_t.

For transparency, note that this improves the model fit in two dimensions. First, and as already anticipated above, it will better capture the contribution of the intensive margin to productivity growth, which is particularly important in a floating arrangement. Second, it circumvents the production boom that the model would otherwise generate. This technical limitation is common to many other papers in the sudden stop literature. Kehoe and Ruhl (2009) show that standard models that abstract from financial frictions are unable to reproduce observed decreases in output with an expansion of net exports. To fix this, the literature has considered featuring imported intermediate goods, labor frictions, variable capacity utilization, Greenwood, Hercowitz and Huffman (1988) preferences, and, as in this paper, exogenous TFP declines.[47]

[47] I choose the latter only because it eases significantly the solution method.

TABLE 6: CALIBRATION

	Parameter	Value	Calibration Target / Source
β	Discount factor	0.99	Annual real return on bonds is 4%
μ	Index of wage rigidity	0.2	Galí and Monacelli (2016)
θ	Elasticity of substitution (labor)	4.3	Galí and Monacelli (2016)
τ	Iceberg trade cost	1.3	Ghironi and Melitz (2005)
γ	Preference parameter	10	Ottaviano (2012)
α	Preference parameter	10	Ottaviano (2012)
η	Preference parameter	10	Ottaviano (2012)
ϕ	Risk premium parameter	0.001	Garcia-Cicco, Pancrazi and Uribe (2010)
$\bar{B}$	Steady state level of debt	0	Steady state trade balance
σ	Labor share	0.64	National Accounts Spain
n	Relative size of SOE	0.12	Business Demographic Statistics
k	Shape productivity parameter	1.9	Estimated from ESEE data
A	Foreign demand parameter	0.01	Domestic productivity cutoff (1.55)
B	Foreign demand parameter	0.33	Share of exporting firms (63.6%)
$\bar{M}$	Number of total firms	173	Active domestic firms (75.86)
ρ_ξ	Persistence of risk premium shock	0.92	OECD
ρ_A	Persistence of common productivity shock	0.94	Estimated from ESEE data

Notes: This table summarizes the baseline calibration for the model described in section 3. The first set of parameters are standard and set in line with the literature. The second set of parameters are set using Spanish aggregate or firm-level data directly. The third set of parameters are set to match the model's predictions in steady state with moments of the Spanish firm-level data. The fourth set of parameters are estimates of the model's two exogenous shocks.

Calibration

Table 6 provides a summary of the parameters of the model, their baseline values and the source or the empirical target. The first set of parameters are standard and, thus, values are set in line with the literature and, when possible, consistent with Spanish statistics taking the 2002-08 period as a reference. The time period of the model is a quarter. Accordingly, the discount factor β is chosen to be 0.99. The output elasticity parameter σ is set to 0.64, roughly the average labor share and within the range that is common in the literature. For the elasticity of substitution for labor types and the index of wage rigidities, values are taken from Galí and Monacelli (2016) which are based on empirical studies on European countries conducted by the OECD. In terms of trade costs, τ is equal to 1.3 following Ghironi and Melitz (2005) and many others. The steady state level of debt, $\bar{B}$, is assumed to be zero, such that trade is balanced in steady state. Regarding the preference parameters, α, γ and η, I borrow the values used in Ottaviano (2012), all equal to 10.

The ESEE firm-level data presented in section 2 is then used to estimate the shape parameter of the Pareto distribution, following the approach proposed by Del Gatto, Mion and Ottaviano

(2006). Given the observed cumulative distribution, $G(z)$, I run the following regression for every year and industry:

$$ln\left(1-G\left(z\right)\right)=\beta_0+\beta_1 ln\left(z\right)+\eta$$

where, assuming a Pareto distribution, the slope coefficient, β_1 provides a consistent estimator for k. For the 2002-08 period, k is estimated to be, on average, equal to 1.9, close to Del Gatto, Mion and Ottaviano (2006)'s result of 2 for a combination of European countries in the year 2000. In addition, the regression R^2, which is equal to 0.7, confirms that the Pareto distribution is a reasonable assumption in this setting.

The above estimation provides an additional coefficient, β_0, that maps one-to-one to the realized distribution's cutoff, $\bar{z}^H$. I use the corresponding 2002-08 average as a first moment target in two different ways. On the one hand, I combine it with the 2002-08 average number of firms in the ESEE sample to back up the value of M given that the number of potentially active firms is unobservable. The corresponding expression is given by $M=\left(\frac{b}{\bar{z}^H}\right)^k \bar{N}^H$.

On the other hand, I use $\bar{z}^H$ to determine the value of the foreign demand parameters, A and B. To do so I proceed in three steps. First, I set the relative size of the domestic economy, n, to match the 12% share of all Euro-area manufacturing firms that Spanish firms represent according to Eurostat's Business Demography Statistics. Next, I take the average 2002-08 propensity to export as an additional first moment target which combined with $\bar{z}^H$ pins down $\bar{z}^{*F}$ as $\frac{\bar{N}^{*F}}{\bar{N}^H}=\left(\frac{\bar{z}^H}{\bar{z}^{*F}}\right)^k$. Third, I back up the wage level that is consistent with the estimated cutoff using a combination of equilibrium conditions (9), (10), (13) and (12) in steady state. Parameter values for A and B then follow naturally using equation (11) and the trade balance condition.

The risk premium parameter, ϕ, is a theoretical shortcut to ensure stationarity in small open economy frameworks. It measures the sensitivity of the country interest-rate premium to debt. I follow Garcia-Cicco, Pancrazi and Uribe (2010) in choosing a very small value while I have also explored alternative parameterizations, which show that results are not sensitive to the choice.

Finally, Table 6 also includes estimates of the first-order autocorrelations for the model's two exogenous shocks. The risk-premium, ξ_t, is measured as the difference between the Spanish and the German 10-year government yield over the last forty years. The common productivity shifter, Z_t, however, requires more careful thought. Aggregate productivity is not well suited because it is driven by entry and exit dynamics as well as changing market shares. Instead I exploit the firm-level data and construct an unweighted measure of average log productivity for a balanced sample of firms. Under the model's assumption that firm idiosyncratic productivity, z, is time-invariant, this is the correct empirical counterpart. In addition, since there is no statistical significant correlation between the two time series, the shocks are modeled as independent.

Impulse Responses Functions

Figure 3 summarizes the model response of key macroeconomic variables to a simultaneous one percentage point increase in the risk-premium and a one percentage point decrease to the TFP shifter. All variables, but the current account, are expressed in log deviations from steady state. The current account is expressed in levels as trade balance is assumed to hold before the realization of the shock.

As expected, a sudden stop is characterized by a depreciation of the real exchange rate and a current account surplus. The model predicts a slight delay in the adjustment within a currency union. This is entirely driven by nominal rigidities as the model disregards additional policy instruments available under a currency union, such as public capital inflows, that might directly cushion the adjustment in the data.

The path of TFP clearly diverges across regimes. On the one hand, under the baseline calibration, the positive effect of a lower aggregate demand offsets the negative effect of lower production costs and fewer competing firms on the domestic productivity cutoff and, thus, TFP improves in the currency union. On the other hand, productivity falls unambiguously in the floating regime. I study the sensitivity of these results to alternative parameter values next.

Output and consumption are measured in real terms. The model predicts a fall in the two variables under both regimes although the decline is more pronounced in a currency union. Similarly, the decline in employment is only evident when productivity rises.

The current account surplus, denominated in domestic currency, is generated through an increase in export and a decline in import revenues.[48] However, regimes differ in the relative magnitude of these simultaneous effects: in a floating regime the expansion of exports dominates while in a currency union the main driving force is the retrench of import revenues. This highlights the importance of the demand mechanism in the model as it is the larger domestic contraction generated by the adjustment of wages that additionally reduces imports in a currency union.[49]

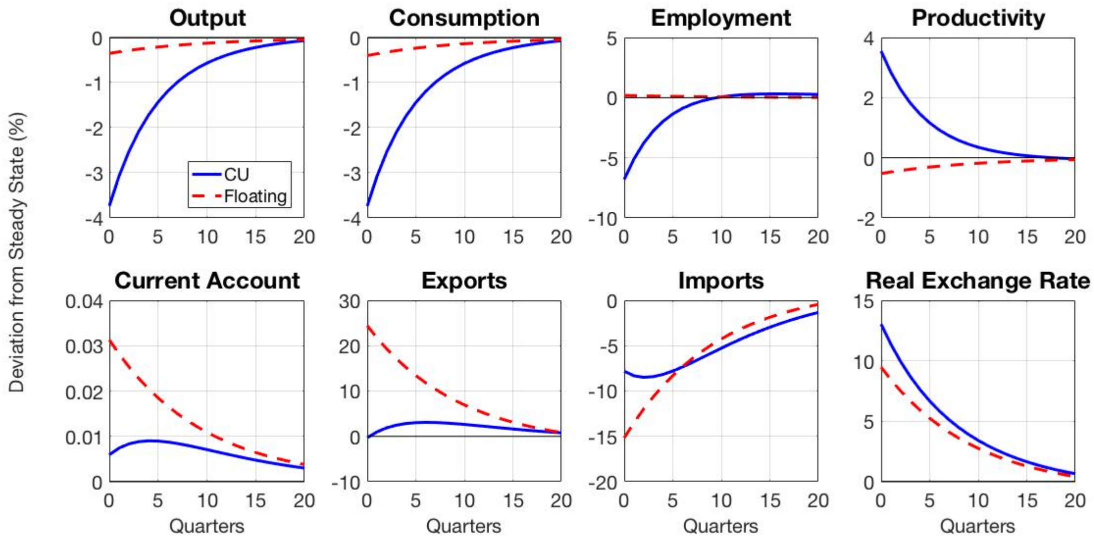
Sensitivity of the TFP fact The analytical results of section 4 point to three structural parameters as the main determinants of the overall response of TFP: the degree of wage rigidities, μ, the share of labor income, σ, and the shape parameter of the productivity distribution, k. I next explore the role of each of these parameters in driving TFP behavior in the numerical model.

The first graph in Figure 4 plots the immediate response of TFP, in log deviations from steady state, to a sudden stop shock under both the currency union and the floating arrangement regimes for different values of wage flexibility i.e. $0.1 \leq \mu \leq 0.9$. By definition, under the floating arrangement wages are stabilized completely and, thus, there is no effect of wage frictions on macroeco-

[48]The current account, imports and exports are denominated in terms of the domestic currency to ease comparison with the empirical counterparts in Figures 5 and 6.

[49]Impulse response functions for all other endogenous variables in the model can be found in Figure A.7.

FIGURE 3: MACROECONOMIC EFFECTS OF A SUDDEN STOP



Notes. These figures plot the impulse response functions of key macroeconomic variables to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter as predicted by the model described in section 3. All variables but the current account are expressed in log deviations from steady state. The current account, assumed to be zero in steady state, is expressed in levels. The current account, exports and imports are denominated in domestic currency; all other variables are expressed in real terms.

nomic variables whatsoever. For the currency union, nevertheless, higher wage flexibility (higher μ) leads to a smaller increase in TFP as hinted by the analytical results.[50]

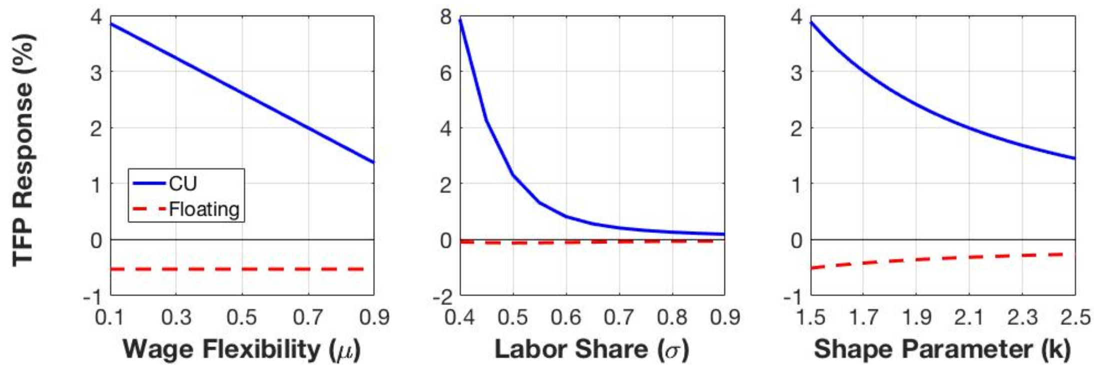
Similarly the following two graphs in Figure 4 repeat the exercise for the other two key parameters: the labor share and the shape parameter. In a currency union, the improvement of TFP is larger when there is a looser link between wages and the unit production cost (lower σ) and there is a lower concentration of firms at the lower end of the productivity scale (lower k) again in line with the intuition provided by the different channels. In a floating arrangement, the labor share is irrelevant as the adjustment of the exchange rate is not affected by the production structure of the economy whereas more heterogeneity (lower k) increases the decline in TFP.[51]

All in all, the results depicted by Figure 4, show that the behavior of TFP is robust to different parameterizations of μ, σ and k and the intuition developed along the analytical section is useful in predicting the direction of most numerical results.

[50]While Figure 4 depicts the immediate effect of a sudden stop shock on TFP, conclusions remain true if the cumulative effect on TFP is considered.

[51]The latter might sound counter-intuitive given Lemma 1. To rationalize this result, consider second round effects of a nominal depreciation - while a larger k initially leads to a larger decline in the number of importers, the resulting decline in the domestic threshold leads to a larger (cushioning) increase in the number of both domestic and importing firms. Under the current calibration the strength of such a cushioning effect is increasing in k

FIGURE 4: THE TFP FACT UNDER ALTERNATIVE CALIBRATIONS



Notes: All three figures plot the immediate response of TFP in log deviations to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter keeping all but one parameter values unchanged. The first figure focuses on different degrees of wage rigidities - higher μ implies lower rigidities. The second figure allows for plausible calibrations of the labor share - higher σ implies a larger labor share. The last figure explores alternative values of the shape parameter of the Pareto distribution - higher k implies lower dispersion of productivity draws.

A Quantitative Decomposition of Productivity

Table 7 redoes the TFP growth decomposition exercise once again but attaching magnitudes to the model's predictions. To ease comparison with the empirics, it also reports results in Table 1 normalized by the size of within firm contribution. As in the qualitative version, the full model generates a fall in productivity under a floating arrangement and an increase in the currency union. Here, however, the former is entirely driven by the contribution of incumbent firms and, more specifically, by the decline in the within-firm component. There is a positive, yet negligible, contribution of net entrants and a positive contribution of reallocation of market shares, both in line with the data.

In order to reconcile this result with the previous intuition, notice that it is the sum of the domestic threshold and the common productivity shifter, $\log(Z_t) + \hat{z}_t^H$, that is now required to adjust given the deleveraging shock. Since the common shifter is assumed to fall simultaneously, it is possible that the exogenous decline in the first term suffices to ensure the adjustment of the sum i.e. $\hat{z}_t^H$ might increase moderately. This is exactly the case depicted in Table 7.

The qualitative predictions for the currency union still hold in the fully-fledged model as shown in the last column of Table 7. Moreover, the exit of unproductive firms and the reallocation of idle resources is large enough to offset the exogenous decline in the firm-level productivity of incumbents.

In terms of magnitudes, the model explains 50% of the difference in the contribution of the extensive margin across episodes. However, it does poorly in matching the relative size of the intensive margin, underestimating the effect in a floating regime while overestimating it in a currency

TABLE 7: MODEL GENERATED QUANTITATIVE DECOMPOSITION OF PRODUCTIVITY GROWTH

	Data (Normalized)		Model	
	1992-1993	2010-2013	Floating	CU
Productivity Growth (%)	-1.12	4.16	-0.53	3.50
Contribution to Productivity Growth				
Incumbent's Contribution	**-1.16**	**1.27**	**-0.53**	**3.00**
Within-firm Contribution	-1.00	-1.00	-1.00	-1.00
Between-firm Contribution	0.05	1.56	0.47	4.04
Cross-term Contribution	-0.20	0.71	-0.00	-0.04
Net Entry Contribution	**0.03**	**2.89**	**0.01**	**0.51**
Entrants' Contribution	-0.08	-0.30	-	-
Exiters' Contribution	0.11	3.19	0.01	0.51

Notes: The first two columns of this table show results depicted in Table 1 normalized by within-firm contribution for comparison purpose. The last two columns of this table reproduce the same productivity growth decomposition exercise through the lens of the model described in section 3 . It builds on the numerical results discussed in section 4.4, which are quantitative. Online Appendix B.4 provides more details on the required derivations.

union. This is mainly driven by the sizable between-firm contribution that the model predicts in a currency union that does not hold in the data. Accounting for reallocation frictions in the model could partly address this issue.

5 Extensions

This section briefly introduces a number of extensions to the baseline framework and discusses how (if anything) the previous results change.

5.1 A Second Factor of Production

The analysis has so far abstracted from explicitly modeling a second factor of production, in particular, capital. This simplification eases the derivation of the analytical results in section 4.3 and follows the original Melitz (2003) framework. Moreover, the firm-level analysis presented in section 2 provides no evidence of a relevant role for a capital input. Nonetheless, this extension incorporates physical capital as a second factor of production and confirms that the concave cost assumption is not driving the baseline results.

The setting is standard: the production function is Cobb-Douglas in labor, L_t, and capital, K_t. Capital goods are owned by the representative consumer and rented to firms in exchange of a rental rate κ_t. For the time being I assume the stock of capital is fixed - section 5.3 will incorporate investment decisions. Online Appendix C.1 formalizes this extension and provides details on the resulting equilibrium conditions.

This extension generates the same differences in TFP response across regimes, although the increase in the currency union is now smaller. This is explained by the decline in the rental price of capital as demand for capital collapses, which reduces the unit production cost by more than the wage level, i.e., reinforcing the cost channel. All other variables behave as in the baseline model. See Figure A.8 for more details.

5.2 Imported Intermediate Inputs

Section 2.2 discusses imported intermediate inputs briefly. This extension augments the baseline framework to allow for an expenditure switching effect of exchange rate policy and study whether incorporating intermediate inputs in the production of differentiated varieties affects the model's predictions.

Consider a Cobb-Douglas production function in labor, L_t, and a bundle of intermediate inputs, x_t. Intermediate inputs can be sourced domestically or can be imported. They are combined according to a CES aggregator: $x_t = \left[(x_t^H)^{\frac{\chi-1}{\chi}} + (x_t^F)^{\frac{\chi-1}{\chi}}\right]^{\frac{\chi}{\chi-1}}$, where x_t^H and x_t^F measure domestic and imported intermediate inputs, respectively, and χ is the elasticity of substitution between them. Intermediate inputs are produced under perfect competition using only labor as a factor of production, i.e., prices are equal to the wage level in the source country. Online Appendix C.2 formalizes this extension and provides details on the resulting equilibrium conditions.

The macroeconomic effects of a sudden stop are qualitatively unchanged with the exception of output and employment. Under the current parameterization the decline in the common shifter of firm productivity is no longer enough to offset the production boom generated by the increase in exports.[52] This explains the increase in labor demand. In any case, the TFP fact holds. In addition, the expenditure switching effect is captured by the shift in demand towards domestic intermediate inputs, as the relative price of imported intermediate inputs increases. This effect is present under the two regimes. However, differences in the size of the relative price change (the nominal exchange rate depreciation is larger) will lead to differences in how prominent this effect is. See Figures A.9 and A.10 for more details.

5.3 Long-run Analysis

This extension studies a long-run version of the baseline model that fully endogenizes the number of existing firms, M_t, in line with Ottaviano (2012). The previous framework is augmented by (i) allowing for investment in capital shares; (ii) introducing a new sector that produces capital; and (iii) imposing a fixed input requirement in terms of capital in the production of differentiated varieties.

[52] One would need to impose that the shock to Z_t is four times as big as the interest-rate shock to generate a decline in output.

In particular, the representative consumer is allowed to buy shares, x_t, of the economy's capital stock, K_t, at price V_t. While capital is assumed to fully depreciate after one period; the investment entitles the representative consumer to a fraction of next period's aggregate firm profit. The consumer budget constraint is correspondingly adjusted to read:

$$\int_{\omega\in\Omega} p_t(\omega)\, q_t(\omega)\, d\omega + \epsilon_t B_t + x_t V_t K_t = \int_0^1 W_t^i L_t^i\, di + x_{t-1}\Pi_t + \epsilon_t R_{t-1} B_{t-1}\,.$$

Capital is supplied under perfect competition by a second sector in the economy. A new unit of capital is produced by combining domestic and foreign units of labor using a Cobb-Douglas production technology: $K_t = \left(l_t^{k,H}\right)^{\rho}\left(l_t^{k,F}\right)^{1-\rho}$. [53] Given the fixed capital requirement, the production of capital determines how many firms will be able to enter the market, $M_t = \frac{K_t}{f_E}$. There is a one-period-time-to-build-lag such that firms that enter at time t, will only be able to produce, provided that they satisfy the corresponding productivity threshold condition, in period $t+1$.

Online Appendix C.3 describes this extension in greater detail and provides the full set of equilibrium conditions. It is relevant, however, to highlight one new optimality condition that emerges from this set-up:

$$M_t = \left(\frac{\rho}{W_t}\right)^{\rho}\left(\frac{1-\rho}{\epsilon_t}\right)^{1-\rho}\beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\Pi_{t+1}\right]. \quad (23)$$

Intuitively, a lower price of capital encourages investment and increases the number of existing firms. As capital is produced under perfect competition, price is equal to marginal cost and, thus, a function of the price of both types of labor. The price of foreign labor is equal to the foreign wage, which is normalized to one, in domestic currency units, i.e., the nominal exchange rate. In addition, the number of existing firms is also dependent on the discounted expected profits, as profits represent the return on capital investment. This inter-temporal dimension is missing in the previous analysis, however, solving for this long-run version of the model shows that the main conclusions derived above hold.

While the shape of responses is slightly changed because of the delay in adjustment caused by the new timing assumption, the predictions are qualitatively the same. The exception is output in the floating regime, which rises moderately as the sudden stop hits the economy. See Figure A.11 for more details.

[53] I deviate from Ottaviano (2012) in two ways. First, I introduce foreign labor in the production of capital to ensure a direct role for the nominal exchange rate in firm entry. Second, I consider that while capital fully depreciates, all new units of capital are available for production the following period. The timing is adjusted: investment takes places today; firms are set-up and capital depreciates the following period.

6 Other Sudden Stops

This section explores whether the model's aggregate predictions apply beyond the Spanish experience. To systematically analyze a wider set of countries, I establish a criterion to identify sudden stops and use an event study approach to study the path of macroeconomic variables. Both these steps are standard in the literature. The novelty of the exercise relies on binning the episodes by exchange rate regime.

6.1 Data and Methodology

Following Cavallo and Frankel (2008), I define a sudden stop as an episode in which there is a substantial decline in the capital account surplus together with a recession.[54] In particular, I classify as a sudden stop a period that contains at least one year during which (i) the financial account surplus has fallen at least one standard deviation below its rolling average and (ii) GDP per capita contracts.[55] The start and end of each episode is marked by the first and last year within the period in which the financial account surplus is half a standard deviation below the rolling average.[56] The latter requirement ensures that the capital flow reversals captured by the algorithm strictly qualify as sudden stops; first, by requiring that the financing disruption is accompanied by an appropriate macroeconomic adjustment, and second, by ruling out booming episodes that display similar characteristics, for example a positive trade shock. All data is collected from standard sources and, thus, its description is relegated to Online Appendix D.1

The total number of episodes is 78, representing 5.2% of total available country/year observations in the sample.The full list of episodes per country, plus exchange rate classification, is given by Table A.15. The criterion successfully captures all traditional sudden stop episodes previously discussed by the literature - mostly occurring around the 1994/5 Tequila crisis, the 1997 Asian Financial Crisis, the 1998 Russian default - as well as the most recent balance of payment crisis in the peripheral economies of the European Union.[57,58]

I build on Ilzetzki, Reinhart and Rogoff (2019) updated *de facto* coding system in order to bin episodes by exchange rate flexibility. In my baseline results, I consider as prevalent the exchange

[54] The practice of conditioning on output contraction goes back as far as the canonical Calvo, Izquierdo and Mejía (2004) methodology. While I confine myself to what is standard in the literature, it is fair to acknowledge this is not strictly consistent with the model's definition of a sudden stop.

[55] This contrasts with Cavallo and Frankel (2008), who also require an improvement in the current account deficit (or an equivalent decline in foreign reserves). As this is conceptually equivalent to the first condition, I drop it.

[56] Refer to Online Appendix D.2 for further details.

[57] The methodology does not account for changes in TARGET2 balances in the Eurozone and, thus, prevents me from measuring private capital flows accurately. However, this is not problematic for my purposes as the algorithm already identifies the GIIPS episodes.

[58] Note that the algorithm dates the start of the two Spanish sudden stops differently than Section 2, which is instead based on common narrative. The peseta was depreciated twice already in 1992 and the improvement in the Spanish current account in 2009 is driven by the collapse of global trade in 2008 rather than by country-specific developments. In any case, the empirical results are robust to the assumption that the sudden stops start in 1993 and 2009 respectively.

rate regime that is in place during the last year of the sudden stop. There are four different cases: a currency union, a hard peg, a soft peg and a floating arrangement.[59] Out of the 78 episodes identified, 11 occur within a currency union (8 in the Euro Area and 3 in the West African Economic and Monetary Union), 14 in a hard peg system, 26 in a soft peg regime and 25 in a floating arrangement.

Figure 5 and 6 show the mean and median path of each of these aggregate variables during the episodes conditional on their exchange rate classification together with standard error bands. In order to capture the buildup and end phase of each episode, the plot depicts six-year windows that begin two years before the start of each reversal and marks the start and the average duration of a sudden stop with vertical lines. As is standard in this literature, I focus on the cyclical component of most of the variables by looking at its percentage deviation from an extrapolated pre-crisis linear trend.[60]

6.2 Results

Figure 5 illustrates how domestic variables respond to an unexpected reversal of capital flows when the exchange rate is allowed to adjust freely. First, a sudden stop is associated with a contraction in output and consumption, with most of the decline occurring on impact or shortly after. There is also a small decline in employment levels, measured as the total number of hours worked, and a significant collapse in total factor productivity. The last four graphs capture the response of the external sector: capital outflows coincide with a depreciation of the real exchange rate, represented by a decline in the index. The current account deficit is reduced sharply, almost reaching trade balance as soon as one year after the start of the episode. Finally, the average duration is slightly less than two years.

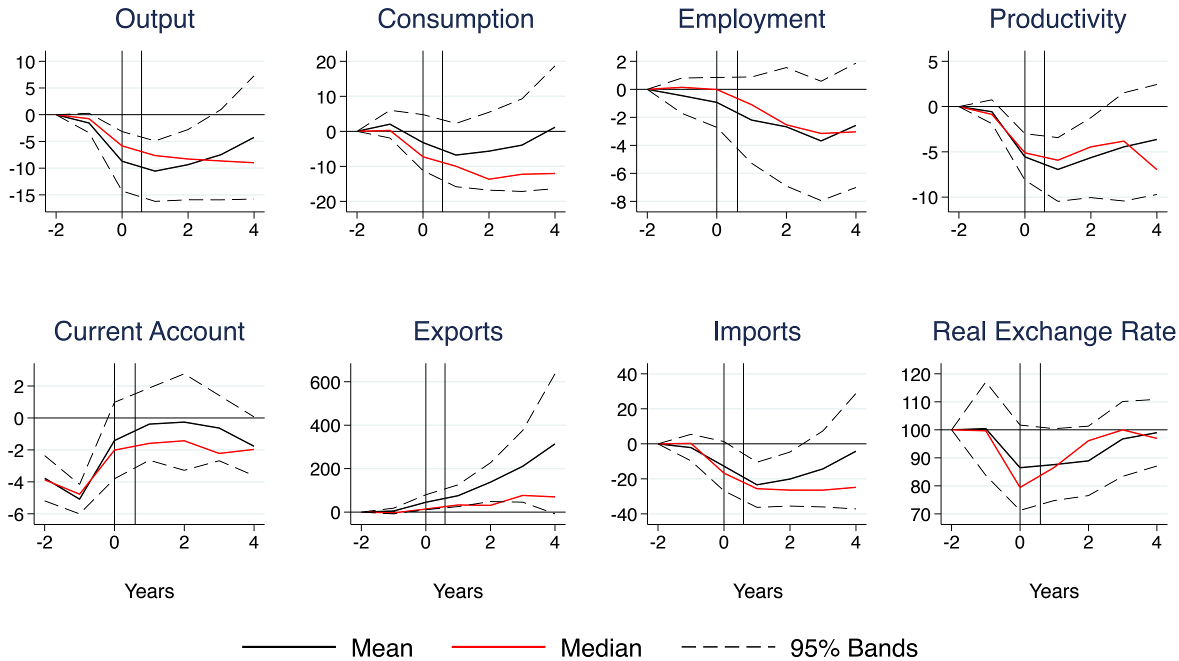
The results for a currency union are summarized by Figure 6. The response of all variables but TFP is similar, in qualitative terms, to that depicted in the flexible exchange rate case. The unexpected reversal of flows is associated with a decline in output, consumption and employment. There is a gradual reduction in the current account deficit that yet persists four years after the onset of the crisis. In line with this result, the real depreciation is more gentle than in the previous case and the episodes last longer; on average, two and a half years.

The most notable difference across the plots is the behavior of TFP: whereas productivity clearly falls in the first case, it remains unchanged or, if anything, improves slightly within cur-

[59]In terms of the Ilzetzki, Reinhart and Rogoff (2019) fine classification, I deviate as follows: (1) I manually divide code 1 into currency union and no separate legal tender, (2) I group codes 2 to 4 under the hard peg category, (3) I group codes 5 to 11 under the soft peg category, (4) I group codes 12 to 14 under the floating arrangement and (5) I rename group 15 as 5, i.e., other categories.

[60]The current account deficit, expressed as a share of GDP, and the real exchange rate index, with base t-2, are the exception.

FIGURE 5: A SUDDEN STOP IN A FLOATING ARRANGEMENT



Notes: This figure plots the response of macroeconomic variables to a sudden stop under a floating arrangement. The black and red solid lines depict the mean and median path of the corresponding variables while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Output, consumption, employment, productivity, exports and imports are expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. Current account is expressed as a share of GDP and the real exchange rate (RER), calculated as an index, is expressed in levels. The data used is collected from IFS, WDI and the Total Economy Database.

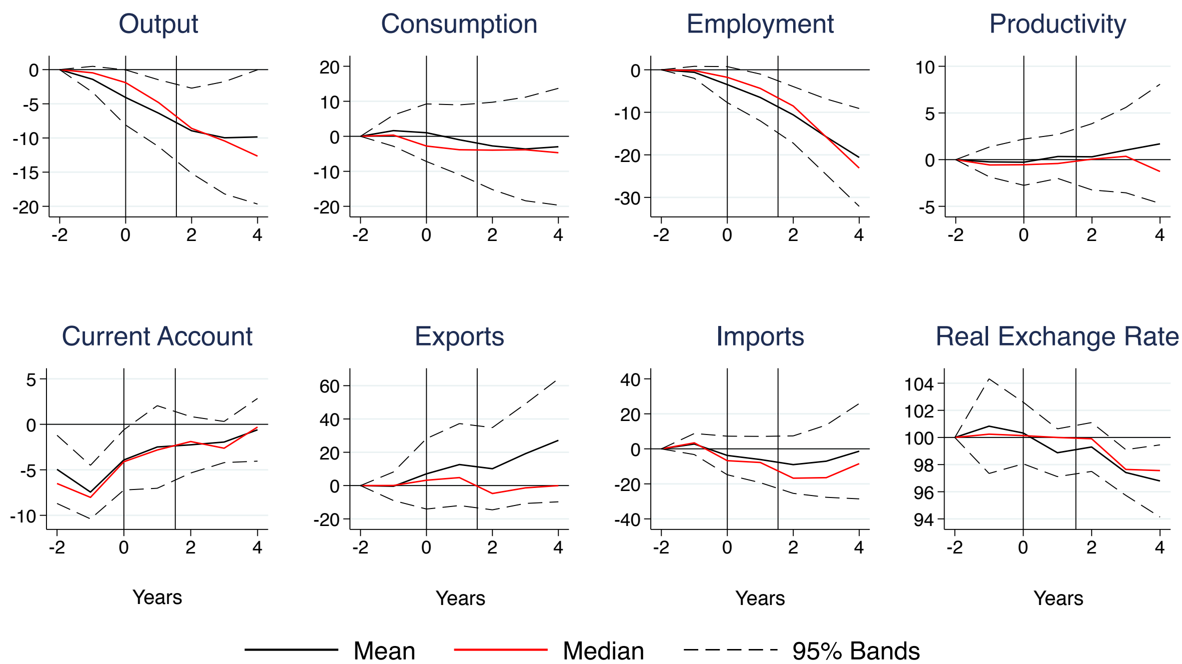
rency unions.[61,62] The positive relationship between the size of the decline in TFP and the degree of exchange rate flexibility is in line with the model's predictions.

Moreover, there are additional, although arguably minor, differences in responses across regimes that are worth highlighting. Although a quantitative comparison is beyond the scope of this exercise, the decline in employment is more pronounced in Figure 6. This holds in both absolute and relative to output terms and is consistent with the predictions of the model. In addition, a closer look at the external sector shows that in floating arrangements the current account reversal is mostly driven by the increase in exports. In a currency union, however, the decline in imports almost matches in magnitude the increase in exports suggesting there is a larger contraction of domestic demand in line with the mechanisms at play in the model.

[61] Given the reduced sample size, standard error bands are admittedly large to be able to conclude that TFP increases significantly.

[62] For completeness, I present the results for the hard and soft pegs in Figures A.12 and A.13. It is still the case that the decline in productivity is increasing in the degree of flexibility: under a hard peg, there is an increase in productivity, although bands are much wider than within a currency union, and under a soft peg, there is some significant decline, especially on impact.

FIGURE 6: A SUDDEN STOP IN A CURRENCY UNION



Notes: This figure plots the response of macroeconomic variables to a sudden stop under a currency union. The black and red solid lines depict the mean and median path of the corresponding variables while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Output, consumption, employment, productivity, exports and imports are expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. Current account is expressed as a share of GDP and the real exchange rate (RER), calculated as an index, is expressed in levels. The data used is collected from IFS, WDI and the Total Economy Database.

Finally, I conduct a battery of robustness checks to evaluate the consistency of the TFP finding including different approaches to exchange rate classification and removing the trend, alternative data sources and controlling for crisis and country characteristics. Results are available in Online Appendix D.3.

7 Conclusion

This paper revisits a classical question in international macroeconomics: how does exchange rate policy affect macroeconomic performance after a shock? While the literature provides many attempts at answering this issue, it has mostly overlooked the effect on firm dynamics. I study the question anew in the context of a sudden stop, emphasizing the divergence in TFP patterns that emerges across exchange rate regimes in the aggregate data and relating them to observed differences in firm exit at the micro level.

Taking the firm-level analysis of two sudden stops in Spain as a starting point, the paper argues that documented differences in the reallocation of resources from unproductive exiting firms to productive survivors might be related to the degree of currency appreciation vis-à-vis wage devaluation. A small open economy DSGE model featuring firm selection, variable markups and elastic labor supply formalizes the mechanism. Productivity is determined by the number of firms (pro-competitive channel), the marginal utility of wealth (demand channel) and the unit cost of production (cost mechanism). The relative magnitude of these forces depends on the exchange rate policy with a currency union generating quantitatively more cleansing because of a larger demand effect. Systematic analysis of the behavior of macroeconomic variables during sudden stops under different exchange rate regimes confirms that the model's implications hold for a wide set of economies.

This paper provides a positive account of the effect of exchange rate policy on short-term productivity growth. However, it raises a new important question: how does productivity translate into welfare gains? Evaluating the trade-off between improving resource reallocation and undoing nominal rigidities seems key in understanding the normative implications of this type of model. In particular, what is the optimal weight policy should put on each of these remains an open question for future research.

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Appendix

Proof of Lemma 1

Proof. Unweighted average productivity is given by

$$\tilde{Z}_t^H = \int_{z_t^H}^{\infty} z\, Z_t \; \frac{g(z)}{1 - G(z_t^H)} \; dz = \frac{k}{k-1} z_t^H \, Z_t \, .$$

Average productivity weighted by output is given by

$$\hat{Z}_t^H = \int_{z_t^H}^{\infty} z\, Z_t \, \frac{q(z)}{q(\tilde{z}_t^H)} \, \frac{g(z)}{1 - G(z_t^H)} \; dz \, .$$

Noting that $\frac{q(z)}{q(\tilde{z}_t^H)} = \frac{z - z_t^H}{\tilde{z}_t^H - z_t^H} \frac{\tilde{z}_t}{z}$, the above expression simplifies to $\hat{Z}_t^H = \tilde{Z}_t^H$.

Average productivity weighted by revenue is given by

$$\bar{Z}_t^H = \int_{z_t^H}^{\infty} z\, Z_t \, \frac{r(z)}{r(\tilde{z}_t^H)} \, \frac{g(z)}{1 - G(z_t^H)} \; dz \, .$$

Noting that $\frac{r(z)}{r(\tilde{z}_t^H)} = \frac{z^2-(z_t^H)^2}{(\tilde{z}_t^H)^2-(z_t^H)^2}\frac{(\tilde{z}_t)^2}{z^2}$, the above expression simplifies to $\bar{Z}_t^H = \frac{2k^3}{(2k-1)(k^2-1)} z_t^H Z_t$. □

Proof of Proposition 1

Proof. By combining equations (9) and (13), the domestic productivity threshold can be rewritten as

$$z_t^H Z_t = \frac{\lambda_t W_t^{\sigma}}{\alpha\gamma}\left[\gamma + \frac{\eta}{2k+2}N_t\right]. \tag{24}$$

To derive the expression in Proposition 1 log-linearize equation (24) around its steady state. □

Proof of Proposition 2

Proof. To see this formally, combine equations (9), (10) and (12) to rewrite the equilibrium number of active firms in the domestic market as

$$N_t = \left(\frac{1}{z_t^H}\right)^k \left[M + M^* \left(\frac{W_t^{\sigma}}{\tau\left(W_t^*\right)^{\sigma}\epsilon_t}\right)^k\right], \tag{25}$$

and combine with the expression for z_t^H above, equation (24), to get

$$z_t^H - \frac{\eta}{2k+2}\frac{\lambda_t W_t^{\sigma}}{\alpha\gamma}\left(\frac{1}{z_t^H}\right)^k \left[M + M^* \left(\frac{W_t^{\sigma}}{\tau\left(W_t^*\right)^{\sigma}\epsilon_t}\right)^k\right] = \frac{\lambda_t W_t^{\sigma}}{\alpha}. \tag{26}$$

Next, substitute equations (9), (10), (11), (19) and (20) into the new balance of payments condition, (22), which gives

$$\gamma\frac{M}{M^*}\frac{A^{k+2}}{B^{k+1}}\frac{\epsilon_t^{2k+1}}{\lambda_t W_t^{2\sigma(k+1)}}(z_t^H)^{k+2} = 1 + \Delta_t. \tag{27}$$

We are now ready to summarize the model's equilibrium in a single equation by combining (26) and (27) as

$$\left[\frac{M^*}{M}\frac{B^{k+1}}{A^{k+2}}\frac{\lambda_t W_t^{2\sigma(k+1)}}{\epsilon_t^{2k+1}}\frac{1+\Delta_t}{\gamma}\right]^{\frac{1}{k+2}} - \frac{\eta}{2k+2}\frac{\lambda_t W_t^{\sigma}}{\alpha\gamma}b^k\left[\frac{M}{M^*}\frac{A^{k+2}}{B^{k+1}}\frac{\epsilon_t^{2k+1}}{\lambda_t W_t^{2\sigma(k+1)}}\frac{\gamma}{1+\Delta_t}\right]^{\frac{k}{k+2}}\left[M + M^*\left(\frac{W_t^{\sigma}}{\tau\left(W_t^*\right)^{\sigma}\epsilon_t}\right)^k\right] = \frac{\lambda_t W_t^{\sigma}}{\alpha}. \tag{28}$$

From here it is straightforward to see that there is a positive relationship between ϵ_t and Δ_t as $k > 1$. It then follows that because there is a negative relationship between ϵ_t and z_t^H given by

(26), an increase in Δ_t, lowers z_t^H unambiguously if wages remain unchanged.

The relationship between W_t and Δ_t is less obvious. The right-hand side of equation (28) is decreasing in wages as $\lambda_t W_t^{\sigma} \propto W_t^{\sigma - \frac{1}{\mu(1-\beta(1-\mu))}}$ by Lemma 2. The left-hand side, however, depends on parameter values. Similarly the relationship between W_t and z_t^H given by (26) is also ambiguous. □

Lemma 2. *There is a negative relationship between the marginal utility of income and the wage level.*

Proof. Given the nature of the shock, $\mathbb{E}_t \log(X_{t+1}) = log(\bar{W})$, where $\bar{W}$ is the steady state wage level. It then follows from rewriting equation (14) for $s = 0$ that

$$log(X_t) = (1 - \beta(1-\mu)) \log(W_t^{flex}) + \beta(1-\mu) \log(\bar{W}) \,.$$

Plugging the above into equation (15) and taking the exponential shows that $\lambda_t \propto W_t^{\frac{-1}{\mu(1-\beta(1-\mu))}}$. □

Proof of Corollary 1

Proof. Suppose $\mu(1-\beta(1-\mu))\sigma(1+k) > \frac{1}{2}$, then the left-hand side of equation (28) is increasing in wages. Thus, there is an unambiguous negative relationship between W_t and Δ_t. If, in addition, $\mu(1-\beta(1-\mu))\sigma(1+k) < 1$, then (26) depicts a negative relationship between W_t and z_t^H. Altogether, this ensure that an increase in Δ_t, rises z_t^H unambiguously if the exchange rate remains unchanged. □

Appendix (for Online Publication) to

Sudden Stops, Productivity, and the Exchange Rate

by Laura Castillo-Martinez

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A Firm-level Data

A.1 Comparability of Episodes

This appendix provides more detailed evidence that the 1992-92 and the 2010-13 sudden stops in Spain were similar in a number of dimensions, which allow for their comparison, but crucially differ in the response of exchange rate policy.

The inflow of capital into the Spanish economy was particularly pronounced during the late 1980s and for much of the 2000s, to a great extent driven by important headways in the European integration agenda. The accession to the European Union club in 1986 and the launch of the common currency in 2002 explain the behavior of the sovereign debt risk premium in the years preceding the sudden stops as depicted in the first plot of Figure A.2. Given the flow of foreign money, these were years of growing current account deficits, which peaked at 3.5% in 1991 and 9.6 % in 2007 respectively. At the same time, Spain was forfeiting its international competitive edge, with its real exchange rate appreciating 28% between 1986-1991 and 16% between 2001-2007.

Both pre-crisis periods were also characterized by a booming construction sector, as summarized by its growing contribution to GDP. While a level comparison is unfortunately uninformative given changes in the methodology used by the National Statistics Office over time, the last plot of Figure A.2 shows that the share of construction value added had been increasing since 1986 when the first sudden stop hit and had shortly reversed from a nine year upward trend when the second unfolded. Similarly, housing prices grew an average of 3.8% and 3.5% per year in the six years preceding the two sudden stops and fell on average by 6.6% and 8.1% per year during the crises as measured by Mack and Martínez-García (2011)'s Real Housing Price Index. Moreover, Martínez-Toledano (2020) argues that Spain experienced two house price cycles over the last three decades and identifies the turning points to be 1991 and 2007, slightly before (or just as) capital inflows started to reverse.

The increase in housing demand and the ease of credit came along with indebtedness for households and non-profit corporations. The escalation of debt held by the private sector, however, was substantially larger in the early to mid 2000s. The IMF estimates that private debt which amounted to almost 80% of GDP in 1991, was roughly 40% higher by 2009. Not surprisingly, the later sudden stop overlapped with a banking crisis, an important caveat that I partially address when considering alternative explanations. The public sector, however, was in a similar good shape, with sovereign debt as low as 42% in 1991 and 39% in 2008.[1]

The onset of each sudden stop shares a common thread: a backlash to European integration. Following the external political turmoil, Spain faced an exodus of foreign investment that narrowed the current account deficit and forced a real depreciation that improved international com-

[1] By 2009 the government had already increased the amount it owed to 53% as a response to the Great Financial Crisis, which unfolded worldwide just before Spain experienced its second sudden stop.

petitiveness. The second and third plots of A.2 show that, despite the differences in magnitude discussed in the main text, the current account follows a similar trend after 1992 and 2010. In addition, the annual decline in the real exchange rate index was close to 4% on average during both sudden stops.

The real effects of the sudden stop translated into negative growth rates and rising unemployment. Real output grew an average of -0.2% and -1.4% during the crises, while unemployment reached its maximum rate at 24.1% in 1994 and 26.1% in 2013. The public deficit skyrocketed due to automatic stabilizers and despite directed efforts to restrain public spending. In the earlier episode, unemployment benefits were slashed both in 1992 and 1993. In the later episode, public wages were cut back in 2010 and 2011 and a controversial array of austerity measures was announced in the summer of 2012. Note that while the latter was wider, affecting even health and education, and larger, amounting to 65 000 million of Euros in two years; it was also implemented at a later stage of the sudden stop. Structural reforms were also implemented in the form of three labor market reforms: in 1994, 2010 and 2012. All three shared, to a certain extent, the aim to enhance collective bargaining, reduce employment protection and encourage internal flexibility.

A key difference across episodes is the exchange rate regime that was in place as the external adjustment occurred. In the first sudden stop, the three consecutive devaluations of the peseta depreciated the nominal effective exchange rate by more than the real effective exchange rate (14.0% vs 8.3%). In the second sudden stop, the common currency prevented the nominal effective exchange rate from fluctuating much (2.6%), especially when compared to the size of the real depreciation (14.7%).

A.2 Data Cleaning, Definition of Variables and Deflating Nominal Measures

This appendix describes the data cleaning procedure, the definition of specific variables in the final dataset and the use of price deflators. Regarding the former, I only leave out firms that report zero or negative values of value added or capital stock. Note that I drop the entire firm record, instead of the corresponding firm-year observation. This is to prevent firms disappearing (and maybe then reappearing) in the sample strictly due to the cleaning procedure, which is vital to correctly capture entry and exit to the market. The efforts devoted to ensure consistency and accuracy during the ESEE data collection process minimize the loss of observations resulting from this requirement.

Regarding the latter, I measure real output as nominal value added divided by an output price deflator. Obtaining an appropriate industry-specific output price deflator series is challenging for two reasons. First, the data needs to go back in time at least until 1990, while Eurostat series, the standard source, only start around 2000. Instead, I use the producer price index provided by the Spanish National Statistics Institute (NSI). Second, the ESEE provides its own industry classification based on the sum of the three-digit NACE Rev.2 codes to 20 manufacturing industries.

Given that the mapping is not strictly one-to-one, deriving corresponding industry-specific deflators requires implementing a weighting strategy.[2] My approach is to use sector contribution to total manufacturing value added in 2018, also provided by the NSI, as the relevant weight.[3]

I follow the literature in using the wage bill, deflated by the above price series, instead of employment to measure the labor input, in order to control for heterogeneity in labor quality across firms. To measure capital stock I use two different variables given existing data restrictions: for the 1990-1999 period I use total real net capital stock whereas for the 2000-2014 period I use the book value of fixed assets deflated by the price of investment goods from the Spanish National Statistics Institute.[4,5]

A.3 Discrepancies with other Firm-level Analysis

This appendix reviews two other papers that have measured TFP in Spain using alternative micro-sources, highlights how their results compare to those here presented and discusses what might be driving any discrepancies.

On the one hand, Gopinath et al. (2017) study the pre-crisis slowdown of productivity in Spain and argue that it is driven by increasin capital misallocation. While the authors exploit micro-data from ORBIS to estimate two-digit industry revenue functions and measure marginal revenue products of capital and labor at the firm level, their observed aggregate TFP measure is computed as a Solow residual at the industry level. Together with differences in the cleaning procedure (the standard approach involves dropping some firm-year observations, generating artificial entry and exit dynamics, which this paper purposely circumvents) and a coverage that extends no longer than 2012, this partly explains why Figure V only captures a flat performance of TFP since 2010.

Fu and Moral-Benito (2018), on the other hand, document an increase in TFP since 2010 using firm-level from the Bank of Spain, which is closer to my results. They argue, however, that the extensive margin is not a major contributor of this trend. There are two important differences in sample selection: their focus is on all non-financial firms (versus the manufacturing sector) and their decomposition exercise uses 2010 as the base year and 2015 as the final year (as opposed to 2009 and 2013). More importantly, their dataset is based on the Central Balance Sheet Data (Central de Balances Integrada, CBI, in Spanish), which is put together using the same source

[2]For example, manufacturing industry with ESEE code 7 (paper) corresponds to NACE Rev.2 codes 171 and 172.

[3]The NSI provides weightings for the 2010-2018 period only. I use 2018 figures, as opposed to taking an average or an alternative year, because 2018 is the only year for which there are no missing values.

[4]Total real net capital stock is defined as the value of the stock of total net capital at 1990 constant prices which I simply convert into base year (2015) prices.

[5]I conduct several robustness exercises in order to check whether the change in the capital stock measure has an impact on the results. First, for the years for which the two series overlap, 1993-1999, I estimate that the correlation coefficient at the firm-level is 0.9. Second, for the 1993-1999 period, I estimate the production function using the two series separately and then compare resulting coefficients - for 18 out of 20 industries the differences are of magnitude ± 0.5 on average. Finally, I redo the analysis splitting the sample before and after 1999 such that the two series do not interact in any way during the production function estimation stage.

of data that constitutes the Spanish input for ORBIS, annual financial statements that firms are obliged to submit to the Commercial Registry. It is therefore subjected to the same limitations, in particular, how accurately it captures firm exit.

A.4 Production Function Estimation

This appendix reviews the Ackerberg, Caves and Frazer (2015) correction to the proxy approach to production function estimation. I augment it to account for attrition as first proposed by Olley and Pakes (1996).

Consider the model,

$$y_{it} = \alpha + \beta_s^k k_{it} + \beta_s^l l_{it} + \omega_{it} + \epsilon_{it}\,, \tag{29}$$

where y_{it} is value added, k_{it} is capital and l_{it} is labor input. ω_{it} is unobserved firm-level TFP and modelled as a Markov chain, $\omega_{it} = g(\omega_{it-1}) + \xi_t$.

The standard practice is to estimate industry output elasticities for capital and labor by regressing value added on input choices and to compute firm-level productivity as the Solow residual. When performing the first step, two potential problems emerge. First, productivity is unobservable and strongly correlated with input choices. A simple OLS regression will therefore deliver biased estimates of the desired elasticities because of simultaneity. Second, there is a selection bias due to the fact that firm survival is related to the unobserved productivity level: firms that remain in the sample tend to be the most productive ones.

To overcome the former issue, I follow the proxy variable approach (see Olley and Pakes (1996) and Levinsohn and Petrin (2003)) among the possibilities offered by the literature.[6] Intuitively, this method substitutes unobserved productivity by a proxy variable in the original regression. A proxy variable is an observable input or choice variable for which the mapping with respect to productivity is assumed to be invertible. Coefficients of the inputs that do not enter this mapping, mainly labor, can be non-parametrically estimated using OLS in a first stage. The remaining coefficients, capital, are estimated next by exploiting the zero correlation assumption between the unexpected component of productivity and the input choice using GMM. I use materials deflated by the output price deflator as the proxy variable. To account for labor dynamics, however, I implement the refinement introduced by Ackerberg, Caves and Frazer (2015) that consists of identifying all coefficients in the second stage by using conditional (as opposed to unconditional) moments.[7]

[6] The other alternatives are fixed effects, instrumental variables, first order conditions and a dynamic panel approach.

[7] In addition to accounting for labor dynamics, Ackerberg, Caves and Frazer (2015) improves on the Wooldridge (2009)'s extension of the Levinsohn and Petrin (2003) approach by allowing for unobserved serially correlated shocks to wages. Their framework also overcomes Gandhi, Navarro and Rivers (2016)'s concern regarding the non-identification result of the proxy variable approach by assuming a Leontief production function in materials. As a robustness check, nevertheless, I show that these two alternative methodologies generate firm-level TFP series which are highly correlated with my baseline TFP.

To control for attrition, I include an intermediate stage in which the probability of survival is estimated by fitting a probit model on materials, labor and capital in the spirit of Olley and Pakes (1996). This probability is then included as a regressor in the final stage.

Formally, I assume:

1. There exists an observable input or choice variable $m_{it} = f_t(k_{it}, l_{it}, \omega_{it})$ such that f_t is strictly monotonic in ω_{it}.

2. ω_{it} is the only econometric unobservable in the mapping above.

The production function, equation (29), can be rewritten as:

$$y_{it} = \alpha + \beta_s^k k_{it} + \beta_s^l l_{it} + f_t^{-1}(k_{it}, l_{it}, m_{it}) + \epsilon_{it} ,$$

where all regressors are now observable.

First stage As opposed to the standard proxy approach (Olley and Pakes (1996), Levinsohn and Petrin (2003)), allowing for labor dynamics with functional dependence prevents me from identifying the labor coefficient, β^l, in the first stage. Instead, I am only able to remove the shock ϵ_{it} from the dependent variable y_{it} by treating f_t^{-1} non-parametrically and recover $\hat{\Phi}_{it}$ from:

$$y_{it} = \Phi_{it}(k_{it}, l_{it}, m_{it}) + \epsilon_{it} .$$

Second stage A firm will continue to operate provided its productivity level exceeds the lower bound: $\chi_{it} = 1$ if $\omega_{it} \geq \underline{\omega}_{it}$, where χ_i is a survival indicator variable. I estimate the survival probability, $\hat{P}_{it}$, by fitting a probit model on capital, labor and the proxy variable:

$$P_{it} \equiv Pr\{\chi_t = 1 \,|\, \underline{\omega}_{it}, I_{t-1}\} = h_t(k_{it-1}, l_{it-1}, m_{it-1}) ,$$

where I_{t-1} is the information set at time $t-1$.

Third stage Given guesses for β^k and β^l, it is possible to obtain the residuals

$$\hat{\omega}_{it} = \hat{\Phi}_{it} - \beta^k k_{it} - \beta^l l_{it} ,$$

and, exploiting the Markov chain assumption on ω_{it}, obtain the corresponding residual $\hat{\xi}_{it}$ by simply regressing $\hat{\omega}_{it}$ on $\hat{\omega}_{it-1}$ and $\hat{P}_{it}$. β_k and β_l are estimated using the following GMM criterion function:

$$\frac{1}{N}\frac{1}{T}\sum_i \sum_t \begin{pmatrix} \hat{\xi}_{it} k_{it} \\ \hat{\xi}_{it} l_{it-1} \end{pmatrix} = 0 .$$

A.5 TFP Growth Decomposition

This appendix derives the TFP growth decomposition specification used in Table 1. Define aggregate productivity, Z_t, as a weighted average of firm-level TFP. Given that the focus is on firm dynamics, I express overall aggregate productivity as the weighted sum of the aggregate productivities of incumbents, Z_t^C, entrants, Z_t^N, and exiters, Z_t^X,

$$Z_t \equiv \sum_{i \in N_t} s_{i,t} Z_{i,t} = s_t^C Z_t^C + s_t^N Z_t^N + s_t^E Z_t^E \, ,$$

where $s_{i,t}$ is the employment share of firm i and N_t the total number of firms in the economy, both at time t. In addition, s_t^j is the total employment share and $Z_t^j \equiv \sum_{i \in j} s_{i,t}^j Z_{i,t}^j$ is the aggregate productivity of firms pertaining to group j, where $j = \{C, N, E\}$.

The variable of interest is the change in aggregate productivity from period $t-1$ to period t, ΔZ_t. It follows that the relevant groups for the analysis are: incumbents in both periods, firms exiting at period $t-1$ and firms entering in period t. This implies that $s_{t-1}^E = s_t^X = 0$. By exploiting the fact that $s_{t-1}^C + s_{t-1}^X = 1$ and $s_t^C + s_t^N = 1$ and using the expression above, I can rewrite the change in aggregate productivity as

$$\Delta Z_t = Z_t^C - Z_{t-1}^C + s_t^N \left(Z_t^N - Z_t^C \right) - s_{t-1}^X \left(Z_{t-1}^X - Z_{t-1}^C \right) \, .$$

The interpretation of the above decomposition partly coincides with that of Melitz and Polanec (2015): entrants (exiters) contribute positively to TFP growth when their average productivity is higher (lower) than the incumbents' counterpart. These contributions are weighted by the employment share of entrants, s_t^N, and exiters, s_{t-1}^X, respectively.[8] I abstract, however, from decomposing the contribution of incumbents further using Olley and Pakes (1996)'s approach.[9] Instead, I follow Dias and Marques (2018) in tracking individual incumbent firms over time so that I can distinguish between the contributions of firm-level productivity growth and employment share reallocation among them.

Given the definition of Z_t^C, the change in aggregate productivity can be further decomposed as:

[8]This version differs from the widely used Foster, Haltiwanger and Krizan (2001) decomposition in allowing for differences in the reference productivity for entrants, exiters and incumbents. Intuitively, the contribution of entrants (exiters) is now equal to the change in productivity one would observe if entry (exit) was elided. Moreover, it has a direct mapping into a theoretical model of firm productivity heterogeneity, circumventing the recent criticism to accounting exercises measuring reallocation posed by Hsieh and Klenow (2017).

[9]Olley and Pakes (1996) would simply set:

$$Z_t^C - Z_{t-1}^C = \Delta \bar{Z}_t^C + \Delta \, Cov \left(s_{i,t}^C, Z_{i,t}^C \right) \, .$$

$$\Delta Z_t = \sum_{i \in C} s_{i,t-1} \Delta Z_{i,t} + \sum_{i \in C} Z_{i,t-1} \Delta s_{i,t} + \sum_{i \in C} \Delta s_{i,t} \Delta Z_{i,t} + s_t^N \left(Z_t^N - Z_t^C \right) - s_{t-1}^X \left(Z_{t-1}^X - Z_{t-1}^C \right) .$$

The contribution by incumbents maps exactly into that in Foster, Grim and Haltiwanger (2016). The first term measures the contribution of within-firm productivity changes of incumbents weighted by their initial share. The second term captures the contribution of market share reallocation. The third term is known as the cross-effect, it is the covariance of market share and productivity changes for the individual firm.

A.6 Allocative Efficiency

This appendix summarizes the Hsieh and Klenow (2009) argument that resource misallocation can hinder aggregate productivity and explains how I measure marginal revenue products dispersion.

Consider a framework with a final good featuring a CES production function in differentiated intermediates goods that are imperfectly substitutable. Intermediate good producers have standard Cobb-Douglas production technologies, with capital share α, and are subject to firm-specific exogenous wedges that distort (i) output, τ_{it}^y, and (ii) capital relative to labor, τ_{it}^k. The individual intermediate good producer optimization problem delivers the following first-order conditions with respect to labor, l_{it}, and capital, k_{it}:

$$MRPL_{it} = \left(\frac{1-\alpha}{\mu} \right) \left(\frac{P_{it} Y_{it}}{L_{it}} \right) = \left(\frac{1}{1-\tau_{it}^y} \right) W_t \, , \tag{30}$$

$$MRPK_{it} = \left(\frac{\alpha}{\mu} \right) \left(\frac{P_{it} Y_{it}}{K_{it}} \right) = \left(\frac{1+\tau_{it}^k}{1-\tau_{it}^y} \right) R_t \, , \tag{31}$$

where $P_{it} Y_{it}$ is firm nominal value added, W_t is the cost of labor, R_t is the cost of capital and μ is the constant markup of price over marginal cost. I set the capital share to be equal to 0.35 and the constant markup equal to 1.5 as in Gopinath et al. (2017). I first obtain sector-level measures of dispersion in logs which I then aggregate into an economy-wide employment-weighted average using time-invariant weights corresponding to the 2000-2014 employment share average.

Hsieh and Klenow (2009) formally show that aggregate TFP in this economy is highest when resources are allocated optimally. This is achieved only if firms face equal distortions and marginal revenue products above are equalized. To see this, define physical and revenue productivities at the firm-level as

$$TFPQ_{it} \equiv A_{it} = \frac{Y_{it}}{K_{it}^{\alpha} L_{it}^{1-\alpha}} \, , \tag{32}$$

and

$$TFPR_{it} \equiv P_{it} A_{it} = \frac{P_{it} Y_{it}}{K_{it}^{\alpha} L_{it}^{1-\alpha}} . \tag{33}$$

By substituting equations (30) and (31) into equation (33),

$$TFPR_{it} = \mu \left(\frac{MRPK_{it}}{\alpha} \right)^{\alpha} \left(\frac{MRPL_{it}}{1-\alpha} \right)^{1-\alpha} = \mu \left(\frac{R_t}{\alpha} \right)^{\alpha} \left(\frac{W_t}{1-\alpha} \right)^{1-\alpha} \frac{\left(1+\tau_i^k\right)^{\alpha}}{1-\tau_i^y} ,$$

it follows that optimal allocation of labor and capital ensures that firms with higher TFPQ expand production such that they charge lower prices than more unproductive firms and TFPR is equalized across plants. In other words, dispersion in TFPR is solely driven by the presence of firm-specific distortions in this model. Such distortions can lower aggregate TFP by the following expression:

$$TFP_t = \left[\sum_{i=1} \left(A_{it} \frac{\overline{TFPR}_t}{TFPR_{it}} \right)^{\sigma-1} \right]^{\frac{1}{1-\sigma}} ,$$

where $\overline{TFPR}_t$ is the revenue weighted average TFPR. Periods of higher TFP should be associated with periods of lower marginal revenue product dispersion and differences in the results for capital and labor can be interpreted as evidence of the different types of wedges that prevail.

A.6.1 Differences in Crisis Duration

As already mentioned, a notable difference across the two sudden stops discussed is the length of each of these crises. This could be particularly problematic in a world in which firms postponed their decision to shut down, incurring negative profits, until they are unable to roll on credit any further. Under this assumption, it can be argued that the observed larger contribution of exit during the 2010-13 is a mechanical effect of its duration. In other words, if the 1992-93 crisis had been longer, more unproductive firms would have exited the market.

To account for this possibility, this appendix performs two different exercises: first, it looks at the evolution of exit rates over each of the crisis; second, it decomposes the contribution of incumbents, entrants and exiters year by year. Figure A.3 plots the share of exiting firms by year. With the exception of the 2002-03 jump, the overall trend is relatively flat, with crisis periods just above the average. Particularly relevant for my analysis, the 2010-13 sudden stop is characterized by higher exit rates during the first three (and not the last) years of the crisis. This contradicts the argument that exit patterns are mostly driven by a longer duration.

Table A.3 summarizes the results of the annualized decomposition of TFP growth. This is computed by looking at year-on-year changes and taking averages for the crisis periods. Results show that, although magnitudes are reduced, the main conclusions hold: there is pro-cyclicality of productivity at the firm level in both sudden stops but only a sizable composition effect that overturns the aggregate trend in the later episode.

A.7 Robustness

A.7.1 Aggregating TFP Using Value-Added Weights

Table A.2 presents the results for the TFP growth decomposition exercise in the main text, but defining aggregate TFP as the value-added weighted average of firm-level TFP. The magnitudes of aggregate productivity changes are roughly the same for both sudden stops. It is still the case, that the fall in TFP during the 1992-93 episode is driven mainly by the behavior of incumbents and, more specifically, by the decline in within-firm productivity.

As for the 2010-13 sudden stop, the relative role of the extensive margin is slightly dampened compared to the baseline results. While the contribution of net entrants is still positive and sizable, it now represents 40% of overall growth. This is, once again, fully explained by the exit of unproductive firms. The other main different is the lack of market reallocation, which is compensated by a large positive covariance between productivity and market share changes at the firm level. In sum, although with some minor differences, the main conclusions hold when considering value-added weights.

A.7.2 Accounting for Sampling Weights

Large firms are over-represented in the ESEE, and thus in my sample, for two reasons. First, the initial survey in 1990 included all firms operating in Spain with more than 200 workers but only a stratified, proportional and systematic sample with random seed of firms employing between 10 and 200 workers. Second, incorporation of new firms every year is also biased towards larger firms: all new entrants with more than 200 workers are included versus only a random selection representing 5% of those with 10 to 200 workers.

Accounting for sampling weights would be the standard way to proceed. However, these are not available on a year-to-year basis. As a second best I present the unweighted results as the baseline in the main text and conduct a robustness test with the sampling weights provided. These correspond to years 1990, 2005, 2009 and 2011. I assume sampling weights remain constant between vintages.

All main results are robust to accounting for sampling weights. Figure A.6 resembles strongly its main text counterpart, confirming that the change in log TFP is concentrated on the lowest percentiles of the firm productivity distribution during both sudden stops. The TFP decomposition exercise summarized by Table A.6 underscores the importance of the extensive margin in the 2010-13 episode - the contribution of net entry is larger than previously reported. In fact, as predicted under a negative correlation between firm's propensity to exit and firm size, the baseline result can be interpreted as a lower bound. The main difference, however, is that while the change in aggregate TFP is still positive in the most recent sudden stop, its magnitude is now much smaller. Tables A.7 and A.8 show that accounting for sampling weights barely changes the regressions results for the cleansing hypothesis test.

A.7.3 An Alternative Dataset - ORBIS

The global company database ORBIS, produced by Bureau van Dijk, has risen as the predominant source for firm-level analysis given the extent of companies covered. Particularly relevant to my analysis, it collects data from a large number of smaller firms (SMEs), which account for a greater share of economic activity in Spain and matches better the firm-size distribution of the universe of firms. While it is not as suited to study the role of the extensive margin given its poor monitoring of firm exit and data only goes back to the late 1990s, I redo part of the analysis using ORBIS. Note that the cleaning procedure follows that used for the ESEE dataset.

Tables A.9 and A.10 confirm the prevalence of a cleansing effect during the 2010-2013 sudden stop. According to the ORBIS data, TFP increases during this period almost 9%, which is very close to the baseline finding, 10%. The exit of unproductive firms explains three quarters of growth, while the reallocation of resources to more productive firms overcomes the negative firm-level productivity growth of incumbents. Similarly, the sudden stop is a period during which the negative correlation between propensity to exit and firm productivity strengthens. On the other hand, the interaction coefficient in the labor growth regression is only positive for the incumbent-only subsample. Even in this case, however, it is not statistically significant; this stands in contrast with the baseline results.

ORBIS does not provide any information on whether firms are engaged in foreign trade. This prevents me from testing all the alternative explanations that the main text considers. However, Table A.11 shows that controlling for the exposure to the construction sector and the financial health of the firm does not affect the magnitude nor the stability of the key productivity coefficients. In addition, Table A.12 confirms that firms' markups are increasing in firm-level productivity and declining in aggregate productivity. The latter holds for both TFP at the aggregate level as well as at the industry level.

B Details on the Baseline Model

B.1 Summary of Equilibrium Conditions

Endogenous variables: z_t^H, z_t^F, z_t^{*F}, L_t, N_t, B_t, R_t, P_t, λ_t, W_t, ϵ_t
Equilibrium conditions:

$$z_t^H = \frac{\gamma + \eta N_t}{\frac{\alpha\gamma}{\lambda_t} + \eta P_t} W_t^{\sigma}, \tag{34}$$

$$z_t^F = \frac{\gamma + \eta N_t}{\frac{\alpha\gamma}{\lambda_t} + \eta P_t} \tau \epsilon_t (W_t^*)^\sigma , \tag{35}$$

$$z_t^{F*} = \frac{B}{A} \frac{\tau W_t^\sigma}{\epsilon_t} , \tag{36}$$

$$N_t = M(z_t^H)^{-k} + M^*(z_t^F)^{-k} , \tag{37}$$

$$P_t = \frac{2k+1}{2k+2} \frac{W_t^\sigma N_t}{z_t^H} , \tag{38}$$

$$L_t = \frac{k}{(k+1)(k+2)} \sigma W_t^{2\sigma-1} M \left(\frac{\lambda_t}{\gamma} \left(z_t^H\right)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t} \left(z_t^{F*}\right)^{-(k+2)} \right) , \tag{39}$$

$$1 = \beta R_t \mathbb{E}_t \left(\frac{\epsilon_{t+1}}{\epsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \right) , \tag{40}$$

$$R_t = R_t^* + \phi \left(e^{\bar{B} - B_t} - 1 \right) + \left(e^{\xi_t - 1} - 1 \right) , \tag{41}$$

$$MB \frac{(\tau W_t^\sigma)^2}{\epsilon_t} \left(z_t^{F*}\right)^{-(k+2)} - M^* \frac{\lambda_t \left(\tau \epsilon_t (W_t^*)^\sigma\right)^2}{\gamma} \left(z_t^F\right)^{-(k+2)} = 2(k+2)\epsilon_t (B_t - R_{t-1} B_{t-1}) , \tag{42}$$

$$W_t = \prod_{s=0}^{\infty} \left(\frac{\theta}{\theta - 1} \mathbb{E}_{t-s} \left(\frac{1}{\lambda_t} \right) \right)^{\mu(1-\mu)^s} , \tag{43}$$

$$\text{monetary policy rule} . \tag{44}$$

B.2 A Model of Two Large Countries: The Limit Case

This appendix shows that the assumptions required to treat Home as a small open economy can be derived from the steady state version of a model with two countries which are symmetric in everything except size *i.e.* Home is assumed to be small relative to Foreign. In particular, if the two countries are endowed with n and $n-1$ shares of the world's total number of potentially active firms, $\bar{M}$,

$$M = n\bar{M}, \quad M^* = (1-n)\bar{M}, \quad n \in [0,1],$$

then the limit case to be considered is one in which $n \to 0$. The productivity cutoffs of this model would be given by the steady state versions of equations (34) and (35) together with:

$$z^{*F} = \frac{\gamma + \eta N}{\frac{\alpha\gamma}{\lambda} + \eta P} \tau \epsilon (W^*)^\sigma , \tag{45}$$

$$z^{*H} = \frac{\gamma + \eta N^*}{\frac{\alpha\gamma}{\lambda^*} + \eta P^*} (W^*)^\sigma , \tag{46}$$

The number of active firms in Home and Foreign is given by equation (37) and

$$N^* = (1-n)\bar{M}^*(z^{*H})^{-k} + n\bar{M}(z^F)^{-k}\,, \tag{47}$$

while the aggregate price level is summarized by equation (38) and

$$P^* = \frac{2k+1}{2k+2}\frac{(W^*)^{\sigma}N^*}{z^{*H}}\,. \tag{48}$$

Finally, the balance of payments condition in a zero trade balance steady state can be rewritten as

$$\frac{n}{1-n} = \frac{\lambda}{\lambda^*}\left(\frac{W^*}{W}\right)^{2\sigma}\epsilon^3\left(\frac{z^{*F}}{z^F}\right)^{(k+2)}\,, \tag{49}$$

To summarize, for a given n, the equilibrium in the model with two countries can be described by equations (34), (35), (37), (38), (45)-(49) with nine unknown variables $\{z^H, z^F, z^{*H}, z^{*H}, N, N^*, P, P^*, W\}$, taking foreign labor input as the numeraire ($W^* = 1$).

This system, however, can be further collapsed into three equations in three unknowns, namely, z^H, z^{*H} and W:

$$\alpha\gamma\frac{1-\theta}{\theta}z^H W = W^{\sigma}\left[\gamma + \frac{\eta}{2k+2}\left(\frac{1}{z^H}\right)^k \bar{M}\left(n + (1-n)\left(\frac{W^{\sigma}}{\tau\epsilon}\right)^k\right)\right]\,, \tag{50}$$

$$\alpha\gamma\frac{1-\theta}{\theta}z^{*H} = \left[\gamma + \frac{\eta}{2k+2}\left(\frac{1}{z^{*H}}\right)^k \bar{M}\left((1-n) + n\left(\frac{\epsilon}{\tau W^{\sigma}}\right)^k\right)\right]\,, \tag{51}$$

$$\frac{n}{1-n} = \frac{W^{2\sigma(k+1)-1}}{\epsilon^{2k+1}}\left(\frac{z^{*H}}{z^H}\right)^{(k+2)}\,. \tag{52}$$

As $n \to 0$, equation (51) simplifies to

$$\alpha\gamma\frac{1-\theta}{\theta}z^{*H} = \left[\gamma + \frac{\eta}{2k+2}\left(\frac{1}{z^{*H}}\right)^k \bar{M}\right]\,,$$

which solves for z^{*H} as a function only of parameters. I have, thus, proved the first assumption: the foreign domestic productivity cutoff is not affected by changes at Home for n small enough.

Note that due to the Pareto distribution assumption, z^{*H}, cannot fall below one, the minimum value for productivity. Therefore, I need distinguish between two different cases. Suppose

$$\alpha\gamma\frac{1-\theta}{\theta} < \gamma + \frac{\eta}{2k+2}\bar{M}\,, \tag{53}$$

then the solution to the above equation is larger than one. Once, I have solved for z^{*H}, the foreign demand for the domestic variety is given by

$$q^{*F}(z) = \frac{1}{\gamma + \eta N^*}\left(\alpha + \frac{\eta}{\gamma}\frac{\theta}{1-\theta}P^*\right) - \frac{\theta}{1-\theta}\frac{1}{\gamma}p^{*F}(z)\,, \tag{54}$$

where $N^* = \bar{M}\left(z^{*H}\right)^{-k}$ and P^* is a function of z^{*H} as given by equation (48), and, thus, constant.

Suppose, instead, the opposite is true, and the inequality given by equation (53) does not hold. In such a case, z^{*H} remains at one so that all foreign firms produce, $N^* = \bar{M}$. This also means, that the choke price for Foreign is not binding[10] and a new equation for the aggregate price level in Foreign is required. In particular, the new price level is given by

$$P^* = \left(\frac{2}{\bar{M}} - \frac{\eta}{\gamma + \eta N^*}\right)^{-1}\left[\frac{\alpha\gamma\frac{1-\theta}{\theta}}{\gamma + \eta N^*} + \frac{1}{b}\frac{k}{k+1}\right].$$

The rest of the argument follows: foreign demand for the domestic variety is given by equation (54) which implies that A and B in equation (52) are constants as none of the foreign variables *i.e.* z^{*H}, N^* and P^*, are affected by changes in Home.

B.3 Existence and Uniqueness of Steady State

This appendix solves for the steady state of the model and shows that it is unique provided $\bar{B} = 0$. To ease notation, I drop all time subscripts. The steady state is summarized by one equation in one unknown, which can be solved numerically provided parameter values.

Start by rewriting the wage equation in steady state as

$$\lambda = \frac{\theta}{\theta - 1}\frac{1}{W}\,. \tag{55}$$

Combine (34) and (38) to get

$$z^H\alpha\gamma = W^\sigma\lambda\left(\gamma + \frac{\eta}{2k+2}N\right). \tag{56}$$

Rewrite z^F as a function of z^H, given equations (34) and (35),

$$z^H = \frac{\tau\epsilon}{W^\sigma}z^H\,, \tag{57}$$

and plug into equation (37)

$$N = \left(\frac{1}{z^H}\right)^k\left(M + M^*\left(\frac{W^\sigma}{\tau\epsilon}\right)^k\right).$$

[10]The maximum price faced by foreign consumers is actually lower than the choke price they would be willing to pay.

which can now be combined with equation (55) and (56) such that

$$z^H \alpha\gamma = \frac{\theta}{\theta-1}\frac{1}{W^{1-\sigma}}\left(\gamma + \frac{\eta}{2k+2}\left(\frac{1}{z^H}\right)^k\left(M + M^*\left(\frac{W^\sigma}{\tau\epsilon}\right)^k\right)\right). \tag{58}$$

Next, note that in steady state the interest rate is given by $R = \frac{1}{\beta}$ and bond holdings are $B = \bar{B}$ (see equations (40) and (41) respectively). Imposing this on the balance of payment condition, (42), together with equations (36), (55) and (57), delivers

$$M\frac{A^{k+2}}{B^{k+1}}\frac{\epsilon^{k+1}}{\left(\tau W^\sigma\right)^k} - M^*\frac{\theta}{\theta-1}\frac{W^{\sigma(k+2)-1}}{\gamma}\frac{\left(z^H\right)^{-(k+2)}}{\left(\tau\epsilon\right)^k} = -2\left(k+2\right)\epsilon\frac{(1-\beta)}{\beta}\bar{B}\,. \tag{59}$$

Equation (59) can be rewritten in terms of z^H and then plugged into equation (58). This would deliver a system of one equation in one unknown: if the economy is embedded in a currency union, the exchange rate is equal to one and the unknown is W. If the economy has a floating arrangement, the wage level is equal to the target and the unknown is ϵ. In any case, there exists a steady state equilibrium.

Impose that trade balance holds in equilibrium ($\bar{B} = 0$). Equation (59) is simplified to

$$\frac{1}{z^H} = \left[\gamma\frac{\theta-1}{\theta}\frac{M}{M^*}\frac{A^{k+2}}{B^{k+1}}\frac{\epsilon^{k+2}}{W^{2\sigma(k+1)-1}}\right]^{\frac{1}{k+2}},$$

and can now substitute for z^H in equation (58) as follows

$$\alpha\gamma\frac{\theta-1}{\theta} = \left[\gamma\frac{\theta-1}{\theta}\frac{M}{M^*}\frac{A^{k+2}}{B^{k+1}}\frac{\epsilon^{k+2}}{W^{2\sigma(k+1)-1}}\right]^{\frac{1}{k+2}}\left[\gamma + \frac{\eta}{2k+2}\left[\gamma\frac{\theta-1}{\theta}\frac{M}{M^*}\frac{A^{k+2}}{B^{k+1}}\frac{\epsilon^{k+2}}{W^{2\sigma(k+1)-1}}\right]^{\frac{k}{k+2}}\left(M + M^*\left(\frac{w^\sigma}{\tau\epsilon}\right)^k\right)\right].$$

The left hand side is a positive constant. The right hand side is:

1. A monotonically decreasing function in W with positive limit of zero and a negative limit of $+\infty$ in the currency union regime.

2. A monotonically increasing function in ϵ with positive limit of $+\infty$ and a negative limit of zero in the currency union regime.

Thus, in both cases, there exists a unique solution.

B.4 TFP Growth Decomposition in the Model

This appendix provides the mapping from the model to the TFP growth decomposition exercise. Consistent with the results reported for the Spanish firm-level data, the object of interest is the labor-weighted aggregate TFP, which in the model is defined as:

$$Z_t^H = N_t^H \int_{z_t^H}^{\infty} s_t(z) z\, Z_t \, \frac{g(z)}{1 - G(z_t^H)} \, dz \, ,$$

where $s_t(z) = \frac{l_t^H(z)}{L_t^H}$.

The change in aggregate productivity from period $t-1$ to period t according to the decomposition derived in Online Appendix B.4. is equal to

$$\Delta Z_t^H = \sum_{i \in C} s_{i,t-1} \Delta Z_{i,t}^H + \sum_{i \in C} Z_{i,t-1}^H \Delta s_{i,t} + \sum_{i \in C} \Delta s_{i,t} \Delta Z_{i,t}^H + s_t^N \left(Z_t^{H,N} - Z_t^{H,C} \right) - s_{t-1}^{H,X} \left(Z_{t-1}^X - Z_{t-1}^{H,C} \right) .$$

Suppose that $z_t^H < z_{t-1}^H$ i.e. there is only entry. The mapping to the model is the following:

$$\sum_{i \in C} s_{i,t-1} \Delta Z_{i,t}^H = z_{t-1}^H \left(Z_t - Z_{t-1} \right) \frac{k+2}{k} \, ,$$

$$\sum_{i \in C} Z_{i,t-1}^H \Delta s_{i,t} = -z_{t-1}^H \, Z_{t-1} \frac{k+2}{k} \frac{\frac{z_{t-1}^H}{z_t^H} - 1}{k \left(\frac{z_{t-1}^H}{z_t^H} - 1 \right) + 2 \left(\frac{z_{t-1}^H}{z_t^H} - \frac{1}{2} \right)} \, ,$$

$$\sum_{i \in C} \Delta s_{i,t} \Delta Z_{i,t}^H = -z_{t-1}^H \left(Z_t - Z_{t-1} \right) \frac{k+2}{k} \frac{\frac{z_{t-1}^H}{z_t^H} - 1}{k \left(\frac{z_{t-1}^H}{z_t^H} - 1 \right) + 2 \left(\frac{z_{t-1}^H}{z_t^H} - \frac{1}{2} \right)} \, ,$$

$$s_t^N \left(Z_t^{H,N} - Z_t^{H,C} \right) = -\frac{(k+2)(k+1)}{k} \frac{Z_t}{z_t^H} \frac{\left(z_{t-1}^H - z_t^H \right)^2}{k \left(\frac{z_{t-1}^H}{z_t^H} - 1 \right) + 2 \left(\frac{z_{t-1}^H}{z_t^H} - \frac{1}{2} \right)} \, .$$

Suppose that $z_t^H > z_{t-1}^H$ i.e. there is only exit. The mapping to the model is the following:

$$\sum_{i \in C} s_{i,t-1} \Delta Z_{i,t}^H = z_t^H \left(Z_t - Z_{t-1} \right) \frac{k+2}{k} \frac{\frac{z_t^H}{z_{t-1}^H} + k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right)}{k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right) + 2 \left(\frac{z_t^H}{z_{t-1}^H} - \frac{1}{2} \right)} \, ,$$

$$\sum_{i \in C} Z_{i,t-1}^H \Delta s_{i,t} = z_t^H Z_{t-1} \frac{k+2}{k} \left[1 - \frac{\frac{z_t^H}{z_{t-1}^H} + k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right)}{k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right) + 2 \left(\frac{z_t^H}{z_{t-1}^H} - \frac{1}{2} \right)} \right] ,$$

$$\sum_{i \in C} \Delta s_{i,t} \Delta Z_{i,t}^H = z_t^H \left(Z_t - Z_{t-1} \right) \frac{k+2}{k} \left[1 - \frac{\frac{z_t^H}{z_{t-1}^H} + k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right)}{k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right) + 2 \left(\frac{z_t^H}{z_{t-1}^H} - \frac{1}{2} \right)} \right] ,$$

$$s_{t-1}^X \left(Z_{t-1}^{H,X} - Z_{t-1}^{H,C} \right) = \frac{(k+2)(k+1)}{k} \frac{Z_{t-1}}{z_{t-1}^H} \frac{\left(z_t^H - z_{t-1}^H \right)^2}{k \left(\frac{z_t^H}{z_{t-1}^H} - 1 \right) + 2 \left(\frac{z_t^H}{z_{t-1}^H} - \frac{1}{2} \right)} \, .$$

C Extensions to the Model

C.1 A Second Factor of Production

This appendix describes a version of the baseline model that features physical capital as the second input in the production of differentiated varieties. In particular, the unit cost at time t for a firm with idiosyncratic productivity level z is now given by $\frac{c_t}{zZ_t}$, where:

$$c_t = \left(\frac{W_t}{\sigma}\right)^{\sigma} \left(\frac{\kappa_t}{1-\sigma}\right)^{1-\sigma}, \tag{60}$$

where κ_t is the rental price of capital.

The clearing of the capital market ensures that capital demanded by firms is equal to the constant stock supplied by households:

$$K^s = \frac{(1-\sigma)kb^k}{(k+2)(k+1)} \frac{M}{\kappa_t} \left(\frac{c_t}{Z_t}\right)^2 \left[\frac{\lambda_t}{\gamma}(z_t^H)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t}(z_t^{*F})^{-(k+2)}\right]. \tag{61}$$

The rational expectations equilibrium of this extension is the set of stochastic processes $\{z_t^H, z_t^F, z_t^{*F}, IM_t, EX_t, L_t, N_t, B_t, R_t, P_t, \lambda_t, W_t, \kappa_t, c_t\}_{t=0}^{\infty}$ satisfying equations (3), (5), (12), (16), (18), (60), (61) and

$$\frac{z_t^H Z_t}{c_t}\left(\frac{\alpha\gamma}{\lambda_t} + \eta P_t\right) = \gamma + \eta N_t\,, \tag{62}$$

$$\frac{z_t^F}{\tau\epsilon_t c_t^*}\left(\frac{\alpha\gamma}{\lambda_t} + \eta P_t\right) = \gamma + \eta N_t\,, \tag{63}$$

$$z_t^{*F} Z_t = \frac{B}{A}\frac{\tau c_t}{\epsilon_t}, \tag{64}$$

$$P_t = \frac{2k+1}{2k+2}\frac{c_t N_t}{z_t^H Z_t}, \tag{65}$$

$$L_t = \frac{\sigma kb^k}{(k+1)(k+2)} \frac{M}{W_t} \left(\frac{c_t}{Z_t}\right)^2 \left[\frac{\lambda_t}{\gamma}(z_t^H)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t}(z_t^{*F})^{-(k+2)}\right],$$

$$IM_t = \frac{b^k}{2(k+2)} M * \frac{\lambda_t}{\gamma}\left(\frac{\tau\epsilon_t c_t^*}{Z_t}\right)^2 \left(z_t^F\right)^{-(k+2)}, \tag{66}$$

$$EX_t = \frac{b^k}{2(k+2)} M \frac{B}{\epsilon_t}\left(\frac{\tau c_t}{Z_t}\right)^2 \left(z_t^{*F}\right)^{-(k+2)}, \tag{67}$$

given the exogenous process $\{\xi_t, Z_t\}_{t=0}^{\infty}$, initial conditions $\{R_{-1}, B_{-1}, W_[t-1\}$ and the central bank's policy $\{\epsilon_t\}_{t=0}^{\infty}$. The foreign marginal cost, c_t^*, is normalized to one.

The supply of capital is parameterized such that the steady state is the same as in the baseline model, $K^S = 0.0182$. All other parameters remain unchanged.

C.2 Imported Intermediate Inputs

This appendix describes a version of the baseline model that features domestic and imported intermediate inputs as factors of production. In particular, the unit cost at time t for a firm with idiosyncratic productivity level z is now given by $\frac{c_t}{zZ_t}$, where:

$$c_t = \left(\frac{W_t}{\sigma}\right)^{\sigma}\left(\frac{p_t^x}{1-\sigma}\right)^{1-\sigma}, \tag{68}$$

$$p_t^x = \left[W_t^{1-\chi} + \epsilon_t^{1-\chi}\right]^{\frac{1}{1-\chi}}. \tag{69}$$

The demand for domestic and foreign intermediate inputs follows from the firm's cost minimization problem such that:

$$x_t^H = \epsilon_t^{\chi}\left[\frac{1}{\epsilon_t^{\chi-1} + W_t^{\chi-1}}\right]^{\frac{1}{\chi-1}} \frac{(1-\sigma)kb^k}{(k+1)(k+2)}\frac{M}{p_t^x}\left(\frac{c_t}{Z_t}\right)^2\left[\frac{\lambda_t}{\gamma}(z_t^H)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t}(z_t^{*F})^{-(k+2)}\right] \tag{70}$$

$$x_t^F = W_t^{\chi}\left[\frac{1}{\epsilon_t^{\chi-1} + W_t^{\chi-1}}\right]^{\frac{1}{\chi-1}} \frac{(1-\sigma)kb^k}{(k+1)(k+2)}\frac{M}{p_t^x}\left(\frac{c_t}{Z_t}\right)^2\left[\frac{\lambda_t}{\gamma}(z_t^H)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t}(z_t^{*F})^{-(k+2)}\right] \tag{71}$$

The rational expectations equilibrium of this extension is the set of stochastic processes $\{z_t^H, z_t^F, z_t^{*F}, IM_t, EX_t, L_t, N_t, B_t, R_t, P_t, \lambda_t, W_t, c_t, p_t^x, x_t^H, x_t^F\}_{t=0}^{\infty}$ satisfying equations (3), (5), (12), (16), (62)-(71) and

$$L_t = \frac{\sigma kb^k}{(k+1)(k+2)}\frac{M}{W_t}\left(\frac{c_t}{Z_t}\right)^2\left[\frac{\lambda_t}{\gamma}(z_t^H)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t}(z_t^{*F})^{-(k+2)}\right] + x_t^H,$$

$$EX_t - IM_t - \epsilon_t x_t^F = \epsilon_t(B_t - R_{t-1}B_{t-1}),$$

given the exogenous process $\{\xi_t, Z_t\}_{t=0}^{\infty}$, initial conditions $\{R_{-1}, B_{-1}, W_{t-1}\}$ and the central bank's policy $\{\epsilon_t\}_{t=0}^{\infty}$. The foreign marginal cost, c_t^*, is normalized to one.

There is only one new parameter: the elasticity of substitution between domestic and foreign intermediate inputs, χ. I follow Gopinath and Neiman (2014) in setting $\chi = 4$. I adjust the foreign demand parameters to match the same moments described in the benchmark calibration. This requires setting $A = 1.37$ and $B = 3.14$. All other parameters remain unchanged.

C.3 Long-run Analysis

This appendix describes a long-run version of the baseline model where the number of existing firms, M_t, is endogenous. The set-up follows Ottaviano (2012) in putting Melitz and Ottaviano (2008) in a DSGE framework. The key innovation is the introduction of capital which is supplied by a second sector, accumulated by consumers and required for the set-up of firms producing the differentiated varieties. In what follows, I highlight how these assumptions and new implications fit into the set-up presented in section 3.

The representative household As explained in the main text, the representative consumer is allowed to buy shares, x_t, of the economy's capital stock, K_t, at price, V_t. While capital is assumed to fully depreciate after one period; the investment entitles the representative consumer to a fraction of next period's aggregate firm profit. The consumer budget constraint is correspondingly adjusted to read:

$$\int_{\omega\in\Omega} p_t(\omega)\, q_t(\omega)\, d\omega + \epsilon_t B_t + x_t V_t K_t = \int_0^1 W_t^i L_t^i \, di + x_{t-1}\Pi_t + \epsilon_t R_{t-1} B_{t-1}\,.$$

Regarding the household's optimization problem, there is an additional optimality condition describing the purchase of capital shares. In particular:

$$1 = \beta E_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{\Pi_{t+1}}{V_t K_t}\right]\,.$$

Capital investment is encouraged when the price of capital is low or when expected future returns are high. Given risk aversion, returns are adjusted by the stochastic discount factor: returns are more desirable whenever the marginal utility of income is higher.

Production of capital Capital is produced under perfect competition using a Cobb-Douglas technology that combines units of domestic labor, $l_t^{k,H}$ and foreign labor, $l_t^{k,F}$: $K_t = \left(l_t^{k,H}\right)^{\rho}\left(l_t^{k,F}\right)^{1-\rho}$.

Producers of capital choose labor inputs such that costs are minimized. For this analysis, only the demand for domestic labor is relevant,

$$l_t^{k,H} = \left(\frac{\rho}{1-\rho}\frac{\epsilon_t}{W_t}\right)^{1-\rho} K_t. \tag{72}$$

Production of differentiated varieties I assume that f_E units of capital are required for a firm to produce a differentiated variety. The timing is such that the fixed entry cost is due one period before the firm is able to start production. This implies that the realization of the firm's productivity draw is still unknown. The resulting free-entry condition pins down the number of firms that will be potentially active in period $t+1$, denoted by M_t:

$$M_t = \frac{K_t}{f_E}\,. \tag{73}$$

Aggregation and market clearing The number of active firms in the domestic market, N_t, has to be modified to account for the new timing assumption. In particular, the number of firms at time t will depend on the number of firms that paid the fixed capital requirement in period $t-1$ such that:

$$N_t = M_{t-1}\left(\frac{b}{z_t^H}\right)^k + M^*\left(\frac{b}{z_t^F}\right)^k\,. \tag{74}$$

Aggregate labor demand is augmented to include the domestic labor input used in the production of capital as given by equation (72), such that the labor market clearing condition now reads:

$$L_t = \frac{\sigma k b^k}{(k+1)(k+2)}\frac{M_{t-1}}{W_t}\left(\frac{W_t^\sigma}{Z_t}\right)^2\left[\frac{\lambda_t}{\gamma}\left(z_t^H\right)^{-(k+2)} + B\frac{\tau^2}{\epsilon_t}\left(z_t^{*F}\right)^{-(k+2)}\right] + \left(\frac{\rho}{1-\rho}\frac{\epsilon_t}{W_t}\right)^{1-\rho} f_E M_t\,, \tag{75}$$

where the free market condition, equation (73), is used to substitute for capital.

Given the capital investment decision, aggregate profit is now a variable of interest. It is computed by summing profits from domestic and export sales. More precisely,

$$\Pi_t = \frac{bk}{2(k+1)(k+2)}M_{t-1}\left(\frac{W_t^\sigma}{Z_t}\right)^2\left[\frac{\lambda_t}{\gamma}\left(z_t^H\right)^{-(k+2)} + B\frac{\tau^2}{\epsilon_t}\left(z_t^{*F}\right)^{-(k+2)}\right]\,. \tag{76}$$

A new market clearing condition for capital ensures that demand by consumers is equated to supply by producers. Given the perfect competition assumption, this simply implies that the price of capital is equal to its marginal cost. Formally,

$$V_t = \left(\frac{W_t}{\rho}\right)^\rho\left(\frac{\epsilon_t W_t^*}{1-\rho}\right)^{1-\rho}\,.$$

As the consumer's budget constraint has been modified, the resulting balance of payment condition is:

$$EX_t - IM_t + \epsilon_t B_{t-1}(R_{t-1}-1) = \epsilon_t\left(B_t - B_{t-1}\right) + \left(\frac{W_t}{\rho}\right)^\rho\left(\frac{\epsilon_t W_t^*}{1-\rho}\right)^{1-\rho}(1-\rho)f_e M_t\,, \tag{77}$$

where EM_t and IM_t, the total export and import revenues in domestic currency terms, are given by:

$$EX_t = \frac{b^k}{2(k+2)}M_{t-1}\frac{B}{\epsilon_t}\left(\frac{\tau W_t^\sigma}{Z_t}\right)^2\left(z_t^{*F}\right)^{-(k+2)}\,, \tag{78}$$

and equation (19) respectively. Note that the above balance of payment condition is derived by imposing that, in equilibrium, capital shares add up to one.

Solving the model The rational expectations equilibrium of this extension is the set of stochastic processes $\{z_t^H, z_t^F, z_t^{*F}, IM_t, EX_t, L_t, N_t, B_t, R_t, P_t, \lambda_t, W_t, M_{t-1}, \Pi_t\}_{t=0}^{\infty}$ satisfying equations (3), (5), (9)-(11), (13), (16), (19), (23), (74)-(78) given the exogenous process $\{\xi_t, Z_t\}_{t=0}^{\infty}$, initial conditions $\{R_{-1}, B_{-1}\}$ and the central bank's policy $\{\epsilon_t\}_{t=0}^{\infty}$. The foreign wage, W_t^*, is normalized to one.

This extension of the model is parameterized following the same principles as the baseline framework. The cost of entry is calibrated such that the economy starts at the same steady state as the baseline, $f_E = 4.1531e - 04$, and $\rho = 0.5$.

D Aggregate Data

D.1 Data Sources

Annual data on the current and capital accounts for all available countries comes from the IMF's International Financial Statistics Database (IFS) for the period 1990-2015 and complemented with data on GDP per capita growth from the World Bank's World Development Indicators Database.[11]

To characterize the behavior of the macroeconomy as a sudden stop unfolds I use data on output, final private consumption, employment, TFP, current account deficit and real exchange rate. All variables are compiled from the World Development Indicators except for TFP that is collected from the Conference Board's Total Economy Database and the current account deficit from the IMF's World Economic Outlook Database.

D.2 Identifying Sudden Stops: Algorithm

The following algorithm combines elements of Calvo, Izquierdo and Mejía (2004) and Cavallo and Frankel (2008).

- Use IMF Balance of Payment annual data for all available countries in the period 1990-2015.
- Drop (i) small countries - in terms of population (below 1 million inhabitants) and in terms of wealth (below 1 billion USD); (ii) countries with incomplete time series.
- Compute year-to-year changes in the financial account.
- Compute rolling averages and standard deviations of the change in the financial account with a window length equal to ten years. Check that at least 60% of the observations in the window are available, otherwise set to missing.

[11] I do not consider countries which are small, both in terms of population (below one million inhabitants) and in terms of GDP (below one billion USD). The final sample covers 119 countries.

- Identify reversal episodes as subsequent country-year observations that show reductions in the financial surplus half a standard deviation above the mean change as calculated in the previous step. Classify the first and last country-year observation as the start and end of each episode.

- Filter to keep reversal episodes that contain at least one country-year observation with a reduction in the financial surplus one standard deviation above the mean change.

- Filter again to keep reversal episodes that are accompanied by a fall in GDP per capita during the same year or the year that follows immediately after. Surviving episodes are classified as sudden stops.

Note that one year episodes starting in 2009 are dropped from the final sample as they simply capture the global trade collapse that followed the burst of the 2008 financial crisis instead of a country-specific reversal of capital flows.

D.3 Robustness

This appendix presents robustness checks to the event study discussed in section 6. In the interest of space, only results for productivity are reported. Results for all other variables are available upon request.

D.3.1 Alternative Exchange Rate Classification

The classification of episodes by exchange rate regime is essential to this exercise. I distinguish four regimes based on the degree of exchange rate flexibility (currency union, hard peg, soft peg and floating arrangment) building from an existing *de facto* coding system put together by Ilzetzki, Reinhart and Rogoff (2019). In panel A of Figure A.14, I explore how robust results are to an alternative coding system. More specifically, I rely on Klein and Shambaugh (2008), which allow for regime changes at higher frequency. Although some episodes are now classified under a different exchange rate label, the same conclusions carry through.

A different robustness approach requires taking into account that the exchange rate regime might change during the sudden stop. In the main text, I classify episodes based on the exchange rate regime prevalent during the last year of the sudden stop. This is motivated by the fact that, historically, most countries abandoned pre-existing pegs as a response to a sudden stop, which through the lens of the model is equivalent to a nominal depreciation. However, there are also some cases in which failed currency pegs led to capital outflows, in the first place. Panel B of Figure A.14 classifies episodes based on the exchange rate regime prevalent at the start of the sudden stop. The response of productivity looks remarkable similar to the baseline under a floating arrangemnt and it is completely unchanged under a currency union.

D.3.2 Alternative Detrending Methods

The focus of this literature is on the cyclical component of macroeconomic variables. This requires removing the trend of each raw time series prior to the event study. For the baseline results, I fit a linear trend to the pre-crisis data and extrapolate forward. In panel A of Figure A.15, I instead consider a more sophisticated (and popularized) detrending method: the Hodrick-Prescott (HP) filter. To prevent future states influencing current observations, I use the one-sided version. Given that the frequency of the data is annual, I set the smoothing parameter equal to 6.25. In a currency union, TFP remains almost constant during the sudden stop, while the collapse is significant in a floating arrangement. However, the magnitude of the decline is smaller and the recovery faster than in the baseline results. This is driven by the fact that a HP filter uses observations at $t - i$, $i > 0$ to construct the current time point t, while the baseline method uses the same set of observations for any t such that $t > -2$.

Panel B of Figure A.15 explores the role of the pre-crisis sample in shaping the results. While keeping the sample length constant, I shift the sample selection closer to the year the sudden stop hits. In particular, I calculate the linear trend using observations from periods $t - 4$ to $t - 1$. Results remain unchanged.[12]

D.3.3 Full Window Requirement

In order to account for changes in the composition of the sample, I redo the analysis including only episodes for which all six years of data are available. Figure A.16 shows that this restriction has no discernible effects on the baseline results.

D.3.4 Controlling for Development Level

The reader might be concerned that the exchange rate regime classification is picking up another dimension of heterogeneity across episodes. A legitimate candidate is the underlying degree of economic development of affected countries; the list of sudden stops under a currency union is dominated by rich economies. To address this issue, I conduct the analysis by restricting the sample to either advanced or emerging economies only. I use the IMF country classification as reported by the World Economic Outlook April 2018 release. In addition I manually code Haiti, Gabon, Rwanda, Sierra Leone and Moldova as developing economies.

Results for productivity are reported in Figure A.17. Note that given the reduction in the sample size, I collapse results for a currency union and a hard peg on the one hand, and results for a soft peg and a floating arrangement on the other. Panel A shows the behavior of TFP during a sudden stop in advanced economies. As in the baseline case, there is an increase, albeit non-significant, improvement in productivity when the exchange rate is fixed, either in a currency

[12] I have also explored changing the sample length on its own and together with a sample shift as discussed here.

union or a hard peg; while there is a clear decline when the exchange rate is more freely allowed to adjust.

Panel B depicts a fall in productivity during the sudden stops that take place in developing economies irrespective of the exchange rate regime in place. However, the decline in TFP is non-significant, with wider standard errors, and quantitatively smaller in the case of a currency union or hard peg. To some extent this is driven by the fact that almost all of the episodes here captured fall under the hard peg category (as opposed to currency unions).

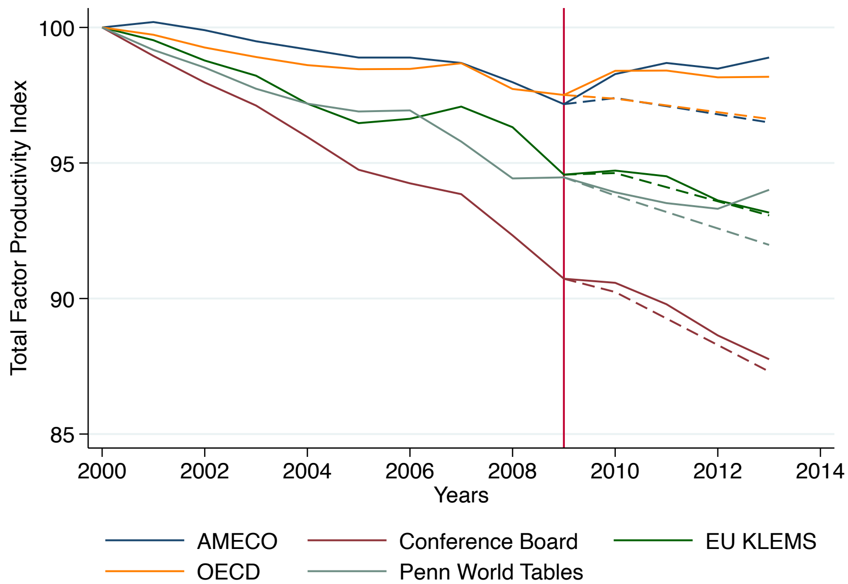
D.3.5 Controlling for the Type of Crisis

Two additional potential dimensions of heterogeneity across episodes are the type and the geographic scope of the crisis in which the sudden stop results. Regarding the former, it is recurrent in economic history that balance of payment crisis coincide in time with banking crisis. To evaluate whether the unison of crises plays a role, I control for the incidence of twin crises. In particular, I generate a dummy variable that equals one if, during a sudden stop, there is a year or a pair of consecutive years in which a banking and a currency crisis take place as reported by Laeven and Valencia (2018). Panel A of Figure A.18 shows that results are robust to controlling for twin crises.

Regarding the latter, sudden stops often take place in several countries simultaneously. To account for the synchronization of international capital flow cycles and spillovers risks, I control for the scope of the associated crisis i.e. whether it is global or regional (as opposed to local). I define the crisis as global if the global GDP growth rate is negative anytime between one year before and one year after the sudden stop's starting date, period $t = 0$. Similarly, I define the crisis as regional if the corresponding regional GDP growth rate is negative anytime between one year before and one year after the sudden stop's starting date, period $t = 0$. The associated crisis is local if it is not regional nor global. Global and regional GDP growth rates are collected from the IMF's World Economic Outlook. Results are reported in panel B of Figure A.18. Note that I group members of a currency union and hard peggers together on the one hand, and soft peggers and floaters on the other, to overcome the reduction in sample size. Once again, there are no major changes in the productivity plots.

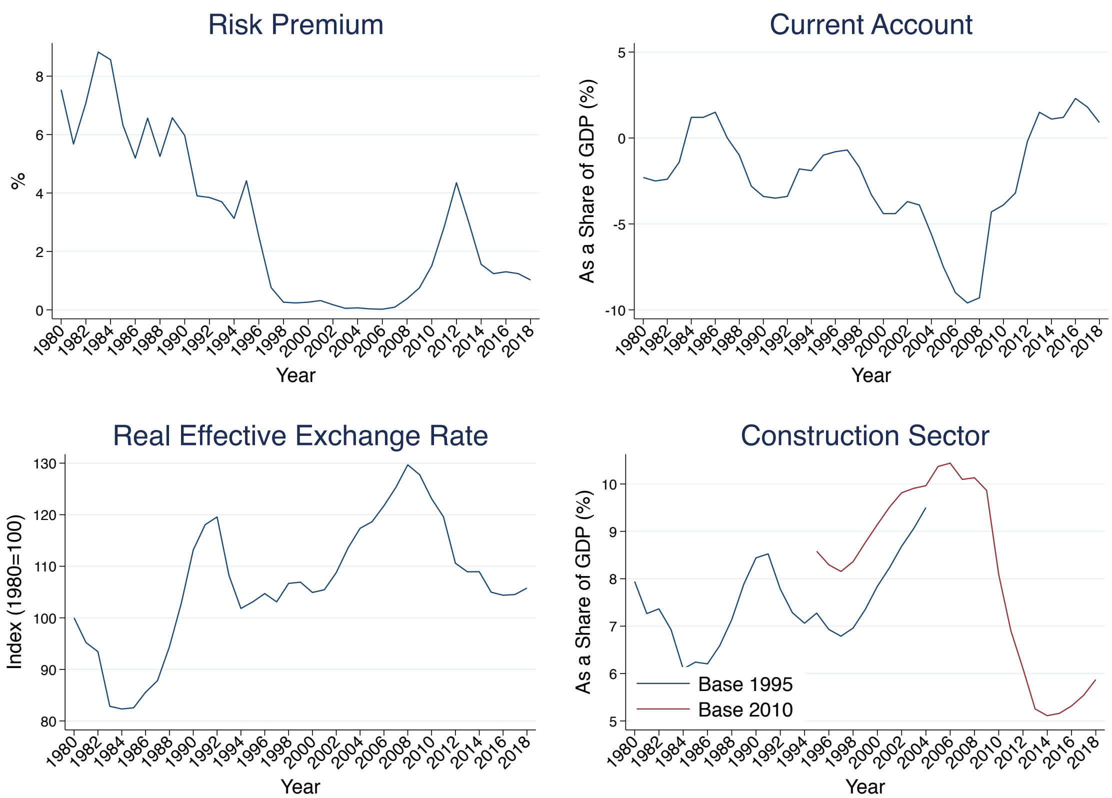
E Additional Figures

FIGURE A.1: TFP IN SPAIN - ALTERNATIVE SOURCES



Notes: This figure plots the evolution of aggregate TFP in Spain according to alternative data sources. The solid line is the actual evolution of the time series while the dashed line corresponds to the extrapolation of a quadratic trend fitted from observations corresponding to the 2000-09 period. The sources of the data are AMECO, Conference Board, EU KLEMS, OECD and Penn World Tables.

FIGURE A.2: EVOLUTION OF THE SPANISH ECONOMY

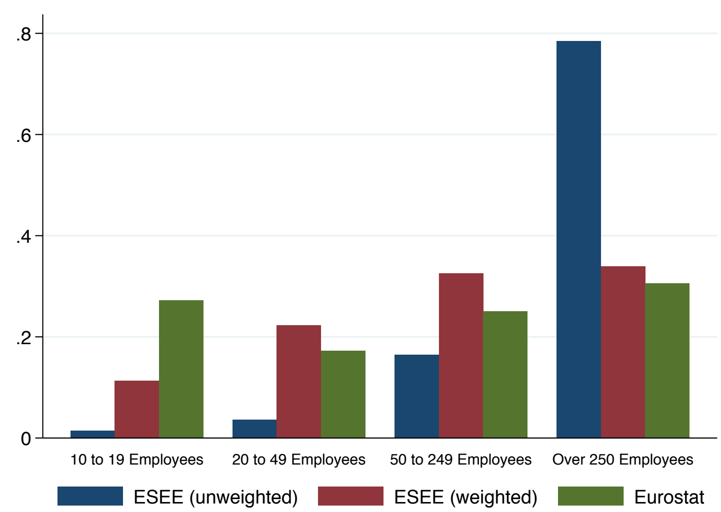


Notes: The first figure plots the evolution of the sovereign debt risk premium calculated as the difference between the Spanish and the German 10-year government bond yield. The second figure plots the evolution of the current account as a share of GDP. The third figure plots the real effective exchange rate (REER) calculated using unit labor costs. An increase in the REER index represents a real appreciation of the domestic currency. The fourth figure plots the evolution of value added in the construction sector as a share of GDP. The sources of the data are OECD, IMF and INE.

Figure A.3: Exit Rate by Year

Notes: This figure plots the exit rate defined as the share of firms that exit at t relative to the total number of firms at $t-1$. The data used is collected from the ESEE dataset.

Figure A.4: Share of Total Employment by Size Class

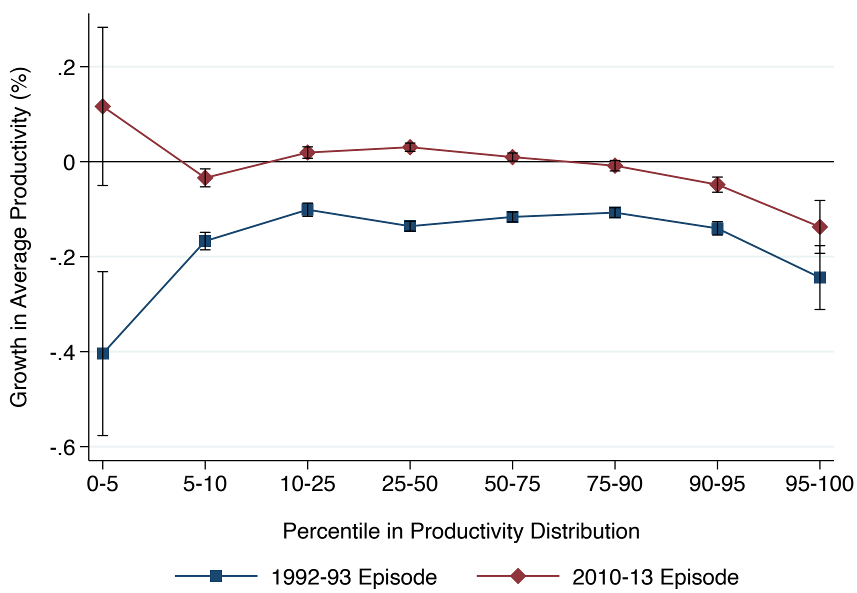


Notes: This figure plots the fraction of total employment accounted for by firms belonging to each size class. The blue and red bars report statistics from the ESEE dataset (unweighted and weighted correspondingly) and the green bar from Eurostat.

Figure A.5: Misallocation

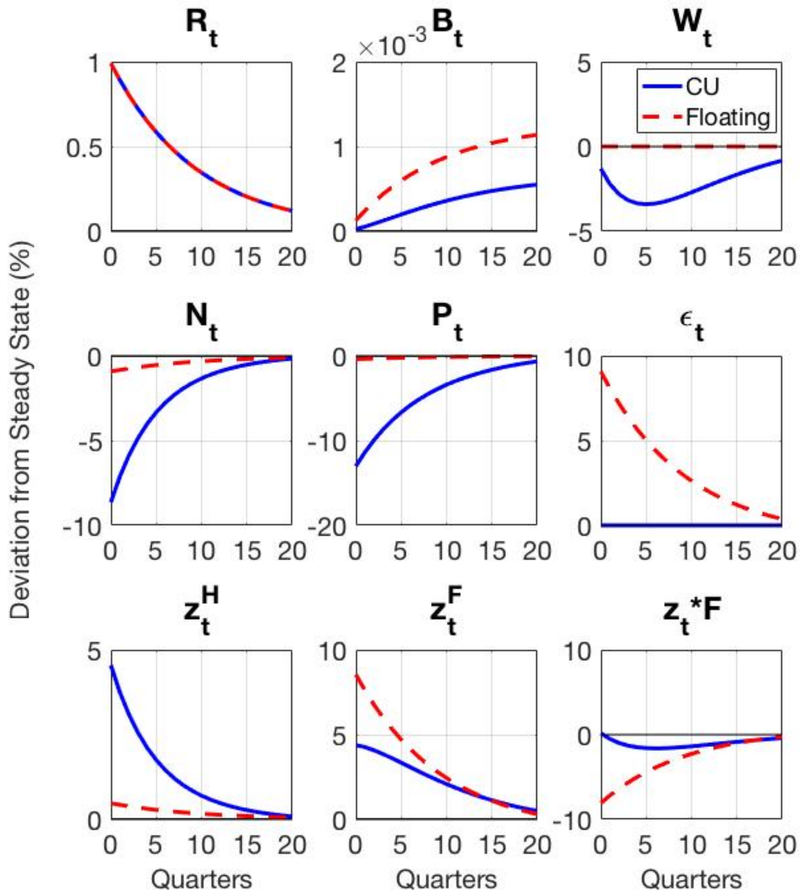
Notes: This figure plots the within-industry dispersion of the marginal revenue products of capital and labor over time using sampling weights described in Online Appendix A.7. The numbers depicted are relative to 2000, which is normalized to one. Marginal revenue products are measured at the firm-level according to the Hsieh and Klenow (2009) framework. Standard deviations at the sector level are aggregated using time-invariant employment weights. The data used is collected from the ESEE dataset.

Figure A.6: Productivity Growth across the Distribution with Sampling Weights



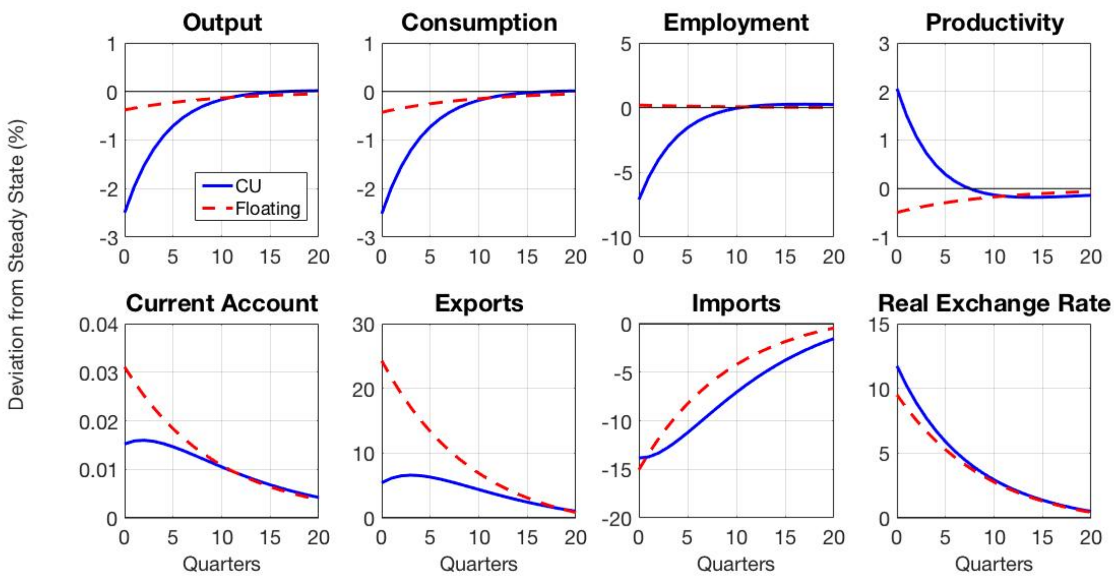
Notes: This graph plots the growth in average TFP by percentile of the productivity distribution. It compares the average TFP of firms in a given percentile before and after each of the two sudden stops. As this is an unbalanced panel, firms are allowed to change percentiles and even exit the sample during the transition. The corresponding base and end years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. To account for variability, the vertical lines represent error bands. The data used is collected from the ESEE dataset.

FIGURE A.7: BASELINE MODEL - OTHER VARIABLES



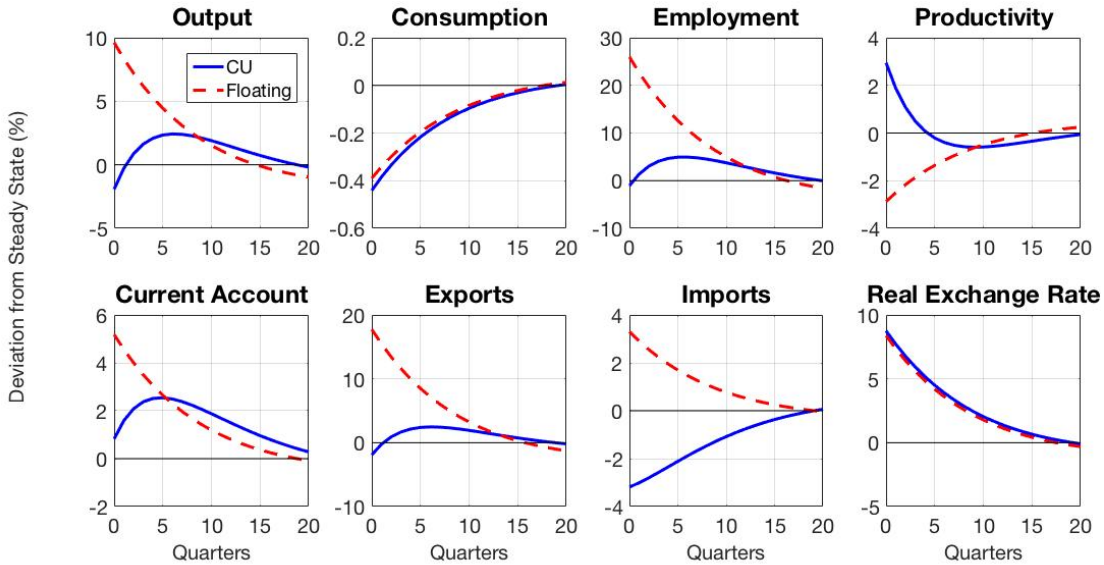
Notes: These figures plot the impulse response functions of additional macroeconomic variables to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter as predicted by the model described in section 3. All variables but debt holdings are expressed in log deviations from steady state. The level of debt, assumed to be zero in steady state, is expressed in levels. The interest rate, R_t, and the level of debt, B_t, are denominated in foreign currency; the wage, W_t and price level, P_t are denominated in domestic currency; the nominal exchange rate, ϵ_t, is defined as domestic currency per unit of foreign currency; all other variables are expressed in real terms.

FIGURE A.8: A MODEL WITH CAPITAL



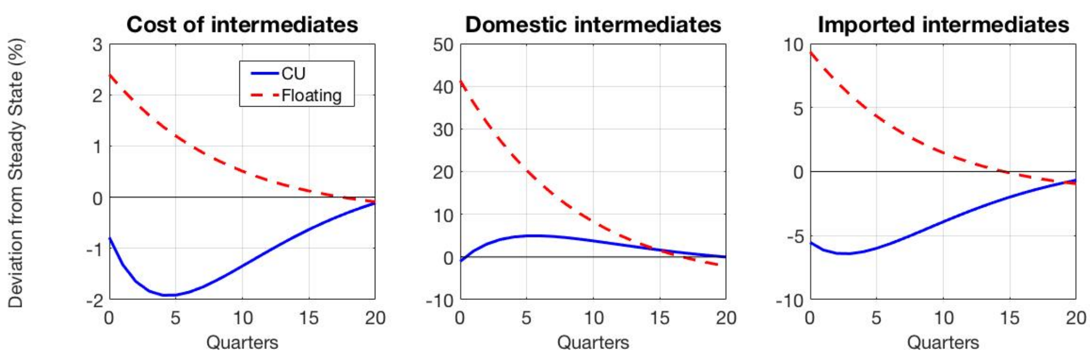
Notes: These figures plot the impulse response functions of key macroeconomic variables to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter in a version of the model featuring physical capital as described in Appendix C.1. All variables but the current account are expressed in log deviations from steady state. The current account, assumed to be zero in steady state, is expressed in levels. The current account, exports and imports are denominated in domestic currency; all other variables are expressed in real terms.

FIGURE A.9: A MODEL WITH IMPORTED INTERMEDIATE INPUTS



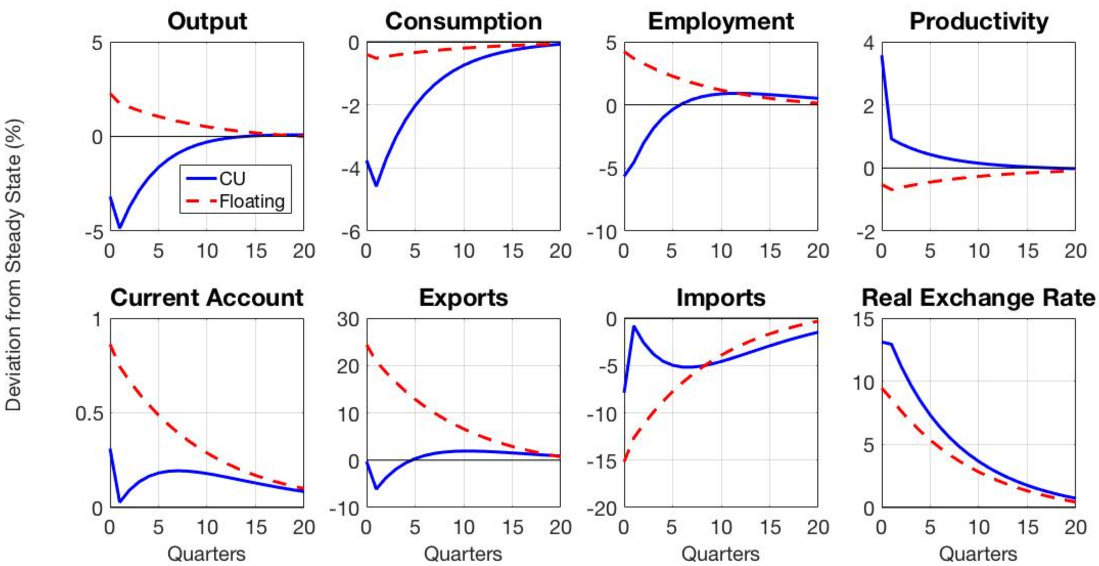
Notes: These figures plot the impulse response functions of key macroeconomic variables to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter in a version of the model featuring imported intermediate inputs as described in Appendix C.2. All variables but the current account are expressed in log deviations from steady state. The current account, assumed to be zero in steady state, is expressed in levels. The current account, exports and imports are denominated in domestic currency; all other variables are expressed in real terms.

FIGURE A.10: A MODEL WITH IMPORTED INTERMEDIATE INPUTS - OTHER VARIABLES



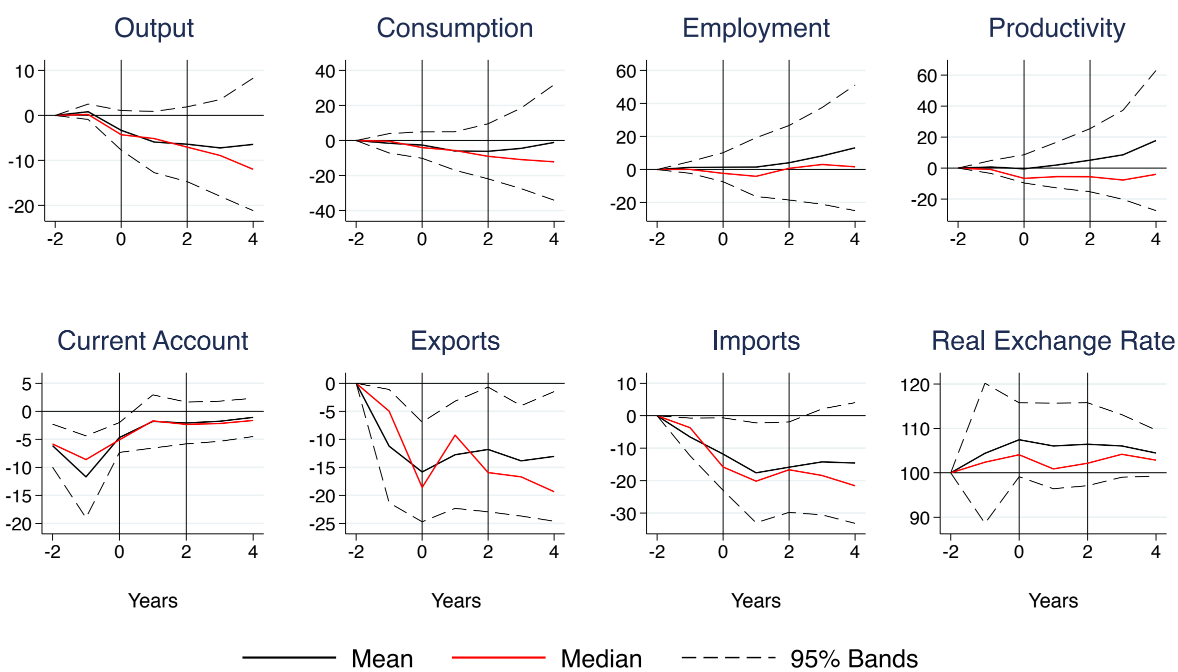
Notes: These figures plot the impulse response functions of the marginal cost and the demand for intermediate inputs to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter in a version of the model featuring imported intermediate inputs as described in Appendix C.2. Variables are expressed in log deviations from steady state. The cost of intermediates is denominated in domestic currency while the demand for intermediate inputs is in real terms.

FIGURE A.11: LONG-RUN VERSION OF THE MODEL



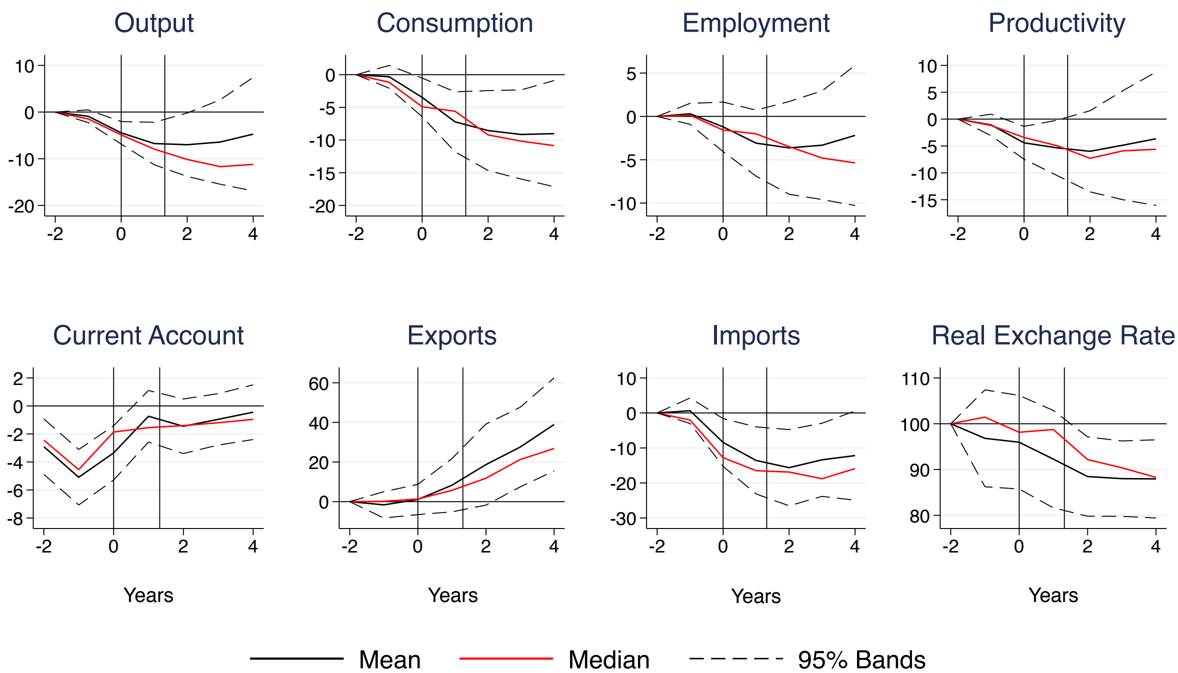
Notes: These figures plot the impulse response functions of key macroeconomic variables to a one percentage point increase to the country-specific risk premium and a one percentage point decrease to the common TFP shifter in the long run version of the model as described in Appendix C.3. All variables but the current account are expressed in log deviations from steady state. The current account, assumed to be zero in steady state, is expressed in levels. The current account, exports and imports are denominated in domestic currency; all other variables are expressed in real terms.

FIGURE A.12: A SUDDEN STOP UNDER A HARD PEG



Notes: This figure plots the response of macroeconomic variables to a sudden stop under a currency union. The black and red solid lines depict the mean and median path of the corresponding variables while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Output, consumption, employment, productivity, exports and imports are expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. Current account is expressed as a share of GDP and the real exchange rate (RER), calculated as an index, is expressed in levels. The data used is collected from IFS, WDI and the Total Economy Database.

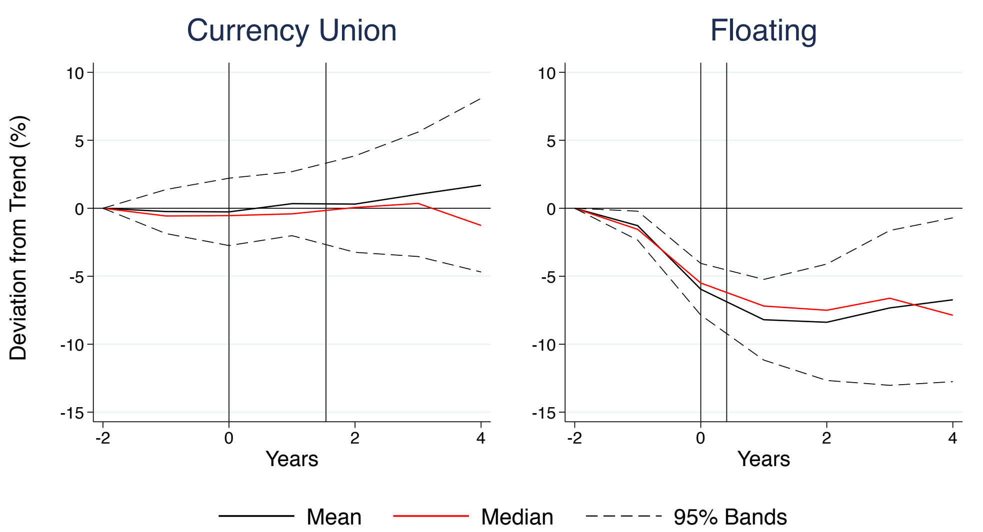
FIGURE A.13: A SUDDEN STOP UNDER A SOFT PEG



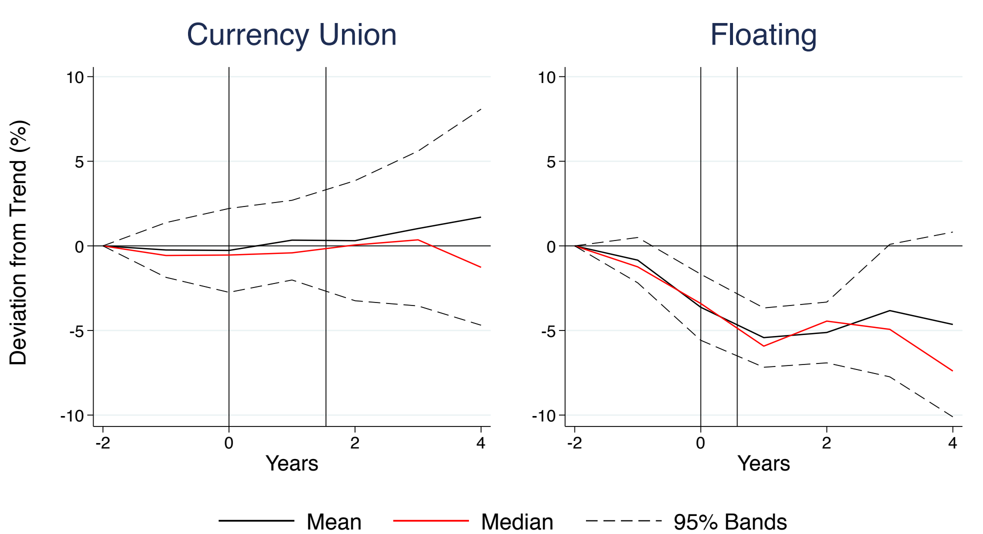
Notes: This figure plots the response of macroeconomic variables to a sudden stop under a soft peg. The black and red solid lines depict the mean and median path of the corresponding variables while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Output, consumption, employment, productivity, exports and imports are expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. Current account is expressed as a share of GDP and the real exchange rate (RER), calculated as an index, is expressed in levels. The data used is collected from IFS, WDI and the Total Economy Database.

Figure A.14: Productivity in a Sudden Stop - Exchange Rate Classification

Panel A: Using Klein and Shambaugh (2008) Coding System



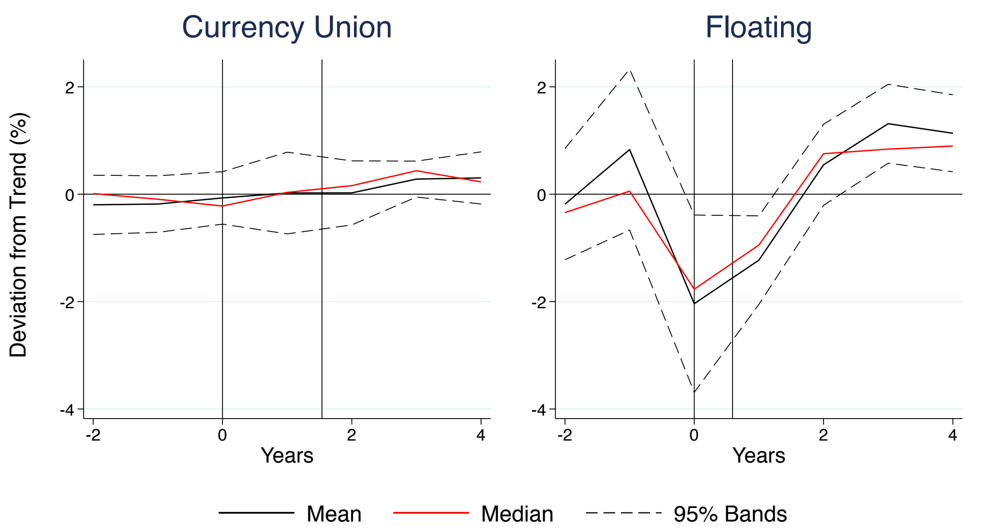
(b) Panel B: Using Pre-sudden Stop Exchange Rate Regime



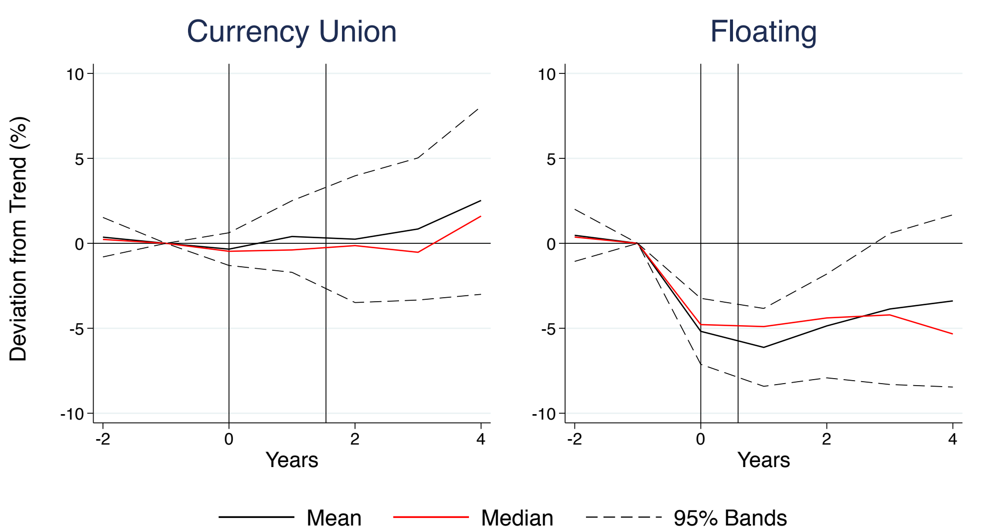
Notes: This figure plots the response of productivity to a sudden stop using alternative exchange rate classifications. Panel A builds on the coding system by Klein and Shambaugh (2008), instead of Ilzetzki, Reinhart and Rogoff (2019). Panel B considers the exchange rate regime in place one year before the sudden stop as the prevalent exchange rate regime. The first column reports sudden stops under a currency union and the second column sudden stops under a floating arrangement. The black and red solid lines depict the mean and median path of productivity while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Productivity is expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. The sources of the data are IFS, WDI and the Total Economy Database.

Figure A.15: Productivity in a Sudden Stop - Detrending Methods

Panel A: One-sided Hodrick-Prescott Filter

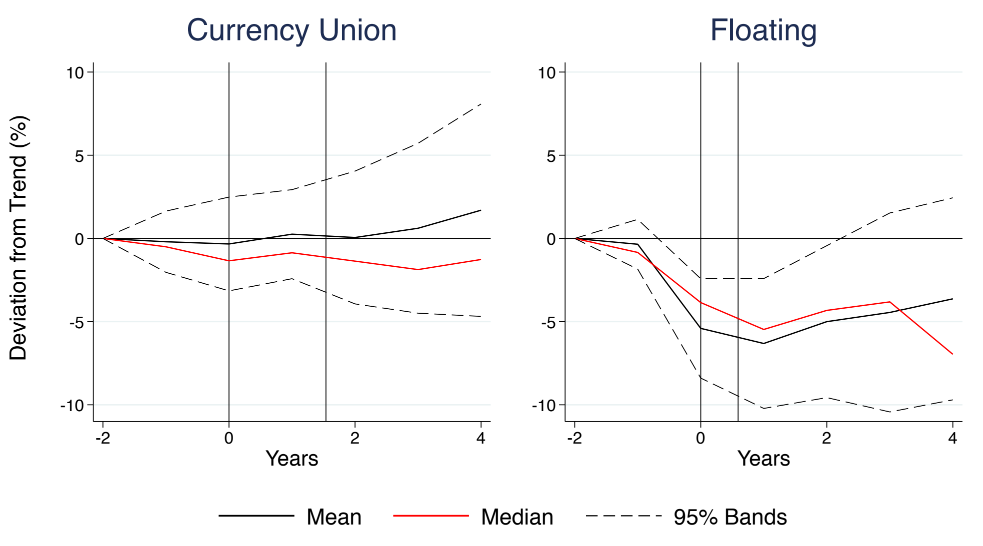


(b) Panel B: Alternative Pre-crisis Sample



Notes: This figure plots the response of productivity to a sudden stop using alternative detrending methods. In panel A productivity is expressed in terms of percentage deviations from a one-sided Hodrick-Prescott filter with smoothing parameter set to 6.25. In panel B productivity is expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-4$ to $t-1$. The first column reports sudden stops under a currency union or hard peg and the second column sudden stops under a soft peg or floating arrangement. The black and red solid lines depict the mean and median path of productivity while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. The sources of the data are IFS, WDI and the Total Economy Database.

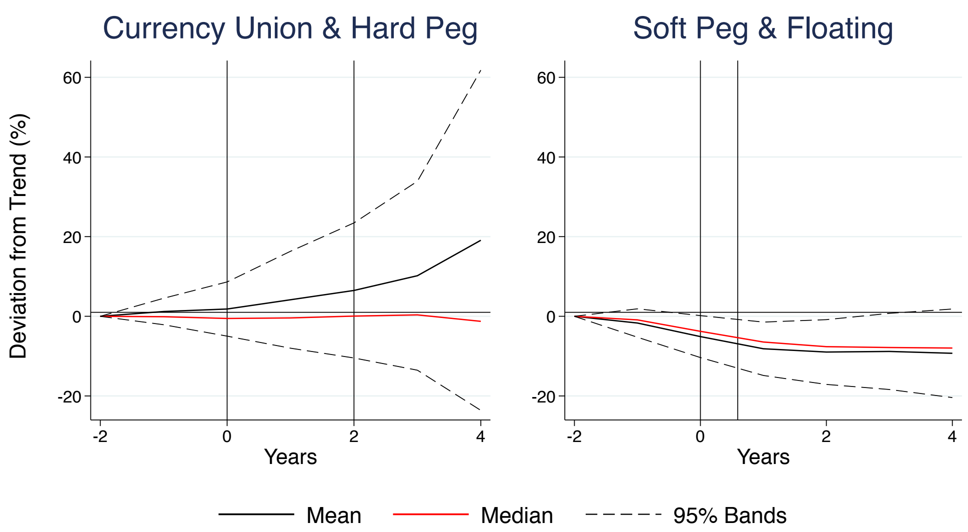
FIGURE A.16: PRODUCTIVITY IN A SUDDEN STOP - FULL WINDOW REQUIREMENT



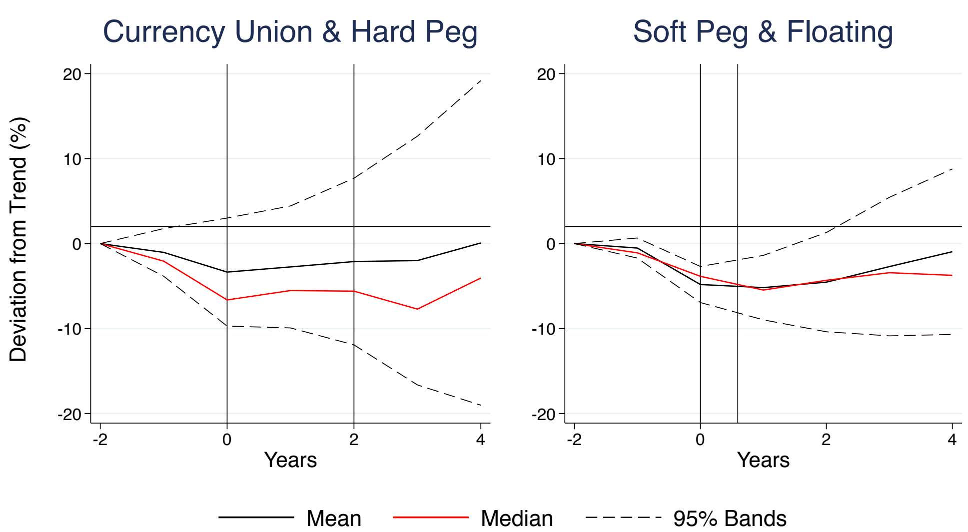
Notes: This figure plots the response of productivity to a sudden stop. The sample is restricted to include only episodes for which there is data for all six years. The first column reports sudden stops under a currency union or hard peg and the second column sudden stops under a soft peg or floating arrangement. The black and red solid lines depict the mean and median path of productivity while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Productivity is expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. The source of the data areIFS, WDI and the Total Economy Database.

FIGURE A.17: PRODUCTIVITY IN A SUDDEN STOP - LEVEL OF ECONOMIC DEVELOPMENT

PANEL A: ADVANCED ECONOMIES



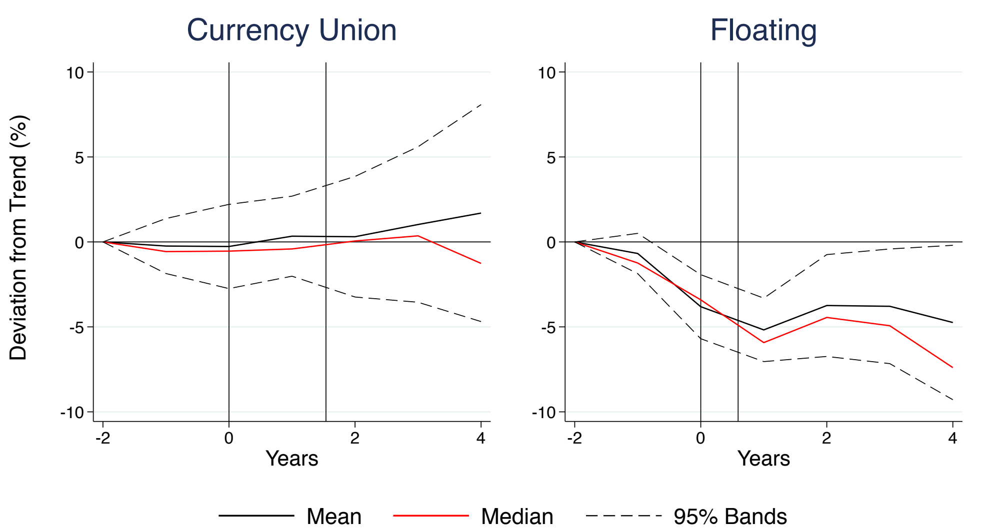
PANEL B: DEVELOPING ECONOMIES



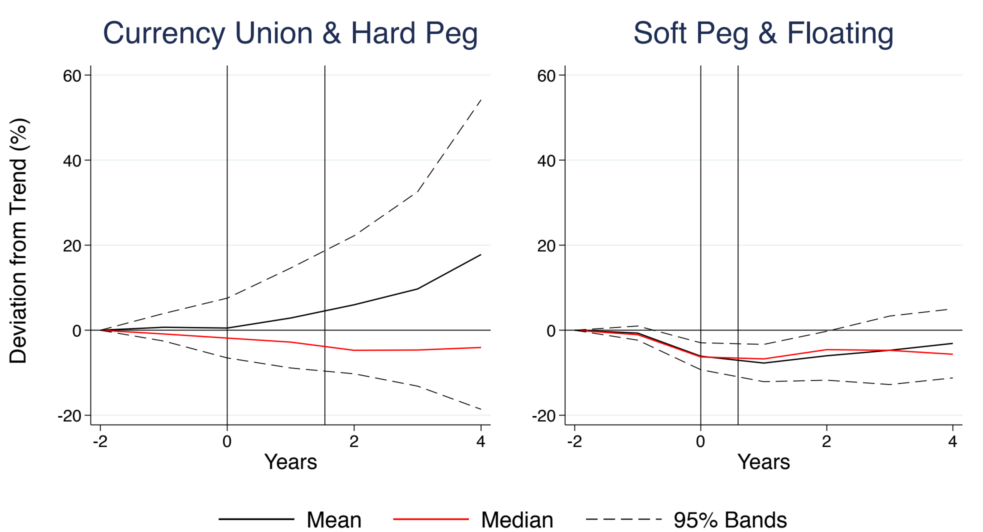
Notes: This figure plots the response of productivity to a sudden stop. The sample is restricted to advanced economies in Panel A and developing economies in Panel B as classified by the IMF. The first column reports sudden stops under a currency union or hard peg and the second column sudden stops under a soft peg or floating arrangement. The black and red solid lines depict the mean and median path of productivity while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Productivity is expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. The sources of the data are IFS, WDI and the Total Economy Database.

FIGURE A.18: PRODUCTIVITY IN A SUDDEN STOP - TYPE OF CRISIS

PANEL A: CONTROLLING FOR TWIN CRISES



PANEL B: CONTROLLING FOR GEOGRAPHIC SCOPE



Notes: This figure plots the response of productivity to a sudden stop. Panel A controls for the incidence of a twin crisis defined as a simultaneous currency and banking crisis. Panel B controls for the scope of the crisis, i.e., whether it is global or regional (as opposed to local). The first column reports sudden stops under a currency union and the second column sudden stops under a floating arrangement. The black and red solid lines depict the mean and median path of productivity while the black dashed lines represent standard error bands. The two vertical lines show the start and end of an average episode. Productivity is expressed in terms of percentage deviations from an extrapolated linear trend calculated from periods $t-5$ to $t-2$. The sources of the data are IFS, WDI and the Total Economy Database.

F Additional Tables

Table A.1: Moments of the Productivity Distribution

	1992-93 Episode		2010-13 Episode	
	Pre-sudden Stop	Sudden Stop	Pre-sudden Stop	Sudden Stop
Mean	0.28	0.14	0.11	0.12
Mode	0.29	0.17	0.14	0.16
St. Dev.	0.58	0.62	0.69	0.62
Skewness	-0.40	-1.24	-2.37	-0.89
Kurtosis	7.04	10.42	27.92	7.13
Min	-3.73	-5.28	-9.07	-3.68
Max	2.58	2.40	2.49	2.49

Notes: This table summarizes moments of the distribution of firm-level TFP (in logs) before and after a sudden stop. The first two columns refer to the 1992-93 episode, while the last two focus on the 2010-13 episode. Pre-sudden stop measures are calculated using data from the year before the sudden stop starts. Sudden stop measures are calculated using data from the last year of the sudden stop. The data used is collected from the ESEE dataset.

Table A.2: Decomposition of Productivity Growth Using Value-added Weights

	Sudden Stops	
	1992-1993	2010-2013
Productivity Growth (%)	-10.13	10.91
Contribution to Productivity Growth		
Incumbents' Contribution	**-9.69**	**6.59**
Within-firm Contribution	-18.75	-12.02
Between-firm Contribution	-10.48	-6.98
Cross-term Contribution	19.54	25.6
Net Entry Contribution	**-0.44**	**4.31**
Entrants' Contribution	-1.35	-1.35
Exiters' Contribution	0.91	5.17

Notes: Productivity growth refers to accumulated TFP growth for the stated period. Base and final years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. Contribution of incumbents and net entrants add up to productivity growth. Contribution of within-firm, between-firm and cross-term components add up to incumbents' contribution. Contribution of entrants and exiters add up to net entry contribution. Details of the formal decomposition can be found in Online Appendix A.5. The data used is collected from the ESEE dataset.

Table A.3: Annualized Decomposition of Productivity Growth

	Sudden Stops	
	1992-1993	2010-2013
Productivity Growth (%)	-5.44	2.50
Contribution to Productivity Growth		
Incumbents' Contribution	**-5.73**	**0.33**
Within-firm Contribution	-5.24	-0.31
Between-firm Contribution	0.43	1.45
Cross-term Contribution	-0.92	-0.81
Net Entry Contribution	**0.29**	**2.18**
Entrants' Contribution	-0.54	-0.05
Exiters' Contribution	0.83	2.23

Notes: Productivity growth refers to the average year-on-year growth for the stated period. Contribution of incumbents and net entrants add up to productivity growth. Contribution of within-firm, between-firm and cross-term components add up to incumbents' contribution. Contribution of entrants and exiters add up to net entry contribution. Details of the formal decomposition can be found in Online Appendix A.5. The data used is collected from the ESEE dataset.

TABLE A.4: FIRM EXIT AND PRODUCTIVITY WITH ADDITIONAL CONTROLS II

	(1)	(2)	(3)	(4)	(5)
TFP_{it}	-0.020***	-0.020***	-0.021***	-0.016***	-0.016***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)
$ss^1_{t+1} * TFP_{it}$	-0.004	-0.004	-0.007	-0.005	-0.010
	(0.014)	(0.014)	(0.017)	(0.013)	(0.015)
$ss^2_{t+1} * TFP_{it}$	-0.038***	-0.036***	-0.039***	-0.032***	-0.032***
	(0.010)	(0.009)	(0.010)	(0.008)	(0.008)
$intrate_{it}$		-0.000			0.000
		(0.001)			(0.001)
$ss^1_{t+1} * intrate_{it}$		0.001			0.001
		(0.001)			(0.001)
$ss^2_{t+1} * intrate_{it}$		0.004*			0.005*
		(0.002)			(0.002)
$\Delta sales_{it}$			-0.009*		-0.010*
			(0.005)		(0.005)
$ss^1_{t+1} * \Delta sales_{it}$			0.022*		0.030**
			(0.012)		(0.013)
$ss^2_{t+1} * \Delta sales_{it}$			0.004		0.006
			(0.006)		(0.006)
ROE_{it}				-0.000	-0.000
				(0.000)	(0.000)
$ss^1_{t+1} * ROE_{it}$				-0.000	-0.000
				(0.000)	(0.000)
$ss^2_{t+1} * ROE_{it}$				0.002*	0.003**
				(0.001)	(0.001)
Observations	36,261	34,817	32,268	34,318	30,830
Year FE	Yes	Yes	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes	Yes	Yes

Notes: All regressions are linear probability models where exit=1 if the firm reports positive activity in period t and no activity in period $t+1$. TFP_{it} is the log firm-level TFP at time t, ss^1_{t+1} is a dummy equal to one for years 1992-1993 and ss^2_{t+1} is a dummy equal to one for years 2010-2013. $intrate_{it}$ measures the average cost of long-term debt. $\Delta sales_{it}$ is the growth in sales between periods $t-1$ and t. ROE_{it} is the return on equity. Firm size classes in period t are used to control for firm size effects. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

TABLE A.5: DISPERSION OF MARGINAL REVENUES PRODUCTS - ECONOMY-WIDE

	1992-93 Episode		2010-13 Episode	
	Pre-sudden Stop	Sudden Stop	Pre-sudden Stop	Sudden Stop
Dispersion of Capital	1.125	1.063	1.178	1.112
Dispersion of Labor	0.422	0.460	0.577	0.474

Notes: This table summarizes the weighted average of within-sector standard deviations of marginal revenue products of capital and labor. The first two columns refer to the 1992-93 episode, while the last two focus on the 2010-13 episode. Pre-sudden stop measures are calculated using data from the year before the sudden stop starts. Sudden stop measures are calculated using data from the last year of the sudden stop. The data used is collected from the ESEE dataset.

TABLE A.6: DECOMPOSITION OF PRODUCTIVITY GROWTH WITH SAMPLING WEIGHTS

	Sudden Stops	
	1992-1993	2010-2013
Productivity Growth (%)	-15.31	3.59
Contribution to Productivity Growth		
Incumbents' Contribution	**-14.78**	**-4.99**
Within-firm Contribution	-12.24	-6.78
Between-firm Contribution	-2.50	1.86
Cross-term Contribution	-0.03	-0.06
Net Entry Contribution	**-0.53**	**8.58**
Entrants' Contribution	-1.71	-0.31
Exiters' Contribution	1.18	8.89

Notes: Productivity growth refers to accumulated TFP growth for the stated period. Base and final years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. Contribution of incumbents and net entrants add up to productivity growth. Contribution of within-firm, between-firm and cross-term components add up to incumbents' contribution. Contribution of entrants and exiters add up to net entry contribution. Details of the formal decomposition can be found in Online Appendix A.5. The data used is collected from the ESEE dataset.

TABLE A.7: REALLOCATION AND PRODUCTIVITY WITH SAMPLING WEIGHTS

	Exit	Labor Growth (Incumbent & Exiters)	Labor Growth (Incumbents Only)
	(1)	(2)	(3)
TFP_{it}	-0.026	0.037***	0.022***
	(0.019)	(0.002)	(0.005)
$ss^1_{t+1} * TFP_{it}$	0.005	-0.015**	-0.005
	(0.023)	(0.007)	(0.011)
$ss^2_{t+1} * TFP_{it}$	-0.041**	0.011	0.015**
	(0.019)	(0.009)	(0.007)
Observations	36,261	32,268	28,275
Year FE	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes

Notes: Regression for exit is a linear probability model where exit=1 if the firm reports positive activity in period t and no activity in period $t+1$. Labor growth is measured from period t to period $t+1$. TFP_{it} is the log firm-level TFP at time t, ss^1_{t+1} is a dummy equal to one for years 1992-1993 and ss^2_{t+1} is a dummy equal to one for years 2010-2013. Firm size classes in period t are used to control for firm size effects. Observations are weighted using sampling weights. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

TABLE A.8: FIRM EXIT AND PRODUCTIVITY WITH ADDITIONAL CONTROLS - SAMPLING WEIGHTS

	(1)	(2)	(3)	(4)	(5)
TFP_{it}	-0.027	-0.026	-0.023	-0.025	-0.022
	(0.018)	(0.018)	(0.014)	(0.017)	(0.013)
$ss^1_{t+1} * TFP_{it}$	0.008	0.003	0.000	0.005	-0.002
	(0.023)	(0.023)	(0.020)	(0.022)	(0.020)
$ss^2_{t+1} * TFP_{it}$	-0.040**	-0.042**	-0.029*	-0.038**	-0.028*
	(0.019)	(0.019)	(0.015)	(0.018)	(0.014)
$cons_i$		0.053			0.028
		(0.040)			(0.020)
$ss^1_{t+1} * cons_i$		-0.166**			-0.165*
		(0.077)			(0.090)
$ss^2_{t+1} * cons_i$		-0.040			-0.092
		(0.083)			(0.114)
$leverage_{it}$			0.000		0.000
			(0.000)		(0.000)
$ss^1_{t+1} * leverage_{it}$			0.000		0.000
			(0.000)		(0.000)
$ss^2_{t+1} * leverage_{it}$			0.000		0.000
			(0.000)		(0.000)
$importer_{it}$				-0.013	-0.009
				(0.014)	(0.010)
$ss^1_{t+1} * importer_{it}$				-0.002	-0.009
				(0.017)	(0.017)
$ss^2_{t+1} * importer_{it}$				-0.024	-0.021
				(0.018)	(0.015)
Observations	36,261	36,261	34,307	36,261	34,307
Year FE	Yes	Yes	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes	Yes	Yes

Notes: All regressions are linear probability models where exit=1 if the firm reports positive activity in period t and no activity in period $t+1$. TFP_{it} is the log firm-level TFP at time t, ss^1_{t+1} is a dummy equal to one for years 1992-1993 and ss^2_{t+1} is a dummy equal to one for years 2010-2013. $cons_i$ measures the exposure of firm i to the construction sector according to the sector it operates in. $leverage_{it}$ is captured by the debt-to-assets ratio. $importer_{it}$ is a dummy equal to one if the firm reports any positive imported value. Firm size classes in period t are used to control for firm size effects. Observations are weighted using sampling weights. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

TABLE A.9: DECOMPOSITION OF PRODUCTIVITY GROWTH USING ORBIS

	Sudden Stop 2010-2013
Productivity Growth (%)	8.83
Contribution to Productivity Growth	
Incumbents' Contribution	**2.20**
Within-firm Contribution	-1.28
Between-firm Contribution	1.89
Cross-term Contribution	1.59
Net Entry Contribution	**6.63**
Entrants' Contribution	-0.19
Exiters' Contribution	6.82

Notes: Productivity growth refers to accumulated TFP growth for the stated period. Base and final years are 2009 and 2013. Contribution of incumbents and net entrants add up to productivity growth. Contribution of within-firm, between-firm and cross-term components add up to incumbents' contribution. Contribution of entrants and exiters add up to net entry contribution. Details of the formal decomposition can be found in Online Appendix A.5. The data used is collected from ORBIS.

TABLE A.10: REALLOCATION AND PRODUCTIVITY USING ORBIS

	Exit	Labor Growth (Incumbent & Exiters)	Labor Growth (Incumbents Only)
	(1)	(2)	(3)
TFP_{it}	-0.049**	0.033***	0.026***
	(0.017)	(0.005)	(0.007)
$ss^2_{t+1} * TFP_{it}$	-0.060***	-0.005	0.001
	(0.021)	(0.007)	(0.010)
Observations	43,286	26,435	17,204
Year FE	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes

Notes: Regression for exit is a linear probability model where exit=1 if the firm reports positive activity in period t and no activity in period $t+1$. Labor growth is measured from period t to period $t+1$. TFP_{it} is the log firm-level TFP at time t and ss^2_{t+1} is a dummy equal to one for years 2010-2013. Firm size classes in period t are used to control for firm size effects. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

TABLE A.11: FIRM EXIT AND PRODUCTIVITY WITH ADDITIONAL CONTROLS USING ORBIS

	(1)	(2)	(3)	(4)
TFP_{it}	-0.049**	-0.049**	-0.044*	-0.044*
	(0.017)	(0.017)	(0.020)	(0.019)
$ss^2_{t+1} * TFP_{it}$	-0.060***	-0.054***	-0.082***	-0.080***
	(0.021)	(0.021)	(0.024)	(0.024)
$cons_i$		-0.113		-0.115
		(0.111)		(0.081)
$ss^2_{t+1} * cons_i$		0.238		0.245*
		(0.133)		(0.114)
$leverage_{it}$			0.017***	0.017***
			(0.004)	(0.004)
$ss^2_{t+1} * leverage_{it}$			0.000	0.000
			(0.008)	(0.008)
Observations	43,286	43,286	25,751	25,751
Year FE	Yes	Yes	Yes	Yes
Firm Size FE	Yes	Yes	Yes	Yes

Notes: All regressions are linear probability models where exit=1 if the firm reports positive activity in period t and no activity in period $t + 1$. TFP_{it} is the log firm-level TFP at time t and ss^2_{t+1} is a dummy equal to one for years 2010-2013. $cons_i$ measures the exposure of firm i to the construction sector according to the sector it operates in. $leverage_{it}$ is captured by the debt-to-assets ratio. Firm size classes in period t are used to control for firm size effects. Standard errors (in parentheses) are clustered at the year level; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

TABLE A.12: MARKUPS AND PRODUCTIVITY USING ORBIS

	(1)	(2)
Firm-level TFP	1.002***	1.000***
	(0.005)	(0.005)
Aggregate TFP	-0.114*	
	(0.061)	
Industry TFP		-0.838***
		(0.145)
Observations	49,125	49,125
R-squared	0.808	0.782
Industry FE	Yes	Yes

Notes: This table reports the results of a cross-section regression of firm-level markups on different measures of productivity: at the firm level, at the industry level and at the economy level. All variables are measured in logs. Standard errors (in parentheses) are clustered by industry; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.10$.

TABLE A.13: ESEE COVERAGE OF THE MANUFACTURING SECTOR

PANEL A: RELATIVE TO 2007 EU KLEMS RELEASE

Year	Employment	Wage Bill	Value Added
1990	0.08	0.10	0.09
1991	0.10	0.13	0.11
1992	0.11	0.15	0.13
1993	0.11	0.15	0.13
1994	0.12	0.16	0.15
1995	0.12	0.15	0.15

PANEL B: RELATIVE TO 2016 EU KLEMS RELEASE

Year	Employment	Wage Bill	Value Added
1995	0.12	0.16	0.16
1996	0.11	0.14	0.15
1997	0.12	0.16	0.17
1998	0.12	0.17	0.17
1999	0.12	0.16	0.16
2000	0.16	0.24	0.25
2001	0.15	0.23	0.23
2002	0.14	0.21	0.20
2003	0.12	0.17	0.17
2004	0.12	0.17	0.18
2005	0.15	0.21	0.21
2006	0.15	0.20	0.20
2007	0.16	0.20	0.21
2008	0.15	0.20	0.19
2009	0.15	0.20	0.18
2010	0.15	0.19	0.20
2011	0.15	0.19	0.17
2012	0.15	0.19	0.17
2013	0.15	0.18	0.16
2014	0.14	0.17	0.15

Notes: This table shows the coverage by year in employment, wage bill and value added of the ESEE dataset relative to the aggregate data for Total Manufacturing reported by EU Klems. Panel A refers to the 2007 release while Panel B focuses on the 2016 release.

TABLE A.14: DECOMPOSITION OF PRODUCTIVITY GROWTH WITH NO ENTRY

	Sudden stops	
	1992-1993	2010-2013
Productivity Growth (%)	-10.10	10.73
Contribution to Productivity Growth		
Incumbents' Contribution	**-11.20**	**3.05**
Within-firm Contribution	-9.69	-2.41
Between firm Contribution	0.47	3.75
Cross-term Contribution	-1.98	1.71
Net Entry Contribution	**1.10**	**7.68**
Entrants' Contribution	-	-
Exiters' Contribution	1.10	7.68

Notes: Productivity growth refers to accumulated TFP growth for the stated period. Base and final years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. Sample is restricted to firms that were operating in 1991 and 2009 respectively. Contribution of incumbents and net entrants add up to productivity growth. Contribution of within-firm, between-firm and cross-term components add up to incumbents' contribution. Details of the formal decomposition can be found in Online Appendix A.5. The data used is collected from the ESEE dataset.

TABLE A.15: LIST OF SUDDEN STOPS

Country	Start Year	End Year	Exchange Rate	Country	Start Year	End Year	Exchange Rate
Albania	1991	1992	4	Macedonia FYR	2009	2010	2
Argentina	1995	1995	2	Malaysia	1998	1998	4
Argentina	1999	2002	4	Mali	1991	1991	1
Argentina	2014	2014	3	Mexico	1995	1995	4
Belarus	2014	2015	3	Moldova	1998	2003	3
Brazil	2015	2015	4	Moldova	2012	2013	3
Bulgaria	1991	1991	4	Morocco	1996	1996	3
Bulgaria	2009	2010	2	New Zealand	2004	2010	4
Chile	1999	1999	3	Nicaragua	1991	1991	2
Chile	2009	2010	4	Oman	1999	2000	2
Colombia	1998	1999	3	Oman	2010	2010	2
Croatia	1997	2002	2	Peru	1991	1991	4
Croatia	2009	2010	2	Philippines	1998	1998	4
Cyprus	2011	2011	1	Poland	1990	1990	4
Czech Rep.	1997	2002	3	Portugal	2001	2003	1
Czech Rep.	2008	2008	3	Portugal	2009	2013	1
Czech Rep.	2011	2013	3	Romania	1999	1999	4
Ecuador	1999	2000	0	Russia	1998	2002	3
Estonia	1996	2001	2	Rwanda	1994	1994	4
Estonia	2008	2009	2	Saudi Arabia	1992	1992	2
Ethiopia	1991	1991	3	Saudi Arabia	1999	2000	2
Ethiopia	2003	2003	3	Senegal	1994	1994	1
Finland	1991	1993	3	Sierra Leone	1996	1996	4
Finland	2013	2013	1	Slovak Republic	1997	2002	3
France	1991	1993	2	South Africa	2008	2008	4
Gabon	1999	1999	1	Spain	1993	1993	3
Greece	1993	1993	2	Spain	2009	2010	1
Greece	2009	2013	1	Spain	2012	2013	1
Haiti	2003	2003	4	Sri Lanka	2001	2001	3
Haiti	2009	2010	3	Sudan	2010	2010	3
Indonesia	1998	1998	4	Sweden	1991	1991	3
Iran	1992	1992	4	Sweden	2009	2010	3
Iran	1994	1995	4	Thailand	1997	1998	4
Ireland	2009	2014	1	Turkey	1994	1994	4
Israel	2001	2001	3	Turkey	2001	2001	4
Italy	1993	1994	3	Ukraine	1998	2003	2
Italy	2007	2007	1	Ukraine	2014	2015	4
Italy	2011	2014	1	United Kingdom	1990	1991	3
Kenya	1991	1992	4	United States	2007	2007	4
Korea	1997	1998	4	Uruguay	2001	2001	3
Latvia	2008	2009	3	Venezuela	1994	1994	4
Lithuania	1997	2002	2	Venezuela	1999	2000	3
Macedonia FYR	2000	2006	2	Yemen Rep. of	2009	2014	3

Notes: This table reports the list of sudden stops as identified by the algorithm described in Online Appendix D.2. Exchange rate is a categorical variable that refers to the exchange rate regime in place at the end of the sudden stop: currency union (=1), hard peg (=2), soft peg (=3) and floating arrangement (=4). More details on the exchange rate classification are available in section 6. The data used is collected from the IMF's World Economic Outlook database and Ilzetzki, Reinhart and Rogoff (2019).

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