

Sudden stops, productivity and the exchange rate*

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Abstract

Following a sudden stop, real exchange rates can realign through a nominal exchange rate depreciation, lower domestic prices, or a combination of both. This paper makes four contributions to understand how the type of adjustment shapes the response of macroeconomic variables, in particular, productivity, to such an episode. First, it documents that TFP systematically collapses after a sudden stop under a flexible exchange rate arrangement while it moderately improves if taking place within a currency union. Second, using firm-level data for two sudden stops in Spain, it highlights that the difference in the productivity response is largely driven by entry and exit firm dynamics. Third, it proposes a small open economy DSGE framework with firm selection into production and endogenous mark-ups that is consistent with the empirical findings. The model nests three mechanisms through which a shock 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 demand channel dominates in the latter scenario. Fourth, it uses a quantitative version of the model to revisit the optimality of exchange rate policy after a sudden stop.

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1 Introduction

Friedman (1953) famously argued that, in the presence of nominal rigidities, flexible exchange rates make for a good substitute of internal price adjustments. It would then follow that currency unions are doomed to fail in the event of a current account shock. The recent European sovereign debt crisis has rekindled the interest in this old debate and has added new elements to the discussion. First, the episode provides direct empirical evidence on a special type of balance of payment crisis, a sudden stop, within a currency union. Second, the internal devaluation that followed the initial shock was accompanied by a moderate, but still puzzling, productivity improvement. This clashes with the standard practice of taking TFP declines as given in this literature and raises the following questions: What is the relationship between sudden stops, productivity and the exchange rate regime? How does accounting for this change alter the inherited wisdom on fixed vs floating regimes?

In this paper I study how the type of real exchange rate realignment shapes the response of macroeconomic variables, in particular productivity, to a sudden stop. I show that internal devaluations, as opposed to nominal depreciations, lead to greater cleansing effects of the shock through a larger contraction of labor income and, thus, domestic demand. I then carry out a welfare evaluation of policy options that takes into account this new positive side-effect of currency unions on TFP.

Section 3 provides systematic evidence on the behavior of macroeconomic variables during a sudden stop for both developed and developing economies during the 1990-2015 period. I use a new criterion for sudden stop identification that captures both the episodes that had been previously discussed by the literature as well as the recent Southern-European cases. I classify sudden stops according to the prevalent exchange rate regime and evaluate the response of macroeconomic variables for each regime using an event study approach. Two regularities stand out: first, TFP systematically collapses under flexible exchange rate arrangements, while it improves, albeit moderately, within a currency union. Second, there is a larger decline in employment and a greater contraction in consumption as a share of GDP. The increase in TFP is associated with a greater domestic contraction.

To better understand the drivers of aggregate TFP performance, I next resort to micro evidence in the form of firm-level data from the manufacturing sector. More specifically, I exploit survey data during two sudden stop episodes that occurred in Spain, the 1992-93 Exchange Rate Mechanism crisis and the 2009-13 European Sovereign Crisis. During the former, the national currency, the *peseta*, depreciated in multiple occasions and TFP fell over 10 percent; during the second episode, the country could only regain competitiveness by lowering wages, as a member of a currency union, and TFP increased by 10 percent.

The analysis uncovers four main findings. First, changes in productivity are concentrated on the lower tail of the firm productivity distribution in both episodes. Second, while the produc-

tivity was declining at the firm level during both crises, unproductive exiting firms contributed substantially more to TFP growth in the 2009-2013 sudden stop. Third, the 2009-13 sudden stop had a cleansing effect on productivity while the 1992-93 did not. Finally, there is suggestive evidence that links heterogeneity in price mark-ups with changes in allocative efficiency throughout the sample.

Based on the evidence above, section 5 presents a DSGE model with a micro-structure borrowed from Melitz and Ottaviano (2008) to study the behavior of productivity, output and employment during a sudden stop. In the model, a small open economy has quasi-linear quadratic preferences and firm heterogeneity in productivity. This gives rise to firm selection into production and endogenous variable markups. I model the labor supply decision explicitly by including leisure in the representative agent's utility function. This provides a new channel through which the wage level and individual firm profits interact.

To allow for 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 and two extreme regimes are discussed: a currency union, characterized by a credible commitment to keep the nominal exchange rate equal to one at all times; and a strict wage inflation targeting regime, where the flexible wage equilibrium is always implemented. A sudden stop is an exogenous shock to the risk premium component of the interest rate that domestic consumers pay for international borrowing. By increasing the return on foreign denominated bonds, the domestic economy is forced to save internationally and increase net exports through a real exchange rate depreciation.

The model is able to generate the observed TFP patterns under different exchange rate regimes following a sudden stop. In equilibrium, average productivity is proportional to the domestic productivity threshold: the minimum productivity level a firm is required to have in order to generate positive profits and, thus, select into the domestic market. It suffices to understand how the threshold moves after a sudden stop to inform about overall productivity.

In order to provide intuition, it is useful to first restrict attention to the partial equilibrium result. In partial equilibrium, I show that the domestic threshold is entirely determined by the number of active firms in the market and the wage level. The threshold increases with the number of active firms, as greater competition lowers profit margins for all firms and then requires a higher level of productivity to remain profitable. I call this channel the pro-competitive effect. The relationship between wages and the threshold is less obvious. On the one hand, higher wages increase the demand for overall consumption by increasing the labor income of households (the demand effect), but, on the other, higher wages also increase the costs of production (the cost effect).

The effect of a sudden stop on the domestic productivity threshold will therefore rely on the relative strength of these conflicting forces. This, in turn, depends on how the real exchange rate adjustment is conducted and, more specifically, on whether it takes place through higher

nominal exchange rates or lower wage level. I next consider the two polar cases. In the first case the nominal exchange rate bears the full brunt of the adjustment: only the pro-competitive channel is working, fewer firms import, and productivity unambiguously falls. In contrast, when the exchange rate is fixed, the wage adjusts completely and all three channels operate resulting in a quantitatively ambiguous overall effect. The parameterization restriction that ensures that the demand channel dominates is reasonable under a standard model calibration. Therefore, it is possible (and likely) that a sudden stop generates a productivity improvement in a currency union.

I extend the results to general equilibrium by calibrating the model using Spanish macroeconomic data as well as the firm-level evidence presented in Section 4. I simulate the response of the economy to an unexpected increase in the country risk premium component of the interest rate under the two alternative exchange rate policy regimes. The model mimics a sudden stop episode: the economy runs a current account surplus and the real exchange rate depreciates.

The responses of macroeconomic variables match the empirics along many dimensions. GDP and consumption fall, with a more pronounced although much transient drop of the latter under the currency union. Moreover, relative employment dynamics are correctly captured by the generated impulse response functions with the currency union experiencing greater volatility, though the model cannot generate the absolute decline in employment under a floating regime. The baseline model fully captures the behavior of TFP that I document empirically: in particular, productivity falls when the real exchange rate depreciation translates one-to-one into a nominal depreciation, while it increases as the devaluation takes place through wages instead. I carry out and discuss extensive sensitivity tests using alternative parameterizations of the model.

Finally, to evaluate the overall performance of exchange rate regimes, I study how TFP improvements translate into welfare gains by numerically solving for utility-based welfare and other welfare-relevant variables and evaluating policy rules accordingly. According to the welfare measure, a currency union ranks highest when a sudden stop has the largest impact on firm entry. According to output loss, nonetheless, a currency union always performs worst on impact but best on cumulative terms. This is due to the distortions stemming from nominal wage rigidities, which are fully overcome with strict wage inflation targeting.

The rest of the paper is organized as follows. Section 2 reviews related literature. Section 3 and 4 present aggregate and firm-level evidence of sudden stops respectively. Section 5 introduces the model and defines the equilibrium. Section 6 explains the intuition by restricting attention to partial equilibrium. Section 7 takes the model to the data and shows that it is able to capture the observed behavior of macroeconomic variables during a sudden stop. Section 8 then discusses optimal exchange rate policy. Section 9 presents several extensions to the baseline model and Section 10 concludes.

2 Relation to the literature

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

First, it focuses on sudden stops, as first 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 et al. \(2004\)](#), [Guidotti et al. \(2004\)](#), [Calvo and Talvi \(2005\)](#) and [Kehoe and Ruhl \(2009\)](#) and contributes to their previous analysis in three ways: by modifying the Calvo sudden stop identification methodology to account for gradualism, by expanding the time frame and the set of economies traditionally considered, and by classifying episodes according to the flexibility of the nominal exchange rate.¹ The results show that previous findings - current account adjustment, depreciation of the real exchange rate and fall in output and TFP - apply to economies with flexible exchange rates, but macroeconomic variables in a currency union respond differently.

Related, several articles propose amendments to the standard open economy neoclassical model with flexible exchange rates in order to reconcile theoretical predictions with the observed behavior of macroeconomic variables, especially, TFP, during a sudden stop. For example [Meza and Quintin \(2007\)](#) allow for endogenous factor utilization, [Neumeyer and Perri \(2005\)](#), [Christiano et al. \(2004\)](#) and [Mendoza \(2006\)](#) introduce advanced payments of inputs and [Mendoza \(2010\)](#) directly assumes that exogenous productivity shocks trigger the collateral constraints that drive sudden stops. I bring an alternative explanation to the table: selection into production.

Second, the paper contributes to the floating vs. fixed exchange rate debate. [Cúrdia \(2007\)](#), [Braggion et al. \(2009\)](#) and [Fornaro \(2015\)](#), among others, argue that policy rules that target inflation are superior in terms of welfare to those that prioritize exchange rate stability. I find that accounting for firm dynamics can reverse this conclusion. More recently, [Farhi et al. \(2013\)](#) [Schmitt-Grohé and Uribe \(2016\)](#) and [Galí and Monacelli \(2016\)](#) have emphasized the interaction of wage rigidity and the exchange rate regime. I concur with the latter in concluding that increased flexibility is not necessarily desirable within a currency union. The mechanism in this paper is novel nonetheless: the cleansing effect of an internal devaluation is increasing in the degree of rigidities.

The third strand of the literature to which this paper closely relates is trade models of heterogeneous firms à la [Melitz \(2003\)](#), which emphasize firm selection into domestic and international markets by featuring fixed production and exporting costs.² Even though the main focus of these papers is on the welfare effects of trade liberalizations, the real exchange rate depreciation that results from a balance of payment crisis resembles the reversal of a unilateral trade

¹This is not, however, the first paper to classify the massive reversals that Southern-European countries experienced between late 2009 and 2011 as sudden stop episodes (see [Merler and Pisani-Ferry \(2012\)](#) and [Gros and Alcidí \(2015\)](#) for an earlier discussion).

²For a review of the literature, check [Melitz and Redding \(2014\)](#).

liberalization. This makes the New New Trade Theory framework a suitable starting point for my analysis.

Unlike the canonical [Melitz \(2003\)](#) model, however, I do not restrict attention to competition in the labor market and incorporate pro-competitive effects of trade by departing from constant elasticity of substitution (CES) preferences. In doing so, I follow [Bernard et al. \(2003\)](#), [Feenstra \(2003\)](#), [Behrens and Murata \(2006\)](#) and, more specifically, [Melitz and Ottaviano \(2008\)](#), to feature endogenous variable mark-ups. This allows me to defuse, at least in the short-run, the negative dependence between domestic and exporting cutoffs that drives the baseline result in the [Melitz \(2003\)](#) model. I preserve, however, the role that wages play in the [Melitz \(2003\)](#) model within the [Melitz and Ottaviano \(2008\)](#) framework. My approach is to modify the quasi-linear-quadratic preferences proposed by [Ottaviano et al. \(2002\)](#) and assume that leisure is the homogeneous good. The result is that the demand for differentiated varieties is no longer independent of labor income and a new demand effect of wages emerges.

While most of the standard models are static, this paper is closer to the subset within the trade literature interested in firm dynamics and business cycles.³ The most notable reference is [Melitz and Ghironi \(2005\)](#), which embeds the steady-state version of the [Melitz \(2003\)](#) model into a two country DSGE model. To gain tractability, however, [Melitz and Ghironi \(2005\)](#) assume that all firms that enter the market generate positive profits and, thus, firm exit is exclusively determined by exogenous death shocks.⁴ In addition, because their focus is on the Balassa-Samuelson effect, the main driver of the business cycle is an aggregate productivity shock. My paper, instead, incorporates selection into production and studies the effects of exogenous current account shocks on productivity.⁵ Moreover, it is, to the best of my knowledge, the first study to incorporate nominal rigidities and, thus, to be able to discuss the role for monetary policy in a similar setting.⁶

Finally, this paper is connected to the literature that studies the contribution of reallocation to TFP growth. Two theoretical arguments have been put forward to date. On the one hand, [Hsieh and Klenow \(2009\)](#) show that increases in allocative efficiency that involve closing gaps in the return of inputs increase aggregate productivity. On the other hand, [Caballero et al. \(1994\)](#)'s interpretation of [Schumpeter et al. \(1939\)](#)'s creative destruction argument emphasizes the role of reallocation among new and incumbent firms as an important factor of growth. The paper presents a model based on the second current, emphasizing the cleansing effect of internal devaluations, but discusses both conjectures in the empirical analysis.

³Alternatively, models are commonly assumed to be dynamic but with a stationary equilibrium featuring constant aggregate variables.

⁴As opposed to a framework in which the presence of fixed production costs drives firms generating negative profit out of the market.

⁵[Bilbiie et al. \(2012\)](#) and [Ottaviano \(2012\)](#) among others already consider the effect of endogenous entry and/or new product variety in a business cycle model. They do so, however, in a closed economy setting.

⁶[Bilbiie et al. \(2008\)](#) and [Bilbiie et al. \(2014\)](#) introduce price adjustment costs in a closed-economy DSGE model with endogenous entry and product variety to study optimal monetary policy.

The pre-crisis slowdown of productivity in Southern Europe has prompted an increasingly popular narrative that links declining TFP and enhanced misallocation with capital inflows. Papers on this topic are often grouped according to the margin of misallocation suggested: [Benigno and Fornaro \(2014\)](#) considers a model of misallocation between a tradable and a non-tradable sector; [Dias et al. \(2016\)](#), [García-Santana et al. \(2016\)](#), [Reis \(2013\)](#) and [Gopinath et al. \(2017\)](#) show, and formalize in the latter two cases, that resources were also misallocated within sectors. My work contributes to these hypotheses in two dimensions: from the empirical side, I show that the negative relationship between capital flows and TFP growth in Southern Europe is symmetric, that is, productivity improved as the crisis hit and foreign capital retrenched. From the theoretical side, I provide an alternative framework that reconciles both sets of papers by endogenizing firms' decision to export and, thus, the size of the exporting sector.

3 Aggregate productivity during a sudden stop

How do unexpected capital flow reversals affect macroeconomic performance? To answer this question: (i) I establish a criterion to identify sudden stops, (ii) classify episodes by exchange rate regime and, (iii) characterize the behavior of several macroeconomic variables using a standard event study approach.

3.1 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 reduction in the current account deficit and a simultaneous recession. I develop an algorithm that classifies 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, (ii) there is a simultaneous decline in the current account deficit (or an equivalent decline in foreign reserves) and (iii) GDP per capita contracts.⁷ 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.⁸

The two latter requirements ensure 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. Second, by ruling out booming episodes that display similar characteristics, for example a positive trade shock.

Annual data on the current and capital accounts for all available countries comes from the IMF's

⁷This contrasts with [Cavallo and Frankel \(2008\)](#), who define as noticeable a reduction in the financial account surplus that is two standard deviations above the mean standard deviation for the corresponding decade.

⁸I refer the reader to Appendix [C.3](#) for further details.

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.⁹

The total number of episodes is 78, representing 5.2% of total available country/year observations in the sample.¹⁰ The criterion successfully identifies all traditional sudden stop episodes previously discussed by the literature - mostly 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.¹¹

I build on [Ilzetzi et al. \(2017\)](#) updated *de facto* coding system as opposed to relying on declared exchange rate regime reported to the IMF in order to classify episodes. In my baseline results, I consider as prevalent the exchange rate regime that was in place during the last year of the sudden stop. I distinguish four different cases: a currency union, a hard peg, a soft peg and a flexible arrangement.¹² 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 flexible arrangement.

To characterize the behavior of the macro-economy as a sudden stop unfolds I use data on GDP, final private consumption, employment, total factor productivity, the current account deficit and the real exchange rate. All variables are compiled from the World Development Indicators except for Total Factor Productivity, 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.

Figures 1 and 2 show the mean and median path of each of these aggregate variables across 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. As is standard in much of the literature, I focus on the cyclical component of most of the variables by looking at its percentage deviation from a pre-crisis linear trend.¹³

⁹I 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). My final sample covers 119 countries.

¹⁰The total number of episodes is 105, however, I drop one-year long episodes that start in 2009 as these are rather explained by the global trade collapse as opposed to a country-specific reversal of flows. The complete list of crisis episodes per country, plus data availability, can be found in the Appendix C.3.

¹¹The methodology does not account for changes in Target 2 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.

¹²In terms of the [Ilzetzi et al. \(2017\)](#) 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.

¹³The current account deficit, expressed as a share of GDP, and the real exchange rate index, with base t-2, are the exception.

3.2 Results

Figure 1 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 smooth decline in employment levels, measured as the number of employed workers, and a significant collapse in total factor productivity. The last two 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 plotted in Figure 1. 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 of an episode is slightly less than two years.

The results for a currency union are summarized by Figure 2. 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, 2.5 years.

The most notable difference across the plots is the behavior of TFP: whereas productivity clearly falls in the first case, in line with the findings of the literature, TFP remains unchanged, or, if anything, improves slightly within currency unions.¹⁴ A closer look into individual episodes shows that sudden stops in currency unions are typically preceded by periods of worsening TFP performance which, at least, slow down as the capital flows reversal materializes. In contrast, periods of capital inflows in free-floating regimes are characterized by increasing TFP records that completely reverse as the sudden stop hits the economy.

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 2. This holds in both absolute and relative to GDP terms. Moreover, controlling for the size of output contraction, the fall in private consumption is larger in the currency union. To see this clearly I compute the share of output contraction that is explained by cuts in consumption: 80% on impact and 76% overall in the currency union vs 72% on impact and 68% overall in the free floating regime.

3.3 Robustness

I conduct a battery of robustness checks to evaluate the consistency of my findings.¹⁵ Regarding the exchange rate classification, I consider alternative *de facto* coding systems, such as

¹⁴Given the reduced sample size in Figure 2, standard error bands are admittedly large to be able to conclude that TFP increases significantly.

¹⁵Results available upon request.

Shambaugh (2004) and Klein and Shambaugh (2008), that allow for regime changes in higher frequency. I also redo the analysis taking as given the exchange rate regime prevalent at the start of the sudden stop. This is motivated by the fact that, although in most cases countries abandoned pre-existing pegs because of a sudden stop, in a minority of cases the order reversed. Moreover, I remove episodes in which the exchange rate regime changed more than once as this is due exclusively to missing data. None of the alternative methods change the main conclusions discussed above.

Regarding the event study, I explore different ways of detrending the data including a one-sided HP filter and alternative sample lengths. I also measure labor input as total hours worked instead of employment. To control for changes in the composition of the sample, I redo the analysis including only episodes for which a full six years of data are available. Finally, I control for the degree of economic development and show that results are not driven by advanced vs. developing structural differences. Results hold for all of these specifications too.

4 Firm-level productivity during a sudden stop

What lies behind the observed difference in TFP performance across exchange rate regimes? This section resorts to micro-evidence to document the role of selection into production and firm-level TFP in explaining aggregate productivity patterns.

4.1 Spain: a tale of two sudden stops

Given limited availability in firm-level data, I use a case study approach to study firm dynamics during a sudden stop. In order to control for country fixed effects, it is preferable to compare episodes occurred within the same economy. Based on the results in section 3, Spain emerges as a natural candidate. It has experienced two sudden stops in its recent economic history under the two exchange rate regimes of interest: the first coincides with the 1992-93 Exchange Rate Mechanism (ERM) crisis and the second with the 2009-2013 European sovereign debt crisis.¹⁶ Moreover, the Spanish economy has been previously analyzed within the misallocation debate (see Gopinath et al. (2017)) and, thus, makes for an interesting benchmark for comparison.

There are clear parallels between both Spanish episodes regarding the onset. Both were preceded by periods of increasing capital inflows, declining international competitiveness and widening current account deficits. These were abruptly reverted following a confidence shock 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

¹⁶There are two other countries which have experienced sudden stops under different exchange rate regimes: Finland and Italy. The episodes also correspond to the ERM and the European sovereign debt crisis. The focus on Spain is partly driven by data availability.

government budget deficit more recently. The flight of international investment led to an urgent correction of misaligned real exchange rates and boost exports in order to close the trade gap.

The response of exchange rate policy to these events, however, diverted significantly. While the *peseta* was devalued in three occasions during the 1992-93 crisis, Spain was already sharing a common currency with its largest trading partners in 2010 and underwent a process of internal devaluation.¹⁷ Consistent with my previous results, TFP fell following the nominal depreciation in 1992, while it increased during the 2009-13 period. I take these episodes as representative of sudden stops under flexible arrangements and currency unions, respectively, and use firm-level data to explore what is driving the observed aggregate TFP pattern.¹⁸

4.2 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 Industry. 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 1990-2014.¹⁹ It covers around 35 percent of valued added in Spanish manufacturing and provides information on the 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.²⁰ 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 merge 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.

¹⁷In 1992, it 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 23rd with a third devaluation taking place in May 1993.

¹⁸It 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 Exchange Rate Mechanism, a multilateral party grid of exchange rates established in 1979. However, the repeated realignments of its central rate against the *deutsche mark* implied that the overall devaluation of its currency was even larger than that of the floating currencies such as the pound. In other words, despite the formal membership of the ERM, the exchange rate effectively behaved as flexible.

¹⁹Large firms will be overrepresented in my sample. Given that firms that enter are typically small while those that exit range from small to medium-sized, this could potentially weaken the role of extensive margin in my analysis. Keeping this caveat in mind, my findings should be interpreted as a lower bound.

²⁰The other existing firm-level dataset, as used in [García-Santana et al. \(2016\)](#), 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 built 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 criticism. Please check [Almunia et al. \(018b\)](#) for more details.

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 strictly confidential in Spain.²¹

Finally, I drop the entire firm record, instead of the corresponding firm-year observation, when conducting standard consistency checks on the data. The reason is that I want to prevent firms disappearing (and maybe then reappearing) in the sample strictly due to the cleaning procedure. This is important 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. I only leave out firms that report zero or negative values of value added or capital stock.

4.3 Estimating firm-level TFP

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 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.²² My approach is to use sector contribution to total manufacturing value added in 2018, also provided by the NSI, as the relevant weight.²³

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 National Statistics Institute.^{24,25}

²¹To the best of my knowledge, the only available dataset is the foreign transactions registry collected by the Bank of Spain containing transaction-level data which can be aggregated to the firm-level using the firm's fiscal identifier as done in [Almunia et al. \(018a\)](#). Given the administrative nature of the dataset, however, only large operations are recorded. Moreover, the minimum reporting threshold changed from 12,500 to 50,000 euros in 2008, hindering the possibility of correctly measuring the extensive margin of exports.

²²For example, manufacturing industry with ESEE code 7 (paper) corresponds to NACE Rev.2 codes 171 and 172.

²³The 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.

²⁴Total 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.

²⁵I conduct several robustness exercises in order to check whether the change in the capital stock measure impacts my 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

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.²⁶ 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 in 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.²⁷ Intuitively, this method substitutes unobserved productivity by a proxy variable in the original regression; where 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 [Akerberg et al. \(2015\)](#) that consists of identifying all coefficients in the second stage by using conditional (as opposed to unconditional) moments.²⁸

To control for attrition, I include an intermediate stage in which the probability of survival is estimated from a probit regression of a survival dummy on polynomials in materials, labor and capital in the spirit of [Olley and Pakes \(1996\)](#). This probability is then included as a regressor in the final stage.

4.4 Analysis

Aggregate TFP, defined as the labor-weighted average of firm-level TFP, decreased by 10.87% during the 1992-1993 episode while increased by 10.02% in the 2009-2013 period.²⁹ While

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.

²⁶See [Appendix B.1](#) for a more detailed review of production function estimation techniques.

²⁷The other alternatives are fixed effects, instrumental variables, first order conditions and dynamic panel approach.

²⁸In addition to accounting for labor dynamics, [Akerberg et al. \(2015\)](#) 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 et al. \(2016\)](#)'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.

²⁹I consider labor, as opposed to value added, weights when aggregating TFP for two reasons. On the one hand, I will be presenting a theoretical model with labor as the only factor of production where labor shares are the appropriate weight. On the other, large firms in terms of employment are overstated in my sample, as

consistent with the results of the event study, 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 TFP before and after each of the crises. Figure A.1 plots a kernel probability distribution estimate of log productivity before and after the sudden stop episode for both the 1992-1993 and the 2009-2013 crisis. A number of patterns stand out. First, there is ample heterogeneity in TFP levels among firms in any given year as already highlighted by the literature. Second, the shape of the distribution is reasonably similar and remains unchanged throughout both crisis periods. Third, changes in TFP are not clearly explained by major shifts in the distribution. A visual inspection suggests that the lower tail concentrates most, if not all, of the action: it lengthens as TFP decreases in the former crisis while shortens considerably as TFP increases in the latter case.

Figure 3 summarizes graphically the predominant role of the lower tail by presenting the mean change in $\log(\text{TFP})$ per percentile of the distribution. On average, the change in productivity is close to zero during both episodes across the entire distribution, with the notable exception of the 1% percentile where TFP decreases by 70% during 1991-1993 while increases by 73% during 2009-2013.³⁰ Although the standard errors are admittedly large for the 1% percentiles in both cases, the difference relative to other percentiles is large enough to remain relevant.

Estimating moments of the distribution confirm the above hypothesis with higher-order moments experiencing the largest swings.³¹ During the 1992-93 crisis firms display lower productivity on average and the dispersion of log TFP levels increases. The increase in dispersion, however, is asymmetric, the distribution of unproductive firms expands while that of productive changes little with the coefficient of skewness declining from -0.40 to -1.24. Moreover, increasing kurtosis, 7.04 vs. 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 2009-2013 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 already 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 would therefore consider weighted measures. Moreover, it should aim to disentangle the role of incumbent, entering and exiting firms in shaping TFP patterns.

explained above, and, thus, labor weights are consistent with the interpretation of my results as a lower bound.

³⁰In the former case, the 5% percentile also shrinks although by a smaller magnitude, 36%.

³¹Refer to Table A.2 for further details.

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 labor 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 labor 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 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

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

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 labor share of entrants, s_t^N , and exiters, s_{t-1}^X , respectively.³² I abstract, however, from decomposing the contribution of incumbents further using [Olley and Pakes \(1996\)](#)'s approach.³³ 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 labor share reallocation among them.

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

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

³²This version differs from the widely used [Foster et al. \(2001\)](#) 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 recent critiques to accounting exercises measuring reallocation by [Hsieh and Klenow \(2017\)](#). Even so, results are robust to considering [Foster et al. \(2001\)](#) and [Griliches and Regev \(1995\)](#) alternative decompositions.

³³[Olley and Pakes \(1996\)](#) would simply set:

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

The contribution by incumbents maps exactly into that in [Foster et al. \(2016\)](#). 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 captures the covariance of market share and productivity changes for the individual firm.³⁴

The results of the TFP growth decomposition 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.³⁵

In contrast, the increase in TFP experienced during 2009-2013 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 2009-2013 episode, firms that exit the market were, on average, bigger in terms of labor market share, 7.01% vs. 2.78%, and three times as unproductive in relation to incumbents, 27.16% vs. 9.17%, than their 1992-1993 counterparts. Moreover, the annualized exit rate more than doubled from 4.47% to 9.19%.³⁶

Back to [Table 1](#), the contribution of incumbents, although half as important, is also remarkable. It is still the case that average productivity of incumbents is procyclical, yet the positive effect of the between and cross terms dominate overall. The increase in resource reallocation and a stronger correlation between productivity changes and market share together with the positive contribution of exiting firms is consistent with a cleansing effect of the 2009-13 sudden stop which is absent in the 1992-93 episode. The cleansing hypothesis, as discussed by [Caballero et al. \(1994\)](#), 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.

The cleansing hypothesis 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 more likely to grow every period. The cleansing hypothesis suggests that recessions accelerate these dynamics. One should therefore observe a stronger correlation between survival, employment and capital growth and productivity levels during crises. To test whether this is the case for the two sudden

³⁴As opposed to the covariance term in the [Olley and Pakes \(1996\)](#) expression.

³⁵Note that finding procyclical firm-level productivity is not surprising, especially, given that I have no feasible way of controlling for variable capacity utilization.

³⁶The corresponding averages for the entire sample are the following: the annualized exit rate is 7.71%, the labor share of exiting firms is 6.43% and the difference in TFP between exiting firms and incumbents is 14.09%.

stop episodes considered, I adjust the empirical specification proposed by [Foster et al. \(2016\)](#) and [Dias and Marques \(2018\)](#) and run the following set of regressions:

$$y_{it} = \lambda + \beta tfp_{it} + \delta ss_t^1 + \gamma ss_t^1 * tfp_{it} + \mu ss_t^2 + \theta ss_t^2 * tfp_{it} + \epsilon_{it},$$

where y_{it} stands for a set of explanatory 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 employment and/or capital growth in the regressions for input growth. The regressor ss_t^1 is a dummy variable for the 1992-93 sudden stop, ss_t^2 is a dummy variable for the 2009-13 sudden stop and tfp_{it} captures the log of firm-level productivity.

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 be strengthened during a sudden stop episode and one would anticipate $\gamma < 0$ and $\theta < 0$. Note that the sign of parameters δ and μ provide additional insights regarding the interaction terms. They capture the change in exit rate during the sudden stops that is not correlated with productivity. When positive, it suggests that the increase in exit rates during the crises is disproportionately larger for the least productive firms. For the input growth specification, the exact opposite applies.

Results of these regressions are summarized in [Table 2](#). The first column shows the relationship 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. Based on the estimates, 2009-2013 is a period of increasing exit rates, especially among the less productive firms. Note that while the coefficients δ and γ have the correct sign, they are smaller in magnitude than μ and θ and, more importantly, not statistically different from zero.

The second and third columns support further the predictions of the cleansing hypothesis for the 2009-13 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. Together with the negative sign of coefficient μ , there is evidence that high productivity levels somewhat shielded firms from shrinking during the crisis years. The fourth and fifth columns show the capital growth specifications for completeness. Results, however, are uninformative with estimated coefficients displaying no statistical significance.

To further understand the quantitative relevance of my results, [Figure 4](#) plots the implied differences in exit probability and labor growth between two firms with productivity level one standard deviation above and one standard deviation below the sectoral mean during normal times, the 1992-93 sudden stop and the 2009-13 sudden stop. The difference in exit rates is 3.7% in the baseline scenario and increases during sudden stops. While the increase is minor during the 1992-93 episode, up to 4.3%, the implied difference almost doubles in the latter case,

7.1%. The magnitudes of the difference for labor growth follow a similar pattern. The baseline gap between a high productivity and low productivity firm is only of 0.9%, increasing to 1.1% during the first sudden stop and up to 2.6% over the second. Note that results for labor growth are robust to considering the subsample of continuing firms.

Allocative efficiency Finally, I evaluate an additional theoretical channel through which reallocation may contribute to TFP growth - increased allocative efficiency. Consider the [Hsieh and Klenow \(2009\)](#) 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} :

$$\begin{aligned} MRPL_{it} &= \left(\frac{1 - \alpha}{\mu} \right) \left(\frac{p_{it}y_{it}}{l_{it}} \right) = \left(\frac{1}{1 - \tau_{it}^y} \right) w_t, \\ MRPK_{it} &= \left(\frac{\alpha}{\mu} \right) \left(\frac{p_{it}y_{it}}{k_{it}} \right) = \left(\frac{1 + \tau_{it}^k}{1 - \tau_{it}^y} \right) r_t, \end{aligned}$$

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.

[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.³⁷ Therefore, the degree of dispersion in firm-specific distortions is informative of the degree of misallocation in the economy. As distortions are unobservable in practice, I measure the standard deviation of marginal revenue products as a proxy of allocative efficiency and study the evolution over time. 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.

I set the capital share to be equal to 0.35 and the constant mark-up 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 labor-weighted average using time-invariant weights corresponding to the 2000-2014 labor share average.

Figure 5 reports the within-sector standard deviations of marginal revenue products of capital and labor relative to 1990, which is normalized to one. The dispersion of log (MRPK) is declining over time until the late 1990s when the trend clearly reverses. During the 2000s there is a gradual increase in dispersion, with the more pronounced hikes taking place from

³⁷See Appendix B.2 for a brief revision of their argument.

2005 onwards. This is somewhat interrupted during the recent crisis during which dispersion is reduced slightly with the trend reverting back to the pre-crisis level by the end of the sample. The overall description holds for the dispersion of $\log(\text{MRPL})$ too, although the latter depicts much larger volatility.

The increase in the dispersion of $\log(\text{MRPK})$ during the pre-crisis had been already documented by both [Gopinath et al. \(2017\)](#) and [García-Santana et al. \(2016\)](#) using different datasets for the Spanish manufacturing sector. The difference here is the pattern of $\log(\text{MRPL})$; while the former papers had reported a relatively flat (or even declining) path, I find that it follows a similar, yet more pronounced, trend to that of $\log(\text{MRPK})$. According to the [Hsieh and Klenow \(2009\)](#) framework this can be interpreted as evidence of changing external distortions that affect both factors of production.³⁸ Alternatively, internal distortions, such as heterogeneity in price markups, would generate observationally equivalent patterns. I take the latter stance as the constant mark-ups assumption has been disproved by the industrial organization literature (see [Syverson \(2004\)](#) and [De Loecker and Warzynski \(2012\)](#) as examples).³⁹

In sum, the above findings call for a theory of sudden stops that features heterogeneously productive firms, selection into production and endogenous variables mark-ups. All of these elements, together with the exchange rate dimension, are featured in the theoretical model that I develop in the next section.

5 Theoretical model

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 the consumption goods using labor supplied by the households, and a monetary authority that sets the nominal exchange rate as the policy instrument.

5.1 A representative household

The representative household derives utility from leisure and the consumption of a set of differentiated goods, indexed by ω , and supplies differentiated types of labor input, indexed by i . The lifetime utility is given by:

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

³⁸In the model this is represented by an output distortion.

³⁹See [Fernández et al. \(2015\)](#) for evidence on the evolution of Spanish price-cost markups for the 1995-2012 period.

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 assumed to be:

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

where N_t the number of differentiated varieties available in the economy.

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 and is assumed to be strictly positive. 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 mark-ups, which capture the effect of market competition of 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.⁴⁰ The demand parameters α and η therefore measure the substitutability between the consumption of differentiated goods and leisure and are also assumed to be strictly positive.

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

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

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 bonds B_t which pay a debt elastic rate of return:

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

⁴⁰Given the quasi-linear functional form, there is no income effect for differentiated varieties. However, changes in wages will affect demand through the substitution effect.

where R_t^* is the world interest rate and \bar{B} is the steady state level of debt.^{41,42} The only source of uncertainty is ξ_t which is interpreted as a country risk premium shock, similar to that of [Garcia-Cicco et al. \(2010\)](#) and [Drechsel and Tenreyro \(2017\)](#), and assumed to follow an AR(1) process in logs. A sudden stop in the model is 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 which are imperfect substitutes between them. 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 \(2011\)](#).⁴³ Suppose, for example, that each member of the household specializes in one occupation. The representative household therefore 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:

$$\alpha - \gamma q_t(\omega) - \eta Q_t = \lambda_t p_t(\omega), \quad (4)$$

where Q_t 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:

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

A higher interest rate and expectations of nominal exchange rate depreciation both increase the returns from foreign investments and, thus, encourage consumer savings.

⁴¹ This debt-elasticity of the interest rate is assumed to ensure a stationary solution to the model after detrending following [Schmitt-Grohé and Uribe \(2003\)](#).

⁴² 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.

⁴³ 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.

Solving for the optimal wage for labor type i gives:

$$W_t^i = \frac{\theta}{\theta - 1} \frac{1}{\lambda_t}. \quad (6)$$

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. $W_t = W_t^i$.

Finally, note that the representative household will be willing to satisfy firms' labor demand as long as the real wage covers the marginal rate of substitution between consumption and leisure:

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

5.2 Firms

There is a continuum of measure M of domestic firms, each choosing to produce a differentiated variety ω .⁴⁴ Labor is the only factor of production and the unit production cost is a concave function in the factor price i.e. $C_t = W_t^\sigma$, where $0 < \sigma \leq 1$ is the labor income share.⁴⁵ Firms only differ in the productivity level z which is drawn from a Pareto distribution $1 - G(z) = (\frac{1}{z})^k$ with shape parameter k and minimum productivity level equal to one.

The main focus of the paper is the short-run and, as such, cross-country reallocation of firms is not allowed.⁴⁶ 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:

$$q_t^{*F}(z) = A - B p_t^{*F}(z), \quad (7)$$

where A and B are exogenous given a small-open economy setting. In the spirit of [Demidova and Rodriguez-Clare \(2009\)](#), Appendix C.1 shows 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.⁴⁷

⁴⁴The same is true for the foreign economy: there is a continuum of measure M^* potentially active foreign firms.

⁴⁵To rationalize this functional form, suppose there is a second factor of production, land, which is inelastically supplied by households and the production function is Cobb-Douglas in land and labor. If the rental price of land is assumed to be constant, the unit production cost is given by $C_t = (\frac{W_t}{\sigma})^\sigma \left(\frac{\kappa}{1-\sigma}\right)^{1-\sigma}$.

⁴⁶Note that this is only true for the baseline set-up. In one of the extensions, I allow for firm entry and exit and study long-run implications instead.

⁴⁷In the limit z^{*F} is unaffected by changes in Home, the term A includes the price index, the number of

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

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

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. Note that the corresponding prices are also derived from the above expressions.

The labor demand for a domestic firm with productivity level z is given by:

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

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

5.3 Aggregation and market clearing

I aggregate firm-level variables and impose market clearing conditions as the 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.⁴⁸ This is simply the productivity level of the marginal firm that is indifferent between producing or not in 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. On the demand side, the linearity of consumer's demand gives rise to the existence of a choke price. This is the maximum price that can be charged for a given variety at which demand is driven down to zero. By combining these two conditions the

consumed varieties and the marginal utility of wealth in Foreign while the term B is proportional to the marginal utility of wealth in Foreign.

⁴⁸See Section 6 for the formal proof.

equilibrium thresholds can be expressed as:

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

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

$$z_t^{*F} = \frac{B}{A} \frac{\tau W_t^\sigma}{\epsilon_t}, \quad (11)$$

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 it is irrelevant for the analysis.

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:

$$N_t = M \left(\frac{1}{z_t^H} \right)^k + M^* \left(\frac{1}{z_t^F} \right)^k, \quad (12)$$

where $\left(\frac{1}{z_t^H} \right)^k$ 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.

Price level The aggregate price level is given by the sum of prices of all goods consumed domestically, that is, prices of domestically produced goods consumed domestically and import prices:

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

Combined with the optimal price expressions that result from the firm's maximization problem and the number of active firms in equilibrium, given by equation (12), the above expression is considerably simplified to read:

$$P_t = \frac{2k + 1}{2k + 2} \frac{W_t^\sigma N_t}{z_t^H}. \quad (13)$$

The aggregate price level is determined by the number of firms and the average effective marginal cost. The former follows by definition, the latter 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 aggregate price level decreases in z_t^H .

Wage level I introduce nominal rigidities in the form of sticky information, as in [Mankiw and Reis \(2002\)](#), in the wage setting process. The representative household updates its information set for each labor type it supplies with a probability μ . The aggregate wage is then given by:

$$\log W_t = \mu \sum_{s=0}^{\infty} (1-\mu)^s \mathbb{E}_{t-s} \{ \log W_t^i \} = \log \frac{\theta}{\theta-1} - \mu \sum_{s=0}^{\infty} (1-\mu)^s \mathbb{E}_{t-s} \{ \log \lambda_t \} . \quad (14)$$

A labor type that last updated its information set s periods ago chooses its wage today to be equal to its s -periods-ago expectation of today's flexible wage. Thus, the aggregate wage is a weighted average of the current and all past expectations of today's desired wage. Expectations farther in the past are given less weight because the share of firms that are stuck with old information decays over time.

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), sum across all active domestic firms using the Pareto distribution assumption. Labor market clearing then boils down to:

$$L_t = \frac{k}{(k+1)(k+2)} \frac{\sigma}{W_t^{1-2\sigma}} M \left[\frac{\lambda_t}{\gamma} (z_t^H)^{-(k+2)} + B \frac{\tau^2}{\epsilon_t} (z_t^{*F})^{-(k+2)} \right] . \quad (15)$$

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,

$$EX_t - IM_t = \epsilon_t P_t^* (B_t - R_t B_{t-1}) , \quad (16)$$

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

$$IM_t = \int^{N_t^F} p_t^F(\omega) q_t^F(\omega) d\omega = \frac{1}{k+2} M^* \frac{\lambda_t (\tau \epsilon_t (W_t^*)^\sigma)^2}{\gamma} (z_t^F)^{-(k+2)} , \quad (17)$$

$$EX_t = \epsilon_t \int^{N_t^{*F}} p_t^{*F}(\omega) q_t^{*F}(\omega) d\omega = \frac{1}{k+2} M \frac{B (\tau W_t^\sigma)^2}{\epsilon_t} (z_t^{*F})^{-(k+2)} . \quad (18)$$

5.4 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.

5.5 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), and (9)-(18) given the exogenous process $\{\xi_t\}_{t=0}^{\infty}$ and the central bank's policy $\{\epsilon_t\}_{t=0}^{\infty}$.

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

6 Sudden stops and productivity

Before proceeding to the full characterization of the model's solution, it is useful to build some intuition on the potential impact of a sudden stop on productivity. A sudden stop episode forces a real exchange rate depreciation in the domestic economy. This implies a nominal exchange rate depreciation, an internal devaluation or a combination of both depending on the exchange rate policy in place. To ease understanding, I redefine a sudden stop directly as either an exogenous fall in wages, if in the currency union regime, or as an exogenous increase in the nominal exchange rate, if in the floating arrangement. In other words, I disregard the balance of payment condition, given by equation (16), for this section and study a version of the model with a partial equilibrium flavour.

6.1 Aggregate productivity

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

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

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 normally computed as the unweighted average, $\Omega(z) = \frac{1}{N_t^H}$, weighted by output, $\Omega(z) = \frac{q(z)}{Q_t^H}$, or weighted by revenue $\Omega(z) = \frac{r(z)}{R_t^H}$.⁴⁹ The following Lemma establishes that z_t^H is the key statistic for measuring aggregate productivity independently of which of these weights is used in the aggregation.

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

Proof. See Appendix D.1 □

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

Note further that, given Lemma 1, the terms (domestic) aggregate productivity and (domestic) productivity threshold, z_t^H , are used interchangeably for the rest of this section.

6.2 Pro-competitive, cost and demand channels

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 X_t and \bar{X} be its value at steady state.

Proposition 1. *In equilibrium:*

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

Proof. See Appendix D.2 □

⁴⁹ 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:

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

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 \(2008\)](#) that only considers competition in the goods market.

Second, a higher aggregate wage, $\hat{W}_t > 0$, lowers the firm's profit margin by increasing the costs to all firms. Again, a higher productivity level is then required to remain profitable and select into production, therefore, average productivity increases. This is what I denote the *cost effect*, which is the underlying mechanism in the canonical [Melitz \(2003\)](#) model that 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 remaining in the market. This final channel, a novelty of this model, is referred to as the *demand effect*.⁵⁰

6.3 Sudden stops and productivity

The following proposition considers the effect of a sudden stop, defined as explained above, 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:*

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

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

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

Proof. See [Appendix D.3](#) □

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 with the loss of competitiveness of foreign firms. There is an unambiguous fall in productivity as a result of this negative pro-competitive effect.

⁵⁰There 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.

Suppose instead that the aggregate wage adjusts completely, W_t falls, while keeping the nominal exchange rate unchanged. Under this alternative setting, the negative pro-competitive effect remains 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.⁵¹ In other words, all three channels are operating.

6.4 Increasing TFP in a currency union

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 parameterizations, 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 $1 > \mu \sigma(1 + k)$.*

Proof. See Appendix D.4 □

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 production 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 linear 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 an exogenous decline in the wage level. As the level of wage stickiness increases and fewer labor-types are allowed to adjust, the decline in labor-specific wages, W_t^i , 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.

The shape parameter measures the concentration of firms at the lower end of the productivity distribution. This represents the inverse of the dispersion in firm-level productivity. As firms only differ in their productivity levels, if k increases, they become more homogeneous. This undermines the pro-competitive channel by weakening the link between the number of firms and the degree of market power among domestic competitors.

Two questions remain unanswered. First, is the above requirement satisfied under reasonable parameterization? Second, do these results hold in the fully fledged model? In what follows I discuss how to calibrate and solve for the general equilibrium version of the model.

⁵¹Recall that a negative demand effect is represented by a positive change in $\hat{\lambda}_t$.

7 Taking the model to the data

As the model cannot be solved, I next explore its properties by generating impulse response functions, focusing exclusively on a risk premium shock and studying the role of specific parameters in shaping the TFP result. However, to take the model to the data, I first redefine two assumptions and calibrate parameters using Spanish data.

7.1 Redefining two assumptions

The baseline model, described in Section 5, is modified in two ways to better suit the analysis that follows: first, the number of existing firms is allowed to vary. Second, the exchange rate policy is reformulated as a Taylor-type rule. It is important, however, to stress, that none of these modifications change significantly the results reported in the previous sections.⁵²

The pool of potentially active firms, M , which was assumed to be constant in the benchmark case, will now respond to a sudden stop to circumvent the production boom that the model would otherwise generate.⁵³ This feature of the baseline model 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. The literature has considered featuring imported intermediate goods, labor frictions, variable capacity utilization, [Greenwood et al. \(1988\)](#) preferences, and exogenous TFP declines. Given the new extensive margin introduced in the model, I instead assume a law of motion for the number of incumbents such that in log deviation terms:

$$\hat{M}_t = -\rho\hat{\epsilon}_t - (1 - \rho)\hat{W}_t.$$

The interpretation is the following: additional labor, domestic or foreign, is required to set up a new firm and, thus, the pool of potentially active firms depends negatively on the cost of labor input, either the domestic wage, ϵ_t , or the foreign wage in domestic currency units, ϵ_t . The parameter ρ measures the degree of complementarity between domestic and foreign labor in setting up new firms.

This assumption captures, in essence, some of the implications of the long-run version of the baseline model. Further details of the full extension together with results are available in Section 9.2. In short, the long-run version features a fixed input requirement in the form of capital for the production of any differentiated variety. Capital is produced under perfect competition and accumulated through an investment decision. This follows closely [Ottaviano \(2012\)](#) in putting [Melitz and Ottaviano \(2008\)](#) in a DSGE framework. The only difference is that the fixed input requirement is assumed to be a combination of domestic and foreign capital and, thus, the

⁵²See Appendix E for a detailed discussion.

⁵³Note this is true independently of the exchange rate policy that is implemented.

number of potentially active firms depends on the price of both types of capital i.e. domestic wages and the exchange rate.

The second modification consists of a generalization of the two exchange rate regimes considered in Section 5. Suppose monetary policy sets the nominal exchange rate following:

$$(\Pi_t^w)^{\phi_w} (\epsilon_t)^{1-\phi_w} = 1, \quad (19)$$

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. I refer to all the intermediate cases as a dual mandate.

7.2 Calibration

Table 3 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 2002-2008 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 Melitz and Ghironi (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 proposed 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 et al. (2006). Given the observed cumulative distribution, $G(z)$, I run the following regression for every year and industry:

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

where, assuming a Pareto distribution, the slope coefficient, β_1 provides a consistent estimator for k . For the 2002-2008 period, k is estimated to be, on average, equal to 1.9, close to Del Gatto et al. (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, z^H . I use the corresponding 2002-2008 average as a first moment target in

two different ways. On the one hand, I combine it with the 2002-2008 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 $M = (z^H)^k N^H$.

On the other hand, I use 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 Euroarea 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 z^H pins down z^{*F} as $\frac{N^{*F}}{N^H} = \left(\frac{z^H}{z^{*F}}\right)^k$. 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. In the current setting, it measures the severity of the current account reversal given a one standard deviation shock. Thus, I choose its value such that the second theoretical moment of output during a sudden stop exactly matches its empirical counterpart, 3% for the 2009-2013 period.

There are two remaining parameters: the degree of complementarity between foreign and domestic labor in setting up new firms, ρ , and the weight that the policy-maker places on wage stabilization, ϕ_w . There is no obvious candidate value for the former. Therefore, I consider an intermediate case for the baseline results, $\rho = 0.5$, while also presenting the extreme scenarios, $\rho = 0$ and $\rho = 1$, in Appendix F. By definition, ϕ_w is set to zero and one under a currency union and a strict wage inflation target regime respectively. For the dual mandate, I take 0.5 as a benchmark for illustrative purposes, however, it is allowed to fluctuate freely when discussing optimal exchange rate policy.

7.3 Impulse Responses Functions

Figure 6 summarizes the model response of key macroeconomic variables to a sudden stop. 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 is able to predict 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 within a currency unions, such as public capital inflows, that might cushion the adjustment in reality.

The path of TFP diverges across regimes. On the one hand, under the baseline calibration, the negative effect of a lower aggregate demand offsets the positive 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 in the following section.

GDP and consumption are both measured in units of foreign currency to ease comparison with Figures 1 and 2. The model correctly predicts a fall in both variables and under both regimes. Moreover, for a similar GDP decline, the fall in consumption is twice as large in the currency union, consistent with the aggregate data. Note, interestingly, that although the drop of consumption is larger, the recovery is faster with currency union levels improving upon the floating regime as soon as two periods after the shock.

Finally, the response of employment does not match fully the data; while the event study in Section 3 suggests employment in a currency union weakens more than in a floating arrangement, there is a decline in both cases. This is not captured by the model which predicts instead a minor increase in the labor input.

Impulse response functions for all other endogenous variables can be found in Figure ???. The current account surplus is explained by a simultaneous increase in export and decline in imports. In the currency union, there is an immediate decline in the price index while wages fall in a staggered fashion. In the floating regime, the exchange rate depreciates on impact with wages and prices remaining unchanged. In both regimes, the number of firms and, thus, the number of varieties falls with the shock.

7.4 Sensitivity of the TFP fact

The analytical results of Section 6 point to three structural parameters as the main determinants of the overall response of TFP: the degree of wage rigidities, ω , the share of labor income, σ , and the shape parameter of the productivity distribution, k . I next embed the analysis within the general equilibrium framework.

The upper left graph in Figure 7 plots the immediate impact of TFP, in log deviations from steady state, for both the currency union and the floating arrangement regimes for $0.1 \leq \omega \leq 0.9$. By definition, under the floating arrangement wages are stabilized completely and, thus, there is no effect of wage frictions whatsoever. For the currency union, nevertheless, higher wage flexibility (higher ω) leads to a smaller increase in TFP. This result holds through in cumulative terms (see upper right graph).

The next two graphs, in the lower panel of Figure 7, decompose the effect of a sudden stop on TFP into the demand, pro-competitive and cost effects for the currency union as defined in

Proposition 1.⁵⁴ As wages become more flexible, the unit production cost falls by more. The opposite is true for the demand effect: when more labor types are allowed to adjust their wages, the labor-specific wage declines by less and, thus, the required increase in marginal utility of wealth is smaller i.e. the positive contribution of negative demand shrinks. The magnitude of the pro-competitive effect also varies with the degree of wage flexibility. The intuition relies on second round effects. As wages fall by more and the increase in productivity cutoff is smaller, the reduction in the number of competitor declines and the pro-competitive effect weakens.

Figures ?? and ?? perform the same exercise for $0.1 \leq \sigma \leq 0.9$ and $1.5 \leq k \leq 2.5$ correspondingly. On the one hand, as the share of labor falls, the drop in wages that is required to regain international competitiveness increases substantially in a currency union. The greater the fall in wages, the stronger the demand effect and the larger the improvement in TFP. Once again, there is little change in the floating arrangement as the adjustment of the exchange rate is not affected by the production structure of the economy. On the other hand, the shape parameter measures the relative number of low-productivity firms; as it increases, there is a higher concentration of firms in the lower end of the productivity scale. According to the results depicted in the upper left graph of Figure ??, the behavior of TFP is robust, even in quantitative terms, to different parameterizations of k .

8 Welfare

Given that the model has proven to correctly capture the macroeconomic dynamics that follow a sudden stop episode under the two policy regimes in Section 7, it is a suitable framework to conduct normative analysis. This section first considers a utility-based measure of welfare to revisit the flexible vs. floating debate, next explores optimal policy and concludes with a discussion of other welfare-relevant measures.

8.1 Fixed v.s. floating

As there is no closed-form representation of the welfare function, I evaluate welfare losses numerically. In particular, I compute the fraction of labor, λ_L , that equates the conditional expectation of short-term future utility along the equilibrium as of time zero to its value in the non-stochastic steady state.^{55,56} The interpretation is the following: the welfare loss associated to a sudden stop under a given exchange rate regime is the extra amount of labor that the

⁵⁴Note that for the floating arrangement it is still the case that only the pro-competitive channel operates.

⁵⁵As in [Schmitt-Grohé and Uribe \(2007\)](#), I consider the conditional rather than the unconditional expectation because different policy regimes tend to have different stochastic steady states. Note that although this strategy computes the constrained policy rule associated with a particular initial state of the economy, this is precisely the state that is of interest for my analysis: the non-stochastic steady state.

⁵⁶I consider a finite sum of future utilities because of mean reversion in the capital account dynamics. I set $T = 20$ in line with the IRFs.

consumer is willing to supply (amount of leisure given up) in steady state to remain indifferent between a world with and without a sudden stop episode. λ_L is implicitly given by the expression:

$$\mathbb{E}_0 \left[\sum_{t=0}^T \beta^t U(q_t^r(\omega), L_t^r z) \right] = U(q(\omega), (1 + \lambda_L) L), \quad (20)$$

where $q_t^r(\omega)$ and L_t^r represent the optimal consumption and labor supply paths associated to a particular exchange rate policy r and the right-hand side term measures utility at the non-stochastic steady state. The left-hand side of equation (20) is approximated to second-order.

Figure 8 plots the ratio of the welfare loss of a sudden stop under a currency union to that under a floating arrangement for different degrees of nominal rigidities, with $1 - \omega = 0$ representing a world of perfectly flexible wages. If the ratio is above one, the floating arrangement welfare-dominates the currency union and viceversa. Results of the model are summarized by the blue solid line. As can be seen, the desirability of the floating arrangement is increasing in wage stickiness. However, for a wide range of nominal rigidity levels, a currency union performs better in welfare terms.

To give a sense of how far the calibrated economy is from the indifference point, when the ratio is exactly one, the shaded area in Figure 8 shows the range of values of wage stickiness that have been used by the literature. While the baseline calibration of ω is purposely conservative, $1 - \omega = 0.8$, micro-evidence from the ECB Wage Dynamic Networks has found that the quarterly frequency of unconditional wage adjustments is ranges between 20% and 35% i.e. $1 - \omega \in (0.65, 0.8)$.⁵⁷ According to this, the welfare-dominance of a floating arrangement remains an unsettled question.

The Friedman view How do these findings compare to the inherited wisdom on the fixed vs. floating debate? The standard argument, as first proposed by Friedman (1953), can be summarized in two claims. First, in a world of perfectly flexible wages, a nominal depreciation and an internal devaluation would lead to the same economic outlook. Second, it is the pervasiveness of nominal rigidities, however, that justifies the desirability of floating: when prices do not adjust, quantities do, thus, the lack of wage adjustment in fixed exchange rate regimes leads to suboptimal unemployment.

To capture the predictions of this traditional view, I modify the baseline model in two ways: shutting down entry and exit firm dynamics and imposing linear production in labor. The former requires featuring a fixed number of homogeneous firms in terms of productivity.⁵⁸ The

⁵⁷See Druant et al. (2009) and Le Bihan et al. (2012).

⁵⁸A more detailed description of this version of the model together with the corresponding equilibrium conditions can be found in Appendix F.

latter consists of setting the labor share, σ , equal to one. The resulting welfare loss ratio is depicted by the red dashed line in Figure 8, an upward-sloping convex curve that starts at exactly the indifferent ratio. Consistent with the two claims above, a floating arrangement is always preferred; with the exception of a perfectly flexible wage world, in which the floating arrangement performs equally to a currency union.

In short, the normative implications of the model match the second claim of the standard argument but disagree regarding the first: it is still the case that increases in wage stickiness are relatively more harmful within currency unions; but accounting for firm dynamics, makes a currency union more desirable if wages are sufficiently flexible.

8.2 Optimal exchange rate policy

The previous exercise strictly compares the two extreme exchange rate regimes, while the exchange rate rule defined by equation (19) features many intermediate cases each of which is characterized by the parameter ϕ_w , the weight the monetary authority places on wage stabilization. Figure 9 plots the optimal response of exchange rate policy following a sudden stop for different degrees of wage flexibility where optimal policy is defined as the value of ϕ_w that minimizes the welfare loss computed as explained above. Results show that dual mandates are mostly suboptimal and only first-best for a narrow set of wage rigidity values, $0.68 < \omega < 0.71$.

8.3 Other welfare-relevant measures

(Work in progress)

9 Extensions

9.1 A model with capital *(Work in progress)*

9.2 Long-run analysis *(Work in progress)*

9.3 Accounting for unemployment *(Work in progress)*

10 Conclusion

This paper has sought to answer a classical question in International Macroeconomics: how should exchange rate policy respond to a sudden stop episode? While the literature has commonly supported exchange rate flexibility, it has often overlooked the response of TFP in the analysis. I study the question anew, emphasizing the differences in TFP patterns that emerge

across exchange rate regimes in the aggregate data and relating them to observed differences in firm dynamics at the micro-level.

The empirical analysis of the paper delivers two main findings. First, TFP systematically collapses under a flexible exchange rate arrangement while it improves, albeit moderately, within a currency union. Second, the difference in productivity growth is largely explained by the reallocation of resources from unproductive exiting firms to productive survivors. While this cleansing effect is quantitatively noticeable after an internal devaluation, it is unobserved during a nominal depreciation according to the case studies here considered.

I develop a model that is able to rationalize these empirical facts and then use it to inform the optimal policy debate. The model features three key elements: firm selection, variable mark-ups and elastic labor supply in a small open economy DSGE setting. When jointly combined, productivity is endogenously determined by the number of firms, the marginal utility of wealth and the unit cost of production. The effect of a sudden stop on productivity works through the combination of each of these channels and depends directly on the degree of currency appreciation vis-à-vis wage devaluation.

Simulations of the model show that the welfare ranking of policy rules in this framework is sensitive to the calibration. In particular, a currency union dominates any other form of policy if nominal devaluations lead to a high enough increase in the cost of setting up new firms.

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Tables

Table 1: Decomposition of TFP growth

	Episode	
	1992-1993	2009-2013
Productivity growth (%)	-10.87	10.02
Shares of productivity growth		
Incumbent firms share	-11.20	3.05
Within firm share	-9.69	-2.41
Between firm share	0.47	3.75
Cross-term share	-1.98	1.71
Net entry share	0.33	6.96
Entrants' share	-0.77	-0.72
Exiters' share	1.10	7.68

Notes: Productivity growth refers to accumulated growth for the considered period. Base and final years are 1991 and 1993 for the first episode; 2009 and 2013 for the second episode. Incumbent and net entry shares add up to productivity growth. Within firm, between firm and cross-term shares add up to incumbent shares. Entrants' and exiters' shares add up to net entry share.

Source: ESEE data and own calculations.

Table 2: Reallocation and TFP

	Exit	Labor growth (continuers & exiters)	Labor growth (continuers only)	Capital growth (continuers & exiters)	Capital growth (continuers only)
	(1)	(2)	(3)	(4)	(5)
constant	0.063*** (0.002)	7.619*** (0.291)	7.769*** (0.276)	7.865 (18.446)	6.663 (20.579)
tfp_{it}	-0.041*** (0.005)	0.980* (0.488)	1.060** (0.498)	-11.489 (12.414)	-13.861 (14.679)
ss_t^1	0.005 (0.005)	-0.582 (0.886)	-0.842 (0.883)	-8.362 (13.137)	-10.654 (14.147)
$ss_t^1 * tfp_{it}$	-0.005 (0.010)	0.146 (1.095)	0.087 (1.203)	31.244 (19.993)	34.017 (22.383)
ss_t^2	0.023*** (0.005)	-7.115*** (0.813)	-6.811*** (0.800)	44.912 (57.399)	51.477 (65.758)
$ss_t^2 * tfp_{it}$	-0.031*** (0.008)	1.637** (0.737)	1.804** (0.815)	-22.326 (34.927)	-29.809 (45.192)
Observations	34,854	30,861	28,275	30,861	28,275
Industry FE	Yes	Yes	Yes	Yes	Yes

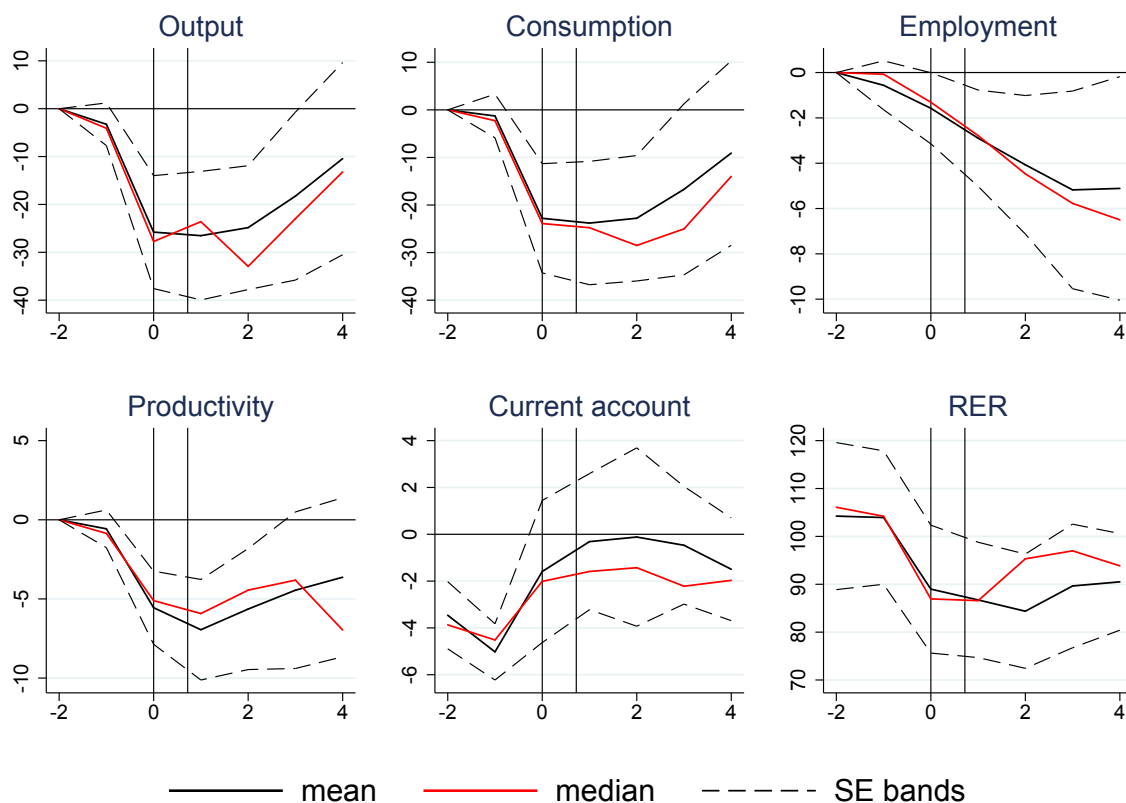
Notes: Regression for exit is a linear probability model where $exit=1$ if the firm reports positive activity in period t and no activity in period $t+1$. Employment and capital growth are measured from period $t-1$ to period t . tfp_{it} is the log firm-level TFP, ss_t^1 is a dummy equal to one for years 1992-1993 and ss_t^2 is a dummy equal to one for years 2009-2013. Standard errors (in parentheses) are clustered by industry; *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

Table 3: Calibration

Parameter	Value	Calibration target/source
β	0.99	Annual real return on bonds is 4%
ω	0.2	Gali and Monacelli (2016)
θ	4.3	Gali and Monacelli (2016)
τ	1.3	Ghironi and Melitz (2005)
γ	10	Ottaviano (2012)
α	10	Ottaviano (2012)
η	10	Ottaviano (2012)
\bar{B}	0	Steady state trade balance
σ	0.64	National Accounts Spain
n	0.12	Business Demographic Statistics
k	1.9	Estimated from ESEE data
A	0.01	Domestic productivity cutoff (1.55)
B	0.33	Share of exporting firms (63.6%)
\bar{M}	173	Active domestic firms (75.86)
ϕ	3.2	Output volatility (3%)

Figures

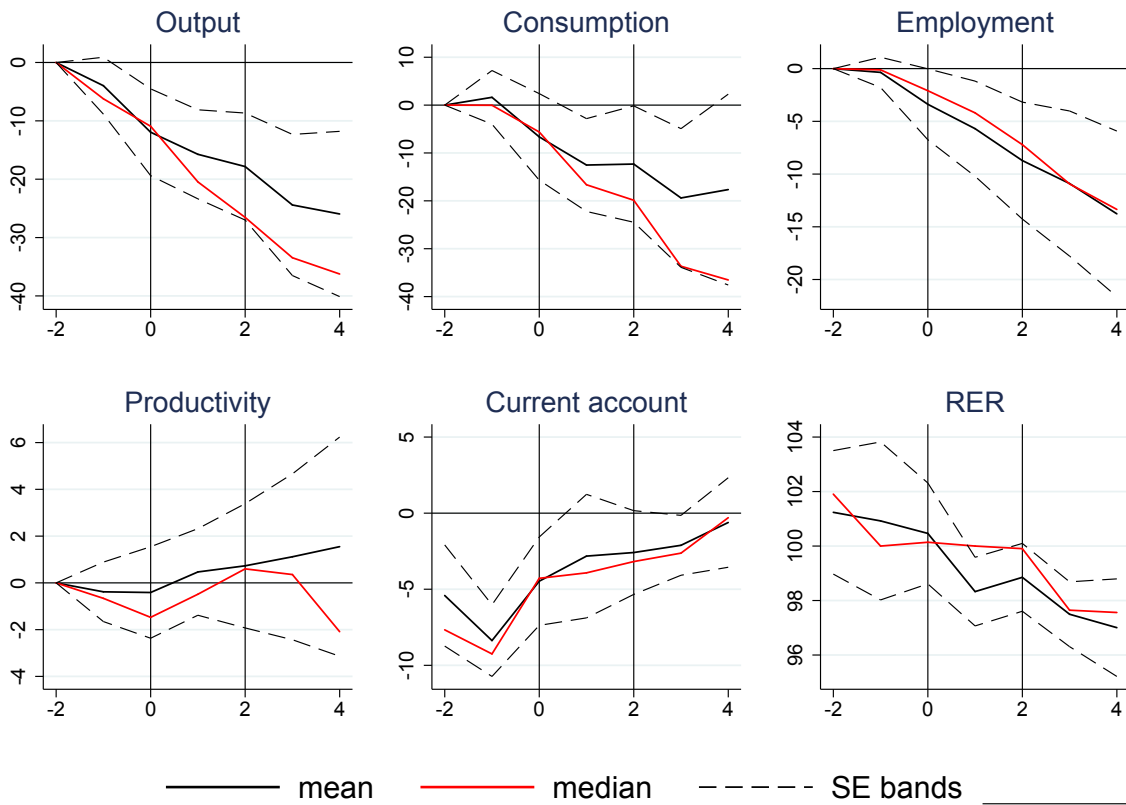
Figure 1: Sudden stops in a floating arrangement



Notes: This figure plots the response on 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 and productivity 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.

Source: IFS, WDI, Total Economy Database and own calculations.

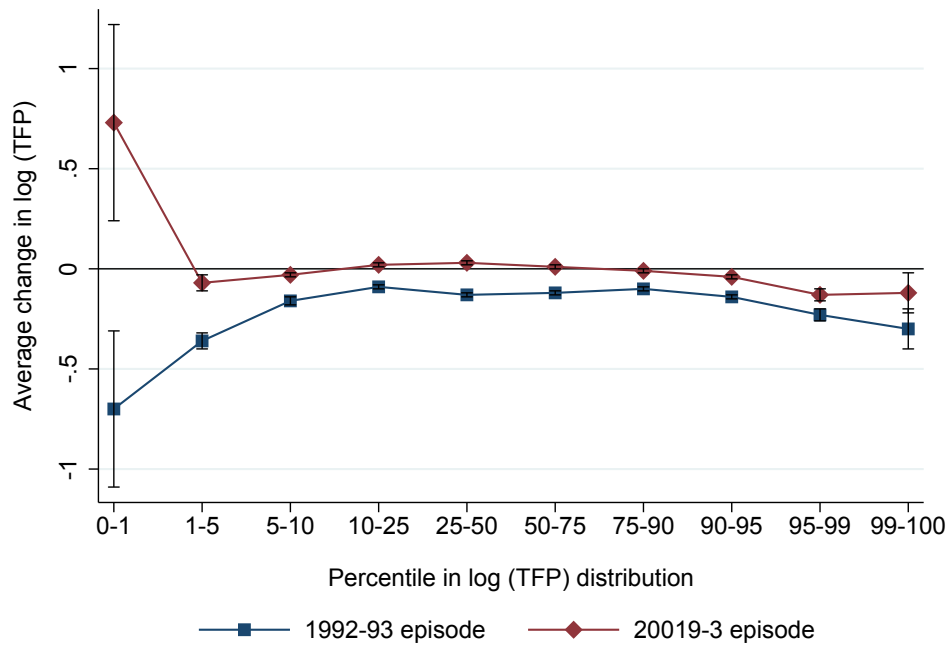
Figure 2: Sudden stops in a currency union



Notes: This figure plots the response on 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 and productivity 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.

Source: IFS, WDI, Total Economy Database and own calculations.

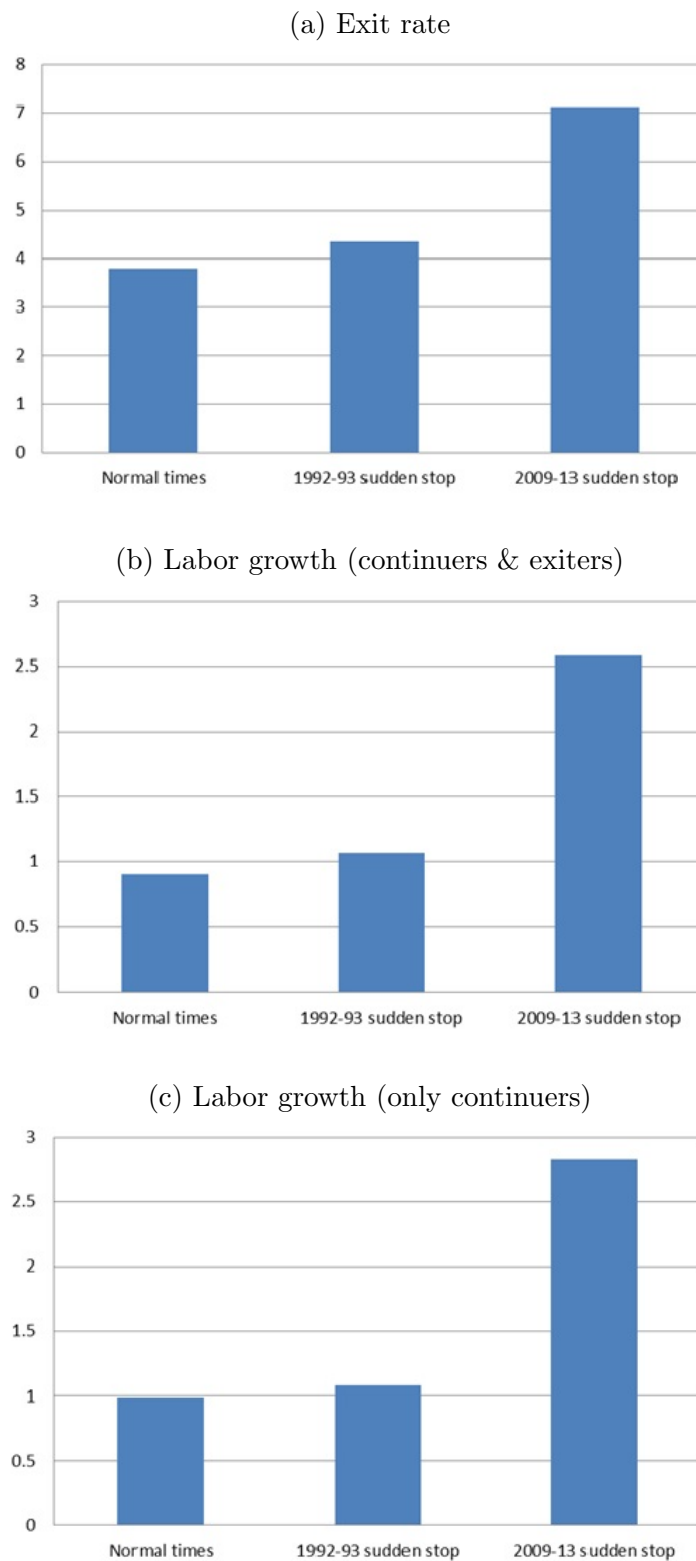
Figure 3: Average change in log (TFP) by percentile



Notes: This graph plots the average change in log (TFP) by percentile of the distribution. It compares the average TFP of firms in a given quantile before and after each of the two sudden stops. As this is an unbalanced panel, firms are allowed to change quantiles 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.

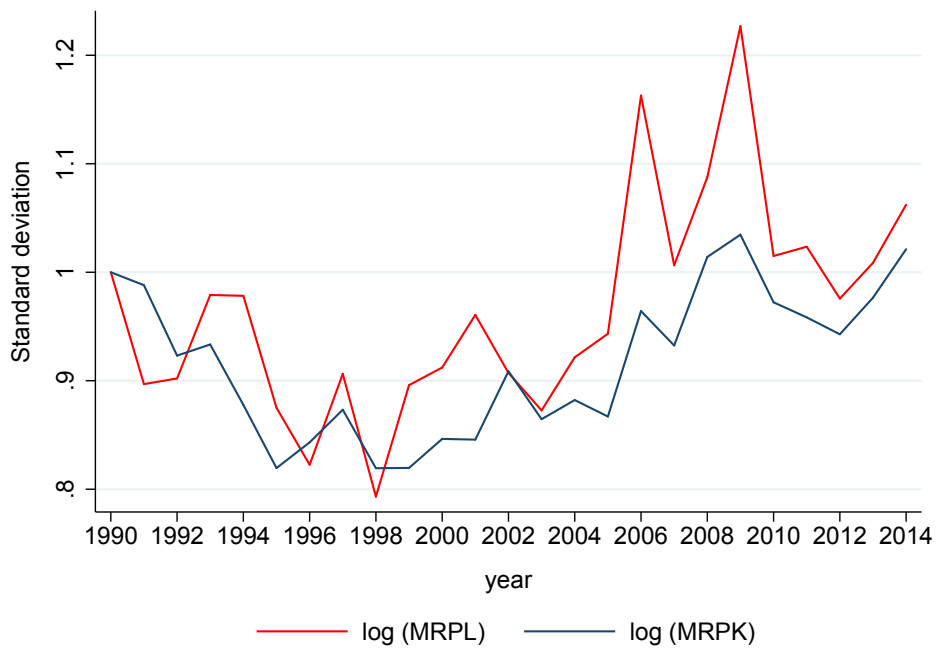
Source: ESEE data and own calculations.

Figure 4: Differences between high and low productivity firms



Notes: This figure depicts the predicted difference in probability of exit (panel A, low minus high) and the predicted difference in labor growth rate (panels B and C, high minus low) between a firm one standard deviation above the sectoral mean and a firm one standard deviation below the sectoral mean. Figures are computed from models estimated in Table 2.

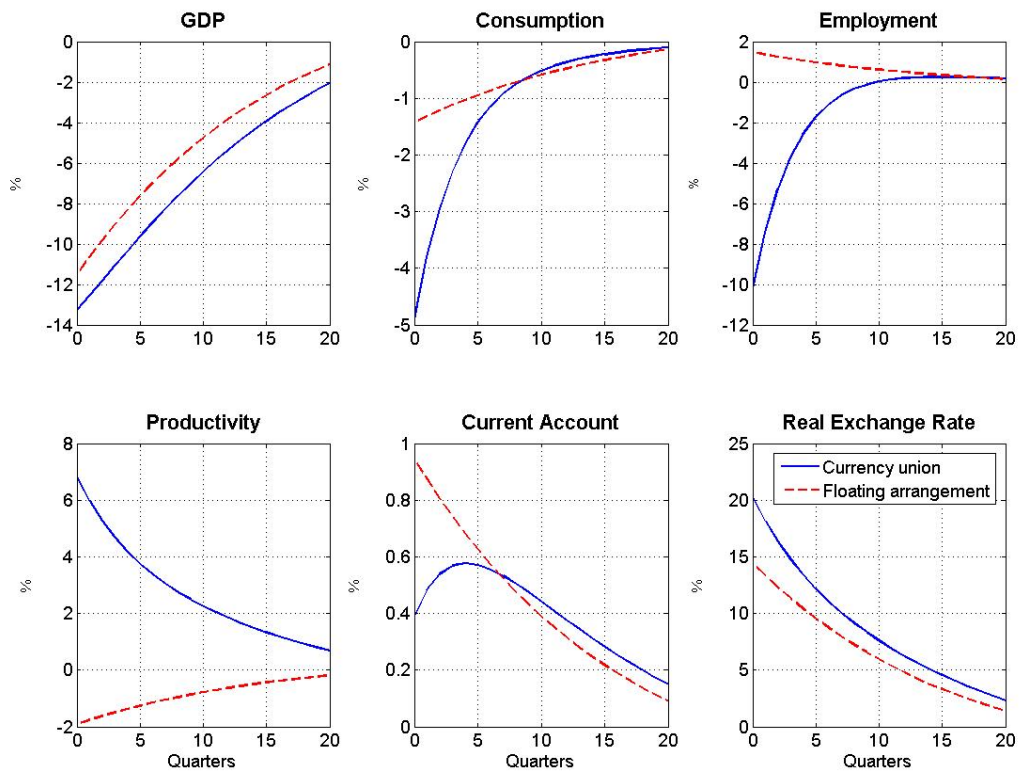
Figure 5: Evolution of allocative efficiency measures



Notes: This figure plots the within-industry dispersion of the marginal revenue products of capital and labor over time. The numbers depicted are relative to 1990, 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 labor weights.

Source: ESEE data and own calculations.

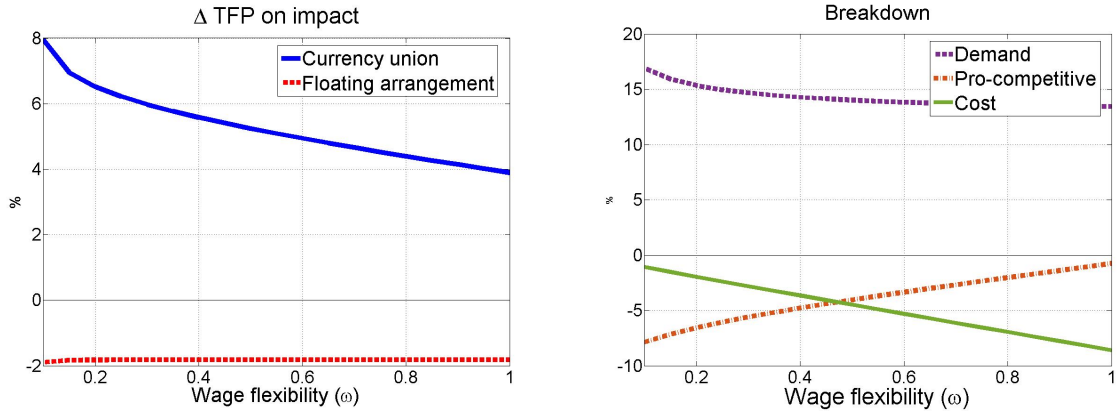
Figure 6: Macroeconomic effects of a sudden stop



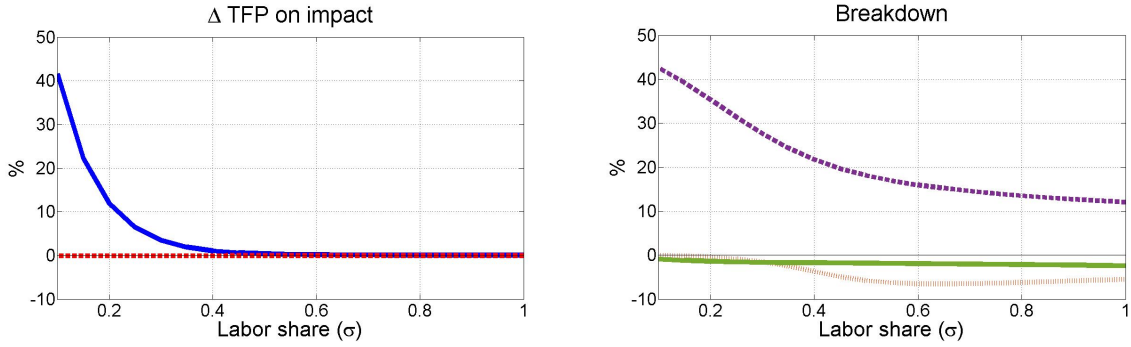
Notes. These figures plot the IRFs of key macroeconomic variables to a one standard deviation shock to the country-specific risk premium. All variables but the current account are expressed in log deviations from steady state. The current account, assumed to be zero in steady state, is expressed in levels.

Figure 7: The TFP fact - robustness to alternative calibrations

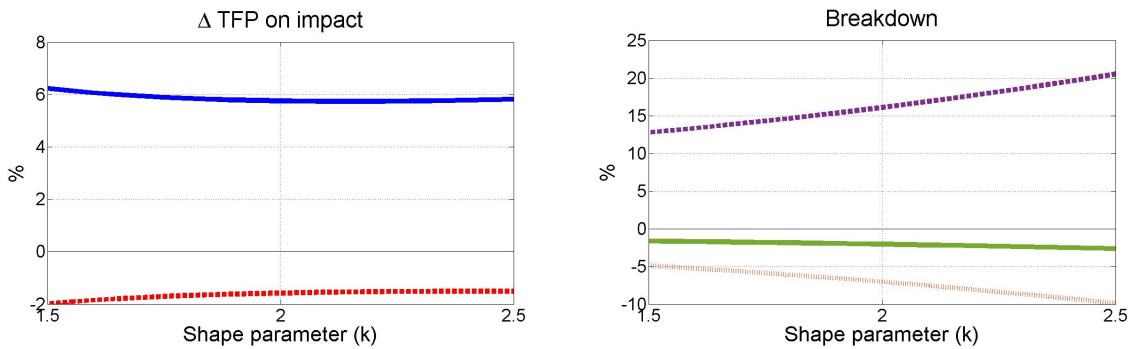
(a) The role of wage rigidities



(b) The role of the labor share

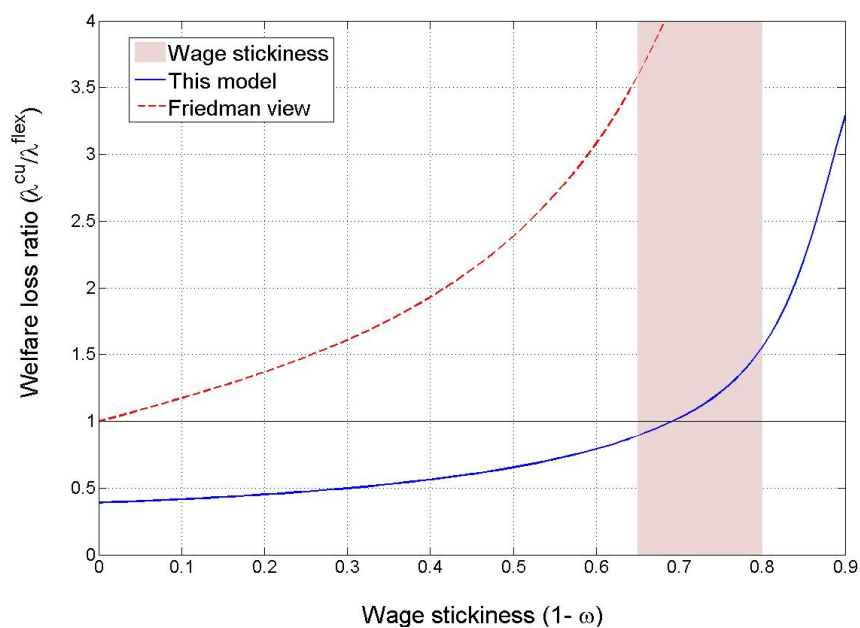


(c) The role of the shape parameter



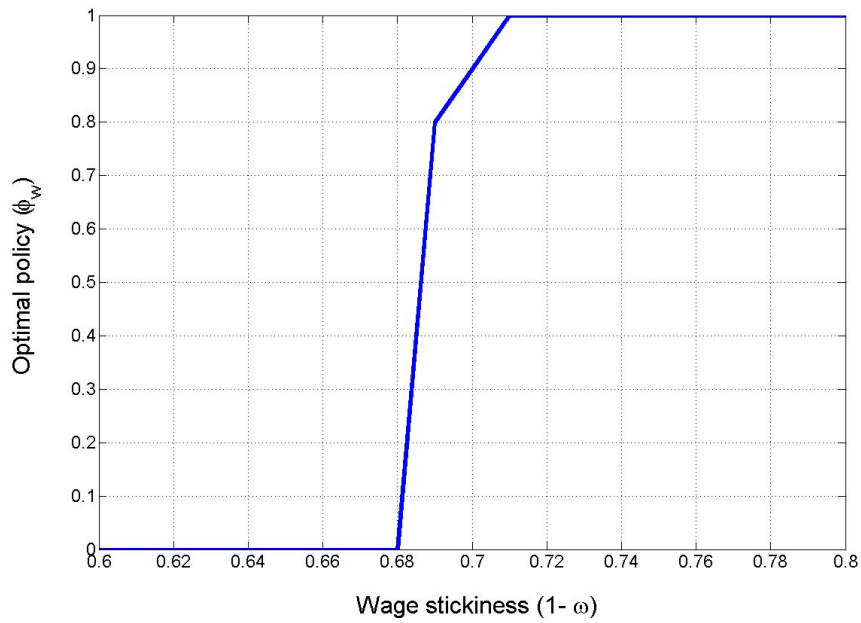
Notes: This figure documents the sensitivity of the TFP fact to different model parameterizations. Panel (a) focuses on different degrees of wage rigidities - higher ω implies lower rigidities. Panel (b) allows for plausible calibrations of the labor share - higher σ implies a larger labor share. Panel (c) explores alternative values of the shape parameter of the Pareto distribution - higher k implies lower dispersion of productivity draws. The first column plots the immediate response of TFP to a one standard deviation shock to the country-specific risk premium in log deviations terms. The second column breaks down the immediate response of TFP into the demand, the pro-competitive and the cost channels as defined by Proposition 1.

Figure 8: Currency union vs. floating arrangement



Notes: This figure plots the ratio of the welfare loss under a currency union to the welfare loss under a floating arrangement following a sudden stop. The welfare loss is calculated as the share of steady state employment that makes the representative consumer indifferent between the steady state and the dynamic equilibrium path after a one standard deviation shock to the country-specific risk premium. The blue solid line refers to the baseline model. The red dashed line refers to a version of the model with no firm dynamics (firms are homogeneous and the number of firms is constant) and linear production in labor ($\sigma = 1$). The shaded area shows the range of plausible values for the wage rigidity parameter as discussed by the literature.

Figure 9: Optimal exchange rate policy



Notes: This figure plots the optimal response of exchange rate policy following a sudden stop for different degrees of wage flexibility. Optimal policy is defined as coefficient ϕ_w , given by equation (19), that minimizes the welfare loss resulting from a one standard deviation shock to the country-specific risk premium. The coefficient ϕ_w measures the weight that the monetary authority puts on wage inflation stabilization.

Appendices

A Aggregate data appendix

A.1 Identifying sudden stops: algorithm

The following algorithm combines elements of [Calvo et al. \(2004\)](#) 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.
- 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.
- Filter again to keep reversal episodes that are accompanied by a fall in the current account deficit during the same year or the year that follows immediately after. Surviving episodes are classified as sudden stops.

Note that two further refinements are made. First, 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. Second, I collapse adjacent sudden stops into the same episode if the gap among the end of the former and the start of the latter is only one year.

B Firm-level data appendix

B.1 Production function estimation

This appendix reviews the [Akerberg et al. \(2015\)](#) 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 standard model,

$$y_{it} = \alpha + \beta_s^k k_{it} + \beta_s^l l_{it} + \omega_{it} + \epsilon_{it}, \quad (21)$$

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, $\omega_{it} = g(\omega_{it-1}) + \xi_t$.

Under the assumptions:

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 (21), 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, in the first stage 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:

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

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:

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

B.2 Allocative efficiency

This appendix summarizes the [Hsieh and Klenow \(2017\)](#) argument that resource misallocation can hinder aggregate productivity.

As explained in the main text, consider 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} :

$$MRPL_{it} = \left(\frac{1 - \alpha}{\mu} \right) \left(\frac{P_{it} Y_{it}}{L_{it}} \right) = \left(\frac{1}{1 - \tau_{it}^y} \right) W_t, \quad (22)$$

$$MRPK_{it} = \left(\frac{\alpha}{\mu} \right) \left(\frac{P_{it} Y_{it}}{K_{it}} \right) = \left(\frac{1 + \tau_{it}^k}{1 - \tau_{it}^y} \right) R_t, \quad (23)$$

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.

Define physical and revenue productivities at the firm level as

$$TFPQ_{it} \equiv A_{it} = \frac{Y_{it}}{K_{it}^\alpha L_{it}^{1-\alpha}}, \quad (24)$$

and

$$TFPR_{it} \equiv P_{it} A_{it} = \frac{P_{it} Y_{it}}{K_{it}^\alpha L_{it}^{1-\alpha}}. \quad (25)$$

By substituting equations (22) and (23) into equation (25),

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

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.

C Model appendix

C.1 A model of two large countries: the limit case

Here I show 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 $n \rightarrow 0$. The productivity cutoffs of this model would be given by the steady state versions of equations (9) and (10) together with

$$z^{*F} = \frac{\gamma + \eta N}{\frac{\alpha\gamma}{\lambda} + \eta P} \tau \epsilon (W^*)^\sigma \quad (26)$$

$$z^{*H} = \frac{\gamma + \eta N^*}{\frac{\alpha\gamma}{\lambda^*} + \eta P^*} (W^*)^\sigma \quad (27)$$

The number of active firms in Home and Foreign is given by equation (12) and

$$N^* = (1 - n)\bar{M}^*(z^{*H})^{-k} + n\bar{M}(z^F)^{-k} \quad (28)$$

while the aggregate price level is summarized by equation (13) and

$$P^* = \frac{2k + 1}{2k + 2} \frac{(W^*)^\sigma N^*}{z^{*H}} \quad (29)$$

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

$$\frac{n}{1 - n} = \frac{\lambda}{\lambda^*} \left(\frac{W^*}{W} \right)^{2\sigma} \epsilon^3 \left(\frac{z^{*F}}{z^F} \right)^{(k+2)} \quad (30)$$

To summarize, for a given n , the equilibrium in the model with two countries can be described by Equations (9), (10), (12), (13), (26)-(30) 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 :

$$\alpha\gamma\frac{1-\theta}{\theta}z^HW = W^\sigma\left[\gamma + \frac{\eta}{2k+2}\left(\frac{1}{z^H}\right)^k\bar{M}(n + (1-n)\left(\frac{W^\sigma}{\tau\epsilon}\right)^k)\right] \quad (31)$$

$$\alpha\gamma\frac{1-\theta}{\theta}z^{*H} = \left[\gamma + \frac{\eta}{2k+2}\left(\frac{1}{z^{*H}}\right)^k\bar{M}\left((1-n) + n\left(\frac{\epsilon}{\tau W^\sigma}\right)^k\right)\right] \quad (32)$$

$$\frac{n}{1-n} = \frac{W^{2\sigma(k+1)-1}}{\epsilon^{2k+1}}\left(\frac{z^{*H}}{z^H}\right)^{(k+2)} \quad (33)$$

As $n \rightarrow 0$, Equation (37) 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

$$\alpha\gamma\frac{1-\theta}{\theta} < \gamma + \frac{\eta}{2k+2}\bar{M} \quad (34)$$

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

$$q^{*F}(z) = \frac{1}{\gamma + \eta N^*}\left(\alpha + \frac{\eta}{\gamma}\frac{\theta}{1-\theta}P^*\right) - \frac{\theta}{1-\theta}\frac{1}{\gamma}p^{*F}(z) \quad (35)$$

where $N^* = \bar{M}(z^{*H})^{-k}$ and P^* is a function of z^{*H} as given by Equation (29), and, thus, constant.

Suppose, instead, the opposite is true, and the inequality given by Equation (34) 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 binding⁵⁹ and a new equation for the aggregate price level in Foreign is required. In particular, the new price level is given by

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

⁵⁹The maximum price faced by foreign consumers is actually lower than the choke price they would be willing to pay.

The rest of the argument follows: foreign demand for the domestic variety is given by Equation (35) which implies that A and B in Equation (7) are constants as none of the foreign variables i.e. z^{*H} , N^* and P^* , are affected by changes in Home.

C.2 Equilibrium summary

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

$$z_t^H = \frac{\gamma + \eta N_t}{\frac{\alpha\gamma}{\lambda_t} + \eta P_t} W_t^\sigma \quad (36)$$

$$z_t^F = \frac{\gamma + \eta N_t}{\frac{\alpha\gamma}{\lambda_t} + \eta P_t} \tau \epsilon_t (W_t^*)^\sigma \quad (37)$$

$$z_t^{F*} = \frac{B}{A} \frac{\tau W_t^\sigma}{\epsilon_t} \quad (38)$$

$$N_t = M(z_t^H)^{-k} + M^*(z_t^{F*})^{-k} \quad (39)$$

$$P_t = \frac{2k+1}{2k+2} \frac{W_t^\sigma N_t}{z_t^H} \quad (40)$$

$$L_t = \frac{k}{(k+1)(k+2)} \sigma W_t^{2\sigma-1} M \left(\frac{\lambda_t}{\gamma} (z_t^H)^{-(k+2)} + \frac{B\tau^2}{\epsilon_t} (z_t^{F*})^{-(k+2)} \right) \quad (41)$$

$$1 = \beta R_t \mathbb{E}_t \left(\frac{\epsilon_{t+1}}{\epsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \right) \quad (42)$$

$$R_t = R_t^* + \phi (e^{\bar{B}-B_t} - 1) + (e^{\xi_t-1} - 1) \quad (43)$$

$$MB \frac{(\tau W_t^\sigma)^2}{\epsilon_t} (z_t^{F*})^{-(k+2)} - M^* \frac{\lambda_t (\tau \epsilon_t (W_t^*)^\sigma)^2}{\gamma} (z_t^F)^{-(k+2)} = 2(k+2) \epsilon_t (B_t - R_{t-1} B_{t-1}) \quad (44)$$

$$W_t = \prod_{s=0}^{\infty} \left(\frac{\theta}{\theta-1} \mathbb{E}_{t-s} \left(\frac{1}{\lambda_t} \right) \right)^{\mu(1-\mu)^s} \quad (45)$$

$$\text{monetary policy rule} \quad (46)$$

C.3 Existence and uniqueness of steady state

This section 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

$$\lambda = \frac{\theta}{\theta-1} \frac{1}{W}. \quad (47)$$

Combine (36) and (40) to get

$$z^H \alpha \gamma = W^\sigma \lambda \left(\gamma + \frac{\eta}{2k+2} N \right). \quad (48)$$

Rewrite z^F as a function of z^H , given equations (36) and (37)

$$z^H = \frac{\tau \epsilon}{W^\sigma} z^H, \quad (49)$$

and plug into equation (39)

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

which can now be combined with equation (47) and (48) such that

$$z^H \alpha \gamma = \frac{\theta}{\theta-1} \frac{1}{W^{1-\sigma}} \left(\gamma + \frac{\eta}{2k+2} \left(\frac{1}{z^H} \right)^k \left(M + M^* \left(\frac{W^\sigma}{\tau \epsilon} \right)^k \right) \right). \quad (50)$$

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 (42) and (43) respectively). Imposing this on the balance of payment condition, (44), together with equations (38), (47) and (49), delivers

$$M \frac{A^{k+2}}{B^{k+1}} \frac{\epsilon^{k+1}}{(\tau W^\sigma)^k} - M^* \frac{\theta}{\theta-1} \frac{W^{\sigma(k+2)-1}}{\gamma} \frac{(z^H)^{-(k+2)}}{(\tau \epsilon)^k} = -2(k+2) \epsilon \frac{(1-\beta)}{\beta} \bar{B}. \quad (51)$$

Equation (51) can be rewritten in terms of z^H and then plugged into equation (50). 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 (51) 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 (50) 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.

D Proofs

D.1 Proof of Lemma 1

Proof. Unweighted average productivity is given by

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

Average productivity weighted by output is given by

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

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

$$\bar{z}_t^H = \int_{z_t^H}^{\infty} z \frac{r(z)}{r(\tilde{z}_t^H)} \cdot \frac{g(z)}{1 - G(z_t^H)} dz$$

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 $\bar{z}_t^H = \frac{2k^3}{(2k-1)(k^2-1)} z_t^H$. □

D.2 Proof of Proposition 1

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

$$z_t^H = \frac{\lambda_t W_t^\sigma}{\alpha \gamma} \left[\gamma + \frac{\eta}{2k+1} N_t \right]. \quad (52)$$

To derive the expression in Proposition 1 log-linearize equation (52) around its steady state. □

D.3 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

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

and combine with the expression for z_t^H above, equation (52), to get

$$z_t^H - \frac{\eta}{2k+2} \frac{\lambda_t W_t^\sigma}{\alpha \gamma} \left(\frac{1}{z_t^H} \right)^k \left[M + M^* \left(\frac{W_t^\sigma}{\tau (W_t^*)^\sigma \epsilon_t} \right)^k \right] = \frac{\lambda_t W_t^\sigma}{\alpha}, \quad (53)$$

from here it is straightforward to see that there is a negative relationship between z_t^H and ϵ_t i.e. the left-hand side of equation (53) is increasing in both z_t^H and ϵ_t . It then follows that $\zeta_{z_t^H, \epsilon_t} = \frac{\partial z_t^H}{\partial \epsilon_t} \frac{\epsilon_t}{z_t^H} < 0$.

The relationship between z_t^H and W_t is less obvious. The right-hand side of equation (53) is decreasing in wages as $\lambda_t W_t^\sigma \propto \frac{1}{W_t^{\frac{1}{\mu} - \sigma}}$ by Lemma 2. The left-hand side, however, depends on parameter value and, thus, $\zeta_{z_t^H, W_t} = \frac{\partial z_t^H}{\partial W_t} \frac{W_t}{z_t^H} \geq 0$. \square

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

Proof. In steady state, wages are equalized across labor types and equation (14) can be rewritten as

$$\lambda_t = \frac{1-\theta}{\theta} \frac{1}{W_t}.$$

During the dynamics, the negative relationship still holds as

$$\lambda_t \propto \frac{1-\theta}{\theta} \frac{1}{W_t^{\frac{1}{\mu}}}.$$

\square

D.4 Proof of Corollary 1

Proof. Suppose $\mu\sigma < \frac{1}{1+k}$, then the left-hand side of equation (53) is increasing in wages. Thus, there is an unambiguous negative relationship between z_t^H and W_t that ensures $\zeta_{z_t^H, W_t} = \frac{\partial z_t^H}{\partial W_t} \frac{W_t}{z_t^H} < 0$. \square

E Auxiliary assumptions

This section discusses how the first of the auxiliary assumptions introduced in Section 7.1, the law of motion for existing firms, changes results derived in Section 6. The second of auxiliary assumptions, the exchange rate rule, consists of a generalization of the two exchange rate regimes considered in the baseline set-up and, thus, does not affect derivations in any way.

The law of motion can be written in levels as

$$M_t = \frac{\bar{M}}{\epsilon_t^\rho \left(\frac{W_t}{\bar{W}}\right)^{1-\rho}}. \quad (54)$$

The definition of average productivity and the equilibrium condition for the domestic productivity threshold remain unchanged. Therefore, Lemma 1 and Proposition 1 still hold.

The proof of Proposition 2 needs to be adjusted slightly to read:

Proof. To see this formally, combine equations (9), (10), (12) and (54) to rewrite the equilibrium number of active firms in the domestic market as

$$N_t = \left(\frac{1}{z_t^H}\right)^k \frac{\bar{M}}{\epsilon_t^\rho \left(\frac{W_t}{\bar{W}}\right)^{1-\rho}} \left[1 + \frac{1-n}{n} \left(\frac{W_t^\sigma}{\tau (W_t^*)^\sigma \epsilon_t}\right)^k\right],$$

and combine with the expression for z_t^H above, equation (52), to get

$$z_t^H - \frac{\eta}{2k+2} \frac{\lambda_t W_t^\sigma}{\alpha \gamma} \left(\frac{1}{z_t^H}\right)^k \frac{\bar{M}}{\epsilon_t^\rho \left(\frac{W_t}{\bar{W}}\right)^{1-\rho}} \left[1 + \frac{1-n}{n} \left(\frac{W_t^\sigma}{\tau (W_t^*)^\sigma \epsilon_t}\right)^k\right] = \frac{\lambda_t W_t^\sigma}{\alpha}, \quad (55)$$

from here it is straightforward to see that there is a negative relationship between z_t^H and ϵ_t i.e. the left-hand side of equation (53) is increasing in both z_t^H and ϵ_t . It then follows that $\zeta_{z_t^H, \epsilon_t} = \frac{\partial z_t^H}{\partial \epsilon_t} \frac{\epsilon_t}{z_t^H} < 0$.

The relationship between z_t^H and W_t is less obvious. The right-hand side of equation (53) is decreasing in wages as $\lambda_t W_t^\sigma \propto \frac{1}{W_t^{\frac{1}{\mu}-\sigma}}$ by Lemma 2. The left-hand side, however, depends on parameter value and, thus, $\zeta_{z_t^H, W_t} = \frac{\partial z_t^H}{\partial W_t} \frac{W_t}{z_t^H} \geq 0$. \square

Given the modified proof of Proposition 2, the corresponding Corollary should now read

Corollary 2. *Following a sudden stop in a currency union, a sufficient condition for $\hat{z}_t^H > 0$ is that $1 + \mu(1 - \rho) > \mu\sigma(1 + k)$.*

Proof. Suppose $(1 + k)\mu\sigma < \mu(1 - \rho)$, then the left-hand side of equation (55) is increasing in wages. Thus, there is an unambiguous negative relationship between z_t^H and W_t that ensures

$$\zeta_{z_t^H, W_t} = \frac{\partial z_t^H}{\partial W_t} \frac{W_t}{z_t^H} < 0. \quad \square$$

However, as $\mu > 0$ and $1 - \rho > 0$, it is the case that the sufficient condition in Corollary 1 is more restrictive than that in Corollary 2 i.e. $1 + \mu(1 - \rho) > 1 > \mu\sigma(1 + k)$.

F The Friedman view

To be completed

Tables

Table A.1: 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	Philippines	1998	1998	4
Croatia	2009	2010	2	Poland	1990	1990	4
Cyprus	2011	2011	1	Portugal	2001	2003	1
Czech Rep.	1997	2002	3	Portugal	2009	2013	1
Czech Rep.	2008	2008	3	Romania	1999	1999	4
Czech Rep.	2011	2013	3	Russia	1998	2002	3
Ecuador	1999	2000	0	Rwanda	1994	1994	4
Estonia	1996	2001	2	Saudi Arabia	1992	1992	2
Estonia	2008	2009	2	Saudi Arabia	1999	2000	2
Ethiopia	1991	1991	3	Senegal	1994	1994	1
Ethiopia	2003	2003	3	Sierra Leone	1996	1996	4
Finland	1991	1993	3	Slovak Republic	1997	2002	3
Finland	2013	2013	1	South Africa	2008	2008	4
France	1991	1993	2	Spain	1993	1993	3
Gabon	1999	1999	1	Spain	2009	2013	1
Greece	1993	1993	2	Sri Lanka	2001	2001	3
Greece	2009	2013	1	Sudan	2010	2010	3
Haiti	2003	2003	4	Sweden	1991	1991	3
Haiti	2009	2010	3	Thailand	1997	1998	4
Indonesia	1998	1998	4	Turkey	1994	1994	4
Iran	1992	1995	4	Turkey	2001	2001	4
Ireland	2009	2014	1	Ukraine	1998	2003	2
Israel	2001	2001	3	Ukraine	2014	2015	4
Italy	1993	1994	3	United Kingdom	1990	1991	3
Italy	2011	2014	1	United States	2007	2007	4
Kenya	1991	1992	4	Uruguay	2001	2001	3
Korea	1997	1998	4	Venezuela	1994	1994	4
Latvia	2008	2009	3	Venezuela	1999	2000	3
Lithuania	1997	2002	2	Yemen Rep. of	2009	2014	3

Table A.2: Moments of the distribution

	1992-93 episode		2009-13 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
sd	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

Figures

(b) 2009-13 episode

