

Sudden Stops, Productivity, and the Exchange Rate*

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Abstract

Following a sudden stop, productivity often declines, while real exchange rates adjust through a nominal depreciation, lower domestic prices, or both. Cross-country evidence suggests that productivity contractions are larger in episodes occurring under more flexible exchange rates. A small open-economy model with firm heterogeneity, endogenous markups, and nominal rigidities rationalizes this pattern through firm selection. The model features three channels through which a sudden stop affects aggregate productivity: pro-competitive, cost, and demand. Their relative strength can generate productivity declines under a float but increases in a currency union, despite larger contractions in output and consumption under the latter. Two sudden stops in Spain under contrasting exchange rate regimes provide evidence consistent with this mechanism. Firm-level manufacturing data show that cleansing through exit is stronger in the currency-union episode than in the more flexible one, with aggregate productivity rising despite weaker firm-level performance. Quantitatively, the model accounts for more than half of the contribution of firm exit to productivity growth in Spain during 2010–13.

JEL codes: D24, E52, F32, F41, O57.

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1 Introduction

The role of fixed versus flexible exchange rates during balance-of-payments crises has long been debated in international macroeconomics. The European sovereign debt crisis offers a compelling opportunity to revisit this question. After Greece admitted to having misreported its public debt figures in late 2009, a sudden stop in capital flows hit the periphery of Europe. This episode was unusual not only because it unfolded within a currency union, but also because most affected countries saw measured total factor productivity (TFP) rise, breaking with the historical pattern of productivity contraction during these crises.¹

I study how exchange rate regimes shape the relationship between sudden stops and productivity dynamics. Cross-country aggregate evidence suggests that productivity contractions are larger in economies with more flexible exchange rates. I propose a small open economy model featuring firm heterogeneity, endogenous markups, and nominal rigidities to rationalize this pattern. The model identifies three channels through which a sudden stop affects firm selection and aggregate productivity: pro-competitive, cost, and demand. Their relative strength depends on the exchange rate regime and can generate productivity declines under a float but increases in a currency union, even as domestic adjustment is larger under the latter.

I provide evidence for this mechanism using aggregate and firm-level data from Spain, which experienced two sudden stops under contrasting exchange rate regimes: one within the euro area in 2010–13 and one under a more flexible exchange rate arrangement in 1992–93. At the aggregate level, the nominal exchange rate absorbed much of the adjustment in the earlier episode, with smaller swings in output and consumption. The firm-level evidence shows that cleansing through exit is stronger in the currency-union episode than in the earlier episode, with aggregate productivity rising despite weaker firm-level performance. I use a quantitative version of the model to simulate Spain’s experience during the 2010–13 episode, quantify the contribution of firm selection to productivity growth, and contrast it with a counterfactual floating regime. Overall, the paper shows that firm heterogeneity reshapes how real exchange rate adjustment translates into macroeconomic outcomes during a sudden stop.

Section 2 explores the behavior of macroeconomic variables during sudden stops across a broad set of economies over the 1990–2015 period. Using a standard criterion to identify sudden stops that captures both the episodes emphasized in the earlier literature as well as the most recent European cases, I first confirm the well-established fact that aggregate TFP declines on average. Conditioning on the prevailing exchange rate regime, however, reveals a new pattern: productivity contractions are larger in economies with more flexible exchange rates. This pattern is statistically significant and robust to alternative exchange rate classifications, detrending meth-

¹During the crisis period, 2010–2013, TFP rose in Ireland (3.5%), Portugal (1.5%), and Spain (1.8%), and remained unchanged in Italy. For context, since 2000, these economies had seen TFP decline by 2.6%, 2.1%, 2.8%, and 6.4%, respectively (AMECO).

ods, controls for crisis characteristics and country-level features, and the magnitude of the real exchange rate depreciation, so that regimes are compared at a common external adjustment, since the size of the underlying shock is not observed. I interpret these results as a descriptive pattern rather than a causal effect of the exchange rate regime. Once differences in real depreciation are accounted for, employment falls more under a currency union, while output and consumption display smaller contractions under floats at later horizons, consistent with the standard shock-absorber role of flexible exchange rates. The remainder of the paper therefore turns to the less familiar behavior of productivity.

To explain this pattern, I develop a small open economy model with firm selection and exchange rate policy in Section 3. Quasi-linear quadratic preferences give rise to variable markups and endogenous selection given firm heterogeneity in productivity. Firm profitability is linked to aggregate conditions through endogenous labor supply, introducing a channel through which income fluctuations affect firms' costs and selection decisions. To capture the exchange rate regime differences documented in the data, I introduce nominal rigidities in the wage-setting process. The central bank follows an exchange rate rule that nests two extreme regimes: a currency union, characterized by a credible commitment to keep the nominal exchange rate constant; and a pure float, where the flexible-wage equilibrium is always implemented.

Section 4 discusses the effects of a sudden stop on aggregate productivity. To obtain analytical results, I assume that firm productivity follows a Pareto distribution. The model then admits a closed-form solution. The key insight is that aggregate productivity is an increasing function of a domestic productivity threshold. The threshold represents the minimum productivity level at which a firm can generate positive profits and, thus, select into the domestic market. It therefore suffices to understand how the threshold moves after a sudden stop to learn about its effect on aggregate productivity.

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

I model a sudden stop as a one-time unexpected increase in the interest rate faced by domestic consumers when borrowing abroad. The effect of the shock on the domestic productivity threshold hinges on the relative strength of these conflicting forces. This, in turn, depends on the extent to which the interest rate increase is offset by a nominal exchange rate depreciation. If the nominal

exchange rate fully adjusts, both the marginal utility of income and wages remain unchanged. As a result, only the pro-competitive channel is active: fewer foreign firms serve the domestic market, leading to an unambiguous decline in productivity. In contrast, if the nominal exchange rate is fixed, the marginal utility of income adjusts accordingly, activating all three channels and making the overall effect quantitatively ambiguous. The model identifies conditions under which the demand channel dominates, allowing a sudden stop to improve productivity in a currency union, and shows that cleansing becomes less likely as the exchange rate regime becomes more flexible.

The comparison across exchange rate regimes also shows how the productivity mechanism interacts with the traditional case for flexible exchange rates. Following a sudden stop, consumption contracts more and output is lower under a currency union than under a float. Thus, the model preserves the standard shock-absorber role of flexible exchange rates, even when productivity moves in the opposite direction. I then use the same framework to study welfare implications. Absent firm-specific distortions, the model recovers the conventional welfare advantage of a float. With heterogeneous markups, stronger selection under a currency union generates an allocative gain that can offset this advantage.

Section 5 revisits two sudden stops in Spain through the lens of the model and provides evidence consistent with its mechanism. Specifically, I contrast the 2010–13 European sovereign debt crisis with an earlier sudden stop that hit Spain in 1992–93 during the Exchange Rate Mechanism crisis. The two episodes share a similar crisis onset but differ sharply in their exchange rate policy response. During the earlier episode, the *peseta* depreciated substantially, whereas during the latter Spain was a member of a currency union and adjustment took place internally. Wage growth was more subdued and output and consumption contracted considerably more in 2010–13, in line with the model’s prediction of a larger domestic adjustment when the nominal exchange rate cannot absorb the shock.

I then turn to firm-level data from the Spanish manufacturing sector to study the role of firm selection in productivity dynamics. Using the Survey on Business Strategies (ESEE), I measure TFP at the firm level and aggregate it to an industry-wide measure. A decomposition of industry-wide productivity growth shows that, although firm-level productivity declines during both crises, the increase in aggregate productivity during 2010–13 is driven by the exit of low-productivity firms. I then test whether selection on productivity itself strengthens during the two episodes. A formal regression-based test for cleansing shows that it does so in 2010–13 but not in 1992–93. These results are largely robust to accounting for firm characteristics and other differences across the two crises, including the concurrent banking crisis.

I also provide empirical support for the relevance of the demand channel by exploiting sectoral variation in the firm-level data. Intuitively, this channel should be stronger in sectors more reliant on domestic consumers. I find that less tradable sectors experience a larger contribution of exiting firms to productivity growth and, less precisely, stronger selection at exit during the

2010–13 sudden stop.

Finally, Section 6 turns to a quantitative version of the model to assess the importance of the selection mechanism. To take the model to the data, I extend it along three dimensions: forward-looking wage setting, richer firm productivity dynamics, and endogenous firm entry and stochastic exit. I then parameterize the model using a combination of values from the literature and a moment-matching exercise based on the Spanish firm size distribution, entry and exit, and trade patterns. The calibrated model also reproduces the untargeted distribution of firms across size classes. I next solve for the transition dynamics following a shock to the interest rate and a common shifter of firm productivity. The quantitative model preserves the key analytical predictions: productivity rises under a currency union and falls under a float, while the contraction in economic activity is more severe under the currency union. These responses also line up with the aggregate evidence documented in Section 2.

Next, I use the quantitative model to simulate the 2010–13 sudden stop in Spain. I begin by filtering the sequences of shocks, the interest rate and the common productivity shifter, required to match the observed evolution of the real exchange rate and output over the 2002–2014 period following Spain’s entry into the euro. The model replicates the observed increase in TFP during the sudden stop episode, although it overpredicts its magnitude. I then perform the productivity growth decomposition exercise described in Section 5. The model accounts for more than half of the contribution of firm exit to productivity growth observed in the data, while also coming close to the observed negative within-firm component. The model overshoots productivity growth mainly because it generates too much reallocation among incumbent firms.

I then study the mechanisms underlying the 1992–93 sudden stop through a counterfactual exercise. Since a direct simulation is not feasible due to data limitations, I consider a scenario in which Spain operates under a flexible exchange rate regime while experiencing the same sequence of interest-rate and common productivity shocks as in the later episode. In contrast to the baseline, productivity declines, driven by a fall in incumbent performance and a milder cleansing effect. This mirrors key patterns observed in the micro-data during the 1992–93 period.

Relation to the literature This paper contributes to several strands of the literature at the intersection of international macroeconomics and firm dynamics.

The starting point of this paper is the literature on sudden stops, first defined by [Calvo \(1998\)](#) as abrupt reversals in foreign capital inflows. This literature documents common empirical regularities across historical episodes (e.g., [Calvo, Izquierdo and Mejía \(2004\)](#), [Guidotti et al. \(2004\)](#), [Kehoe and Ruhl \(2009\)](#)) and develops theoretical frameworks that generate these regularities by modeling sudden stops as adverse shocks to productivity and external borrowing conditions (e.g., [Neumeyer and Perri \(2005\)](#), [Meza and Quintin \(2007\)](#), [Mendoza \(2010\)](#)). This paper contributes to the former by revisiting established stylized facts through the lens of exchange rate policy, and to the latter by incorporating exchange rate policy in a model that departs from the representative-

firm paradigm.

The focus on exchange rate policy also connects this paper to the literature on adjustment under fixed exchange rates going back to [Mundell \(1963\)](#). [Schmitt-Grohé and Uribe \(2016\)](#) argue that downward nominal wage rigidity generates involuntary unemployment under a peg, while [Farhi, Gopinath and Itskhoki \(2013\)](#) characterize fiscal policies that can replicate a nominal devaluation.² This paper adds a firm-selection margin to this literature: the model preserves the standard Mundellian result for consumption and output, but shows that internal adjustment can also strengthen selection and raise aggregate productivity.

A third related line of research embeds firm dynamics into open-economy macroeconomic models to study the transmission of external shocks. [Ghironi and Melitz \(2005\)](#) are among the first to introduce endogenous entry and trade participation in a DSGE framework, while maintaining constant firm heterogeneity. Parallel work adds dynamic firm adjustment through trade states and within-firm margins ([Alessandria and Choi, 2007](#); [Alessandria, Kaboski and Midrigan, 2010](#)). This paper instead builds on the [Hopenhayn \(1992\)](#) tradition by allowing for time-varying firm-level productivity.³ In this sense, the paper is closer to [Ates and Saffie \(2021\)](#), who also study the productivity costs of sudden stops with firm dynamics. Their focus, however, is on the long run effects of entry distortions and how financial selection cushions the fall in endogenous productivity.

Finally, this paper is connected to the literature that studies the contribution of reallocation to TFP growth. In particular, I provide empirical support for [Caballero and Hammour \(1994\)](#)'s cleansing hypothesis and discuss the conditions under which its magnitude is likely to be relevant in the context of a sudden stop.⁴ Moreover, this work adds to the recent set of papers that link declining TFP and enhanced misallocation with capital inflows; see [Reis \(2013\)](#), [Benigno and Fornaro \(2014\)](#) and, especially, [Gopinath et al. \(2017\)](#). They study, however, an earlier period.

2 Revisiting the Stylized Facts

This section provides cross-country evidence on the behavior of macroeconomic variables during sudden stops. I identify sudden stop episodes using a standard criterion and study the associated dynamics using an event-study approach. Both steps are standard in the literature. I build on them by examining how the resulting dynamics vary across sudden stops occurring under different exchange rate regimes.

²In the context of the euro area, [Chodorow-Reich, Karabarbounis and Kekre \(2023\)](#) document substantial declines in wages and prices during the Greek depression, highlighting that significant internal adjustment took place despite the absence of a nominal depreciation.

³Models featuring firm selection and productivity dynamics are well established in closed-economy settings, but have been applied less extensively to open economies, especially in the context of international financial shocks and exchange rate policy.

⁴The cleansing hypothesis is an interpretation of [Schumpeter \(1939\)](#)'s creative destruction argument that emphasizes the role of reallocation among new and incumbent firms at a business cycle frequency.

2.1 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 financial account surplus together with a recession.⁵ In particular, I classify as a sudden stop a period that contains at least one year during which (i) the year-to-year change in the financial account surplus is at least one standard deviation below its rolling average and (ii) GDP per capita contracts in the same year or the year that follows.⁶ The start and end of each episode is marked by the first and last year within the period in which the change in the financial account surplus is half a standard deviation below the rolling average.⁷ The latter requirement ensures that the capital flow reversals captured by the algorithm strictly qualify as sudden stops; first, by requiring that the financing disruption is accompanied by an appropriate macroeconomic adjustment, and second, by ruling out booming episodes that display similar characteristics, for example a positive trade shock. All data is collected from standard sources and, thus, its description is relegated to Online Appendix A.1.

The total number of episodes is 86. The full list of episodes per country, plus exchange rate classification, is given by Table A.1. The criterion successfully captures all traditional sudden stop episodes previously discussed by the literature, mostly occurring around the 1994/5 Tequila crisis, the 1997 Asian Financial Crisis, the 1998 Russian default, as well as the most recent balance of payments crisis in the peripheral economies of the European Union.⁸

I build on [Ilzetzi, Reinhart and Rogoff \(2019\)](#)'s updated *de facto* coding system in order to bin episodes by exchange rate flexibility. In my baseline results, I consider as prevalent the exchange rate regime that is in place during the last year of the sudden stop. There are four different cases: a currency union, a hard peg, a soft peg and a float.⁹ Out of the 86 episodes identified, 13 occur within a currency union (10 in the euro area and 3 in the CFA franc zone), 17 in a hard peg system, 28 in a soft peg regime and 27 in a float. The remaining episode, Ecuador 1999–2000, ends with the adoption of the US dollar and is left unclassified.

⁵The practice of conditioning on output contraction goes back as far as the canonical [Calvo, Izquierdo and Mejía \(2004\)](#) methodology.

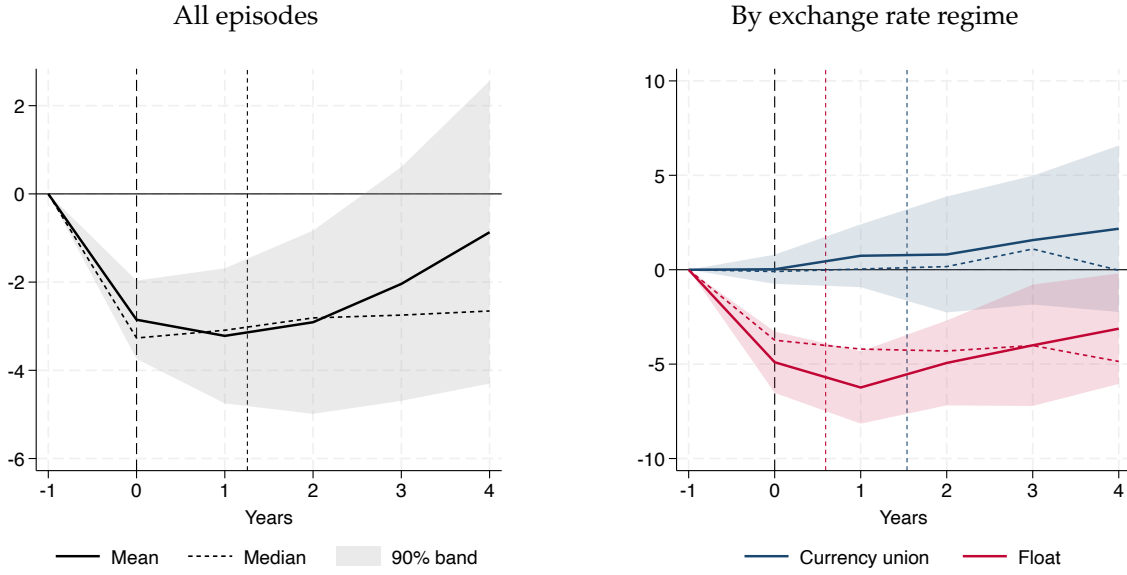
⁶This contrasts with [Cavallo and Frankel \(2008\)](#), who also require an improvement in the current account deficit (or an equivalent decline in foreign reserves). As this is conceptually equivalent to the first condition, I drop it.

⁷Refer to Online Appendix A.2 for further details.

⁸The methodology does not account for changes in TARGET2 balances in the Eurozone and, thus, prevents me from measuring private capital flows accurately. This limitation does not, however, prevent the algorithm from identifying the GIIPS episodes.

⁹In terms of the [Ilzetzi, Reinhart and Rogoff \(2019\)](#) fine classification, I deviate as follows: (1) I manually divide code 1 into currency union and no separate legal tender, (2) I group codes 2 to 4 under the hard peg category, (3) I group codes 5 to 11 under the soft peg category, (4) I group codes 12 to 14 under the float and (5) I rename group 15 as 5, i.e., other categories.

FIGURE I: PRODUCTIVITY DURING A SUDDEN STOP



Notes: The left panel plots the path of TFP around a sudden stop across all identified episodes; the right panel splits episodes by exchange rate regime, contrasting currency unions (blue) with floats (red). In both panels the solid line is the mean and the dashed line the median path of productivity, while the shaded area is a 90% confidence band for the conditional mean, with standard errors clustered at the episode level. The vertical lines mark the start ($t = 0$) and the average end of an episode (by regime in the right panel). Productivity is expressed as percentage deviations from an extrapolated linear trend fitted over the five-year pre-sudden-stop window. The data used is collected from IFS, WDI and the Total Economy Database.

2.2 Event Study Analysis

I study the dynamic behavior of macroeconomic variables following the onset of a sudden stop using an event-study framework. For each episode, the start of the sudden stop is normalized to $t = 0$, and outcomes are traced over a five year window. The analysis focuses on output, consumption, employment, productivity, wages, the real exchange rate, the current account, exports, and imports. All variables are detrended using a linear pre-sudden-stop trend and expressed as percentage deviations from that trend, except for the current account, which is reported as a share of GDP, and the real exchange rate, which is reported in levels.¹⁰

I begin by confirming a well-established empirical regularity: productivity falls sharply following a sudden stop. The left panel of Figure I plots the mean and median path of total factor productivity across all identified episodes, together with 90% confidence bands around the mean. On average, productivity declines on impact and remains depressed in the years following the sudden stop, consistent with earlier evidence in the literature.

The analysis then turns to the role of exchange rate regimes. The right panel of Figure I repli-

¹⁰I choose a five-year window to balance isolating medium-run trends with maximizing the number of episodes for which sufficiently long pre-event data are available. Results obtained using a ten-year pre-sudden-stop window are reported as a robustness check in Online Appendix A.3 and lead to similar conclusions.

TABLE I: MACROECONOMIC VARIABLES DURING A SUDDEN STOP

	Productivity (1)	Output (2)	Consumption (3)	Employment (4)
$t = 0$	0.023 (0.483)	-2.787*** (0.815)	-3.349*** (0.772)	-2.869** (1.131)
$t = 1$	0.739 (1.040)	-4.935*** (1.248)	-6.204*** (1.262)	-5.868*** (1.534)
$t = 2$	0.806 (1.806)	-8.175*** (2.308)	-9.972*** (2.436)	-9.277*** (1.923)
$t = 0 \times \text{Float}$	-2.784** (1.014)	0.229 (1.666)	-0.343 (1.918)	3.159* (1.640)
$t = 1 \times \text{Float}$	-4.942** (1.771)	0.711 (2.131)	0.258 (2.868)	6.143** (2.349)
$t = 2 \times \text{Float}$	-3.807 (2.781)	4.830 (3.027)	6.252* (3.332)	8.879** (3.310)
N	95	96	96	92
Episodes	24	24	24	24
R^2	0.448	0.603	0.616	0.490

Notes: This table reports event-study estimates of macroeconomic variables around a sudden stop, of the form $y_{it} = \alpha_i + \sum_{h=0}^2 (\beta_h + \gamma_h \text{Float}_i + \delta_h \Delta q_i) \mathbf{1}\{\tau_{it} = h\} + \varepsilon_{it}$, where τ_{it} is event time, Float_i a float indicator, Δq_i the episode's real depreciation (centered at the currency-union mean), and α_i an episode fixed effect. The level coefficients β_h give the currency-union response and the interaction coefficients γ_h the float differential. The sample comprises the year before the onset and the first three years of each episode ($t = -1, 0, 1, 2$); $t = -1$ is the omitted category, so coefficients are expressed relative to the year preceding the sudden stop. The estimation uses the 24 episodes (10 in a currency union, all in the euro area, and 14 under a float) with data on the real exchange rate from $t = -1$ to $t = 2$; the number of observations differs across columns because of missing outcome data. Variables are expressed as percentage deviations from an extrapolated linear trend fitted over the five-year pre-sudden-stop window. Standard errors, clustered at the episode level, are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

cates the exercise after binning episodes by their exchange rate arrangement, contrasting sudden stops occurring within a currency union (blue) with those taking place under a float (red). Under a float, productivity exhibits a clear and persistent decline. By contrast, within a currency union, productivity remains broadly unchanged and, if anything, displays a slight improvement in the aftermath of the sudden stop, although the associated confidence bands still contain zero.^{11, 12} This

¹¹Figure A.1 plots the raw productivity series, without detrending, for currency unions and floats from three years before to three years after the sudden stop. The two paths track each other before the sudden stop and diverge only afterwards, indicating that the regime contrast is driven neither by the detrending nor by differential pre-trends.

¹²For completeness, Figure A.2 reports the corresponding results for hard and soft pegs. Consistent with a negative relationship between flexibility and TFP growth, productivity under hard pegs falls only slightly on impact and recovers above trend later, albeit with wider confidence bands than in currency unions, while under soft pegs there is a noticeable and persistent decline. Ordering the four regimes by their degree of exchange rate flexibility, the decline in productivity following the sudden stop increases with flexibility, a pattern significant at $p < 0.001$ in both a linear and a rank-based test. Both tests use one observation per episode: average detrended productivity over the first three years of the sudden stop, for the 56 episodes with productivity data. The linear test regresses this outcome on the four-category flexibility ordering using heteroskedasticity-robust standard errors; the rank-based test is Cuzick's trend test.

pattern is robust to alternative exchange rate classifications, detrending windows, and crisis- and country-specific controls, as shown in Online Appendix A.3.

The behavior of the remaining aggregate variables is consistent with conventional accounts of sudden stops: output, consumption, employment, and wages all decline after the onset, while the external sector adjusts through a sharp contraction in imports, a rise in exports, and a real depreciation, with the current account deficit narrowing over the following years (Figures A.3 and A.4). The real depreciation, however, is far larger under floats: about 16% at the trough, against 5% in currency unions. One might then worry that floats simply experience larger shocks, driving the sharper productivity decline. Since the underlying shock is not directly observed, I instead compare regimes at a common real depreciation.

Table I addresses this by conditioning the response of macroeconomic variables following a sudden stop on the size of the external adjustment. The empirical model interacts event-time indicators with a floating exchange rate dummy and with the size of the real depreciation. It also includes sudden-stop episode fixed effects, with standard errors clustered at the episode level. The level coefficients then describe the response within a currency union, while the interaction terms give the additional response under a float. The productivity gap survives: for the average currency-union real depreciation, the decline under a float is about 3 percentage points larger on impact and about 5 percentage points larger a year later, both significant at the 5% level.

The gaps in other aggregate variables run the opposite way. Employment falls consistently more in currency unions, while output and consumption also display smaller contractions under floats at later horizons. This is the classic Mundellian argument for exchange rate flexibility: a float cushions the real economy by absorbing the shock through the nominal exchange rate, while a currency union adjusts through quantities.

These cross-country patterns are suggestive. Two features of the setting caution against reading them causally. First, a sudden stop is not a clean exogenous shock: episodes are dated, following the literature, from the behavior of capital flows and output, so their timing might be endogenous. Second, the exchange rate regime is not randomly assigned; countries that float can differ systematically from those in a currency union along many dimensions, only some of which I can account for in Online Appendix A.3. This section establishes a robust pattern that motivates the paper: productivity behaves differently around sudden stops depending on the exchange rate regime. To explain it, I now propose a novel theoretical mechanism within a small open economy framework with firm heterogeneity, and provide firm-level data to support it.

3 A Small Open Economy with Firm Heterogeneity

Consider an infinite-horizon small open economy. Time is discrete and indexed by t . The economy is populated by a continuum of households, $i \in (0, 1)$, that consume goods, provide specialized individual labor types and engage in financial transactions with foreign investors. A large number

of firms, domestic and foreign, indexed by j , produce differentiated consumption goods using labor. Finally, a monetary authority sets the nominal exchange rate as the policy instrument.

3.1 Consumers

Households derive utility from leisure and the consumption of differentiated varieties. Labor decisions are outsourced to type-specific labor unions as discussed below. Under the assumption of complete contingent claims markets for consumption, consumption and saving decisions are identical across households. Thus, I drop the household specific index i and, thus, consider a representative consumer for the rest of this section.¹³ Its lifetime utility is given by

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

where $\mathbf{q}_t \equiv \{q_{jt}\}_{j \in [0, N_t]}$ is the consumption profile over the N_t available varieties, q_{jt} is the consumption of variety j , and L_t is labor supplied by the household.

The period utility function is based on [Melitz and Ottaviano \(2008\)](#):

$$U(\mathbf{q}_t, L_t) = \alpha \int_0^{N_t} q_{jt} dj - \frac{1}{2} \gamma \int_0^{N_t} q_{jt}^2 dj - \frac{1}{2} \eta \left(\int_0^{N_t} q_{jt} dj \right)^2 - L_t,$$

where γ determines the level of product differentiation and α and η jointly capture the substitutability between the consumption of differentiated goods and leisure. All three demand parameters are strictly positive.^{14,15}

Households can only engage in financial transactions with foreign investors by trading in risk-free bonds, B_t , denominated in units of foreign currency, which pay a gross nominal interest rate $R_t = R \exp(\varepsilon_t^R)$, where ε_t^R is an interest rate shock around a mean value $R = \beta^{-1}$.¹⁶

¹³Note that this is a slight abuse of notation. There is technically not a representative household in this model due to labor specialization. However, all households face the same budget, choose the same consumption and, thus, have the same marginal utility of income.

¹⁴[Melitz and Ottaviano \(2008\)](#) preferences are appealing for three reasons. First, they capture love of variety. As γ increases, consumers place higher weight on the distribution of consumption across varieties. Second, the quadratic form gives rise to a linear demand function which ensures the existence of a choke price and an extensive margin of production even in the absence of fixed costs of production. Third, they generate endogenous variable markups, which capture the effect of market competition on firm sales (the so-called pro-competitive effect) as opposed to standard CES preferences.

¹⁵[Melitz and Ottaviano \(2008\)](#) also consider a second consumption good, which is homogeneous, non-tradable, and serves only to close the model. I drop non-tradable consumption and instead feature leisure in the utility function. This follows the convention in small open economy models to account for labor supply decisions, and enables the introduction of nominal rigidities in the wage-setting process later on. Note that while linearity in leisure simplifies the algebra, it is not essential to the analysis.

¹⁶Households 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.

The budget constraint is given by:

$$\int_0^{N_t} p_{jt} q_{jt} dj + e_t B_t = W_t L_t + \Pi_t + e_t R_{t-1} B_{t-1}, \quad (2)$$

where p_{jt} is the price of variety j , W_t is the nominal wage, and Π_t is profit received from firms, all expressed in units of domestic currency.¹⁷ In addition, e_t denotes the nominal exchange rate, defined as units of domestic currency per unit of foreign currency.

Each period, the representative household maximizes (1) by choice of q_{jt} and B_t , subject to (2).

3.2 Labor Market

As is standard in sticky wage New Keynesian models, a central authority competitively aggregates units of differentiated labor input, L_t^i , into aggregate employment services, L_t , using a CES technology, $L_t = \left(\int L_t^i \frac{\varepsilon_w - 1}{\varepsilon_w} di \right)^{\frac{\varepsilon_w}{\varepsilon_w - 1}}$, where ε_w is the elasticity of substitution across labor types.

Firms can purchase aggregate employment services at a rate W_t , where $W_t = \left(\int W_t^i 1 - \varepsilon_w di \right)^{\frac{1}{1 - \varepsilon_w}}$. Nominal wages, W_t^i , are set by unions, each of which represents households specialized in a given type of labor. Wage setting is subject to nominal rigidities: a fraction θ of unions have their nominal wage predetermined at the previous period's level W_{t-1} , while the remaining fraction $1 - \theta$ reset their wage to a new level W_t^* each period.

Since flexible unions reset every period, the wage-setting problem is purely static: W_t^* maximizes the current period's utility $U(q_{jt}, L_t)$, subject to the household budget constraint and the labor demand schedule $L_t^i = \left(\frac{W_t^*}{W_t} \right)^{-\varepsilon_w} L_t$.¹⁸ All unions that reset their wage in a given period choose the same wage since they face an identical problem. As a result, I drop the index i and simply distinguish wages based on whether or not they adjust.

Following this wage setting structure, the evolution of the aggregate nominal wage is given by

$$W_t = \left[\theta W_{t-1}^{1 - \varepsilon_w} + (1 - \theta) (W_t^*)^{1 - \varepsilon_w} \right]^{\frac{1}{1 - \varepsilon_w}}. \quad (3)$$

3.3 Firms

There is an exogenous number of potentially active firms at home, M , and abroad, M^* , producing the differentiated varieties. Firms differ in their permanent productivity z , drawn from a distribution $\Gamma(z)$ at home and $\Gamma^*(z)$ abroad. Labor is the only factor of production and the unit nominal

¹⁷All prices and costs in the model are expressed in units of domestic currency. Unlike in the CES case, total consumption under Melitz-Ottaviano preferences is non-homogeneous, making it unfeasible to derive a price index that can be used to deflate nominal variables as it is standard.

¹⁸In the quantitative model of Section 6, the fraction θ is reinterpreted as the probability of being unable to reset à la Calvo (1983), which makes the wage-setting problem forward-looking.

cost is a concave function in the factor price, i.e., $\frac{W_t^\sigma}{z}$, where $0 < \sigma \leq 1$ is the labor income share.¹⁹

Domestic 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 a differentiated good, $q_t^H(z)$, is given by the household's optimization problem above, I assume the foreign demand for a domestic variety is $q_t^X(z) = A - Bp_t^X(z)$, where A and B are exogenous given the small open economy setting. Domestic firms set prices $p_t^H(z)$ and $p_t^X(z)$ to maximize flow profits given by

$$\pi_t(z) = p_t^H(z) q_t^H(z) + e_t p_t^X(z) q_t^X(z) - \frac{W_t^\sigma}{z} (q_t^H(z) + \tau q_t^X(z)) .$$

A domestic firm selects into market $i \in \{H, X\}$ if and only if the corresponding profits are positive.

Foreign firms may choose to serve the domestic market. Similarly to the domestic pricing problem above, flow profits for a foreign firm with productivity z are given by

$$\pi_t^M(z) = p_t^M(z) q_t^M(z) - \frac{e_t \tau}{z} q_t^M(z) ,$$

where $p_t^M(z)$ is the price set by the foreign importer and the demand for imports, $q_t^M(z)$, follows from the household's optimization problem above. A foreign firm selects into importing provided $\pi_t^M(z) > 0$, and M_t^M denotes the resulting mass of importers.

3.4 Exchange Rate Policy

To pin down the nominal variables of the model, I need to determine exchange rate policy. Suppose the central bank implements monetary policy by setting the nominal exchange rate according to the following rule:

$$(\Pi_t^w)^{\phi_w} (e_t)^{1-\phi_w} = 1 , \quad (4)$$

where $\Pi_t^w = \frac{W_t}{W_{t-1}}$ is nominal wage inflation and $0 \leq \phi_w \leq 1$ is the weight that the central bank puts on wage stabilization. I explore two extreme versions of this rule. Under a currency union, the central bank perfectly commits to a currency peg in which $e_t = 1$ at every period t , i.e., $\phi_w = 0$. Under a *pure float*, the central bank offsets all the distortions that originate from nominal rigidities by implementing the flexible wage equilibrium, i.e., $\phi_w = 1$.

3.5 Equilibrium

I now define the competitive equilibrium of this economy and characterize it through the agents' optimality conditions.

¹⁹To rationalize this functional form, suppose there is a second factor of production supplied by households at a constant price κ , and the production function is Cobb-Douglas. The marginal cost is then given by $\frac{1}{z} \left(\frac{W_t}{\sigma} \right)^\sigma \left(\frac{\kappa}{1-\sigma} \right)^{1-\sigma}$.

Goods market clearing. Clearing in the goods market requires

$$e_t (B_t - R_{t-1} B_{t-1}) = e_t M \int p_t^X(z) q_t^X(z) d\Gamma(z) - M^* \int p_t^M(z) q_t^M(z) d\Gamma^*(z), \quad (5)$$

where the right-hand side is the trade balance and the left-hand side is its financing through net foreign lending—new bonds $e_t B_t$ less the matured value $e_t R_{t-1} B_{t-1}$ of last period's holdings.

Definition 1. A *Competitive Equilibrium* consists of consumer demand schedules $q_t(z)$ and bond holdings B_t ; domestic firm prices $\{p_t^H(z), p_t^X(z)\}$; foreign importer prices $p_t^M(z)$; a reset wage W_t^* and an aggregate wage W_t ; and a nominal exchange rate e_t , such that:

1. $q_t(z)$ and B_t solve the household's problem;
2. $p_t^H(z)$ and $p_t^X(z)$ solve the domestic firm's problem;
3. $p_t^M(z)$ solves the foreign importer's problem;
4. W_t^* solves the union's problem and W_t satisfies (3);
5. The exchange rate rule (4) holds;
6. The goods market clears, i.e., equation (5) holds.

3.6 Characterizing the Equilibrium

I show the properties of the representative household, labor unions and firms' optimality conditions and provide some intuition.

Given quadratic preferences, domestic consumption is governed by the existence of a choke price, p_t^{max} , i.e., the maximum price at which the household is willing to consume any differentiated variety. If $p_{jt} > p_t^{max}$, optimal consumption of variety j falls to zero. If instead $p_{jt} \leq p_t^{max}$, optimal consumption of variety j is given by the corresponding first order condition:

$$\alpha - \gamma q_{jt} - \eta \int_0^{N_t} q_{jt} dj = \lambda_t p_{jt},$$

where λ_t is the time t Lagrange multiplier on the budget constraint, equation (2). The demand for variety j can be written compactly as

$$q_{jt} = \max \left\{ \frac{\lambda_t}{\gamma} [p_t^{max} - p_{jt}], 0 \right\}, \quad (6)$$

where $p_t^{max} \equiv \frac{\frac{\alpha\gamma}{\lambda_t} + \eta \int_0^{N_t} p_{jt} dj}{\gamma + \eta N_t}$. As in [Melitz and Ottaviano \(2008\)](#), a larger number of competing varieties induces a decrease in the choke price. In addition, higher income, lower λ_t , increases the choke price.

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

$$\lambda_t = \beta R_t \mathbb{E}_t \left[\frac{e_{t+1}}{e_t} \lambda_{t+1} \right]. \quad (7)$$

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

The optimality condition associated with the union's static problem can be written as

$$W_t^* = \frac{\varepsilon_w}{\varepsilon_w - 1} \frac{1}{\lambda_t}. \quad (8)$$

The reset wage is inversely proportional to the marginal utility of income. When the marginal utility of income λ_t rises, adjusting unions accept lower wages: each dollar earned is more valuable in utility terms, so workers require less nominal compensation to supply labor.

Finally, optimal price setting by domestic firms and importers delivers expressions for prices and output such that:

$$\begin{aligned} p_t^H(z) &= \min \left\{ \frac{1}{2} \left[p_t^{\max} + \frac{W_t^\sigma}{z} \right], p_t^{\max} \right\}, & q_t^H(z) &= \max \left\{ \frac{\lambda_t}{2\gamma} \left[p_t^{\max} - \frac{W_t^\sigma}{z} \right], 0 \right\}, \\ p_t^X(z) &= \min \left\{ \frac{1}{2} \left[\frac{A}{B} + \frac{\tau}{e_t} \frac{W_t^\sigma}{z} \right], \frac{A}{B} \right\}, & q_t^X(z) &= \max \left\{ \frac{B}{2} \left[\frac{A}{B} - \frac{\tau}{e_t} \frac{W_t^\sigma}{z} \right], 0 \right\}, \\ p_t^M(z) &= \min \left\{ \frac{1}{2} \left[p_t^{\max} + \frac{e_t \tau}{z} \right], p_t^{\max} \right\}, & q_t^M(z) &= \max \left\{ \frac{\lambda_t}{2\gamma} \left[p_t^{\max} - \frac{e_t \tau}{z} \right], 0 \right\}. \end{aligned}$$

The optimal price is the midpoint between marginal cost and the relevant choke price, and the min/max operators reflect selection: only firms whose marginal cost lies below the choke price produce, with output increasing in that gap.

4 Sudden Stops and Productivity: A Selection Mechanism

In the following, I define aggregate productivity and discuss the channels through which shocks can potentially affect it. I then show how the effects of a sudden stop on productivity depend on the exchange rate regime. Finally, I turn to the effects on other macroeconomic variables and welfare. All proofs are in the Appendix.

4.1 Aggregate Productivity

Firms' decision to operate can be written in terms of a productivity threshold: a firm will choose to serve market i provided that $z \geq z^i$ where $i \in \{H, X, M\}$.²⁰ Thus, the variable of interest, domestic

²⁰Throughout this section I suppress the time subscript; a prime denotes a next-period value.

aggregate productivity, is given by:

$$Z^H = M \int_{z^H}^{\infty} \Omega(z) z \gamma(z) dz, \quad M \int_{z^H}^{\infty} \Omega(z) \gamma(z) dz = 1, \quad (9)$$

where $\Omega(z)$ is the weight used in the aggregation and $\gamma(z)$ is the probability density function. The second condition normalizes $\Omega(z)$ so that weights sum to one over the set of firms that operate domestically (i.e., $z \geq z^H$). The aggregation accommodates a range of weighting schemes: equal weights $\Omega(z) = 1/[M(1 - \Gamma(z^H))]$, output weights $\Omega(z) = q^H(z)/Q^H$, revenue weights $\Omega(z) = p^H(z)q^H(z)/R^H$, and labor weights $\Omega(z) = \ell^H(z)/L^H$.²¹

To obtain analytical results, I assume productivity is Pareto distributed both at home and abroad: $1 - \Gamma(z) = 1 - \Gamma^*(z) = (1/z)^k$, with shape parameter $k > 1$ and minimum productivity normalized to one for the rest of this section.²² The following lemma establishes that z^H is the key statistic for measuring aggregate productivity, independent of the weights used in the aggregation.²³

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

In other words, in this model, changes in aggregate productivity are entirely driven by firms' extensive margin decisions, captured by the operating threshold z^H .²⁴ This is in contrast to alternatives in the literature that either model productivity exclusively as an exogenous shock to the economy, allow for variable capacity utilization, or consider R&D decisions.

4.2 Pro-competitive, Cost and Demand Channels

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.

Proposition 1. *In the competitive equilibrium,*

$$d \ln z^H = \underbrace{s d \ln N}_{\text{Pro-competitive}} + \underbrace{\sigma d \ln W}_{\text{Cost}} + \underbrace{d \ln \lambda}_{\text{Demand}},$$

²¹ $Q^H = M \int_{z^H}^{\infty} q^H(z) \gamma(z) dz$ is total domestic output, $L^H = M \int_{z^H}^{\infty} \ell^H(z) \gamma(z) dz$ is total employment in domestic production, and $R^H = M \int_{z^H}^{\infty} p^H(z) q^H(z) \gamma(z) dz$ is total domestic revenue.

²²I assume throughout that selection is interior, that is, the operating cutoffs z^H , z^M and z^X lie strictly above this minimum, so that every market has firms on both sides of its cutoff.

²³The reader may wonder how this measure relates to other definitions of aggregate productivity. First, the (model-consistent) Solow residual commonly reported by statistical agencies maps directly to the employment-weighted average. Second, under non-homothetic preferences the welfare-relevant measure of productivity is not uniquely defined; in Melitz and Ottaviano (2008), for example, welfare statements are tied to the unweighted average of firm productivities.

²⁴The quantitative model of Section 6 introduces a common productivity shifter and idiosyncratic firm-level shocks, which generate intensive margin productivity changes as well.

where $s \equiv \frac{\frac{\eta}{2k+2} N}{\gamma + \frac{\eta}{2k+2} N} \in (0, 1)$.

The intuition follows next. In the first place, a larger number of active firms in the market, $d \ln N > 0$, 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 shrink across the productivity distribution. This *pro-competitive channel* was first introduced by Melitz and Ottaviano (2008), with a focus on competition in the goods market.

Second, a higher wage, $d \ln W > 0$, reduces firms' profit margins by raising production costs. As a result, only more productive firms remain profitable and select into production, leading to an increase in aggregate productivity. This is what I denote the *cost channel*, which is the underlying mechanism in the canonical Melitz (2003) model, which focuses on competition in the labor market.

Finally, higher aggregate demand from consumers, $d \ln \lambda < 0$, raises individual firm demand across the productivity distribution and relaxes the productivity threshold for profitability. As a result, less productive firms are more likely to enter or remain in the market. This final channel, a novelty of this model, is referred to as the *demand channel*.

The coefficients in Proposition 1 are the partial elasticities of the cutoff with respect to each driver, and follow from the closed-form solution for z^H given by (14) in the Appendix. The pro-competitive channel has elasticity s , which measures how much an additional competitor tightens selection. It is stronger the more a new variety diverts demand from incumbents: increasing in the substitutability with respect to leisure η , and decreasing in product differentiation γ . It is weaker the more concentrated is the productivity distribution k , since a more homogeneous pool leaves the typical firm small and close to the cutoff.²⁵ Moreover, the effect of an additional competitor is increasing in N . The cost channel has elasticity σ , the labor share, and is strongest when production is linear in labor ($\sigma = 1$). The demand channel has unit elasticity, shifting the cutoff one-for-one. These partial elasticities describe how the cutoff responds to each driver in isolation; to trace the effect of a sudden stop, I turn next to how the mass of competitors, the wage, and the marginal utility of income each move under different exchange rate regimes.²⁶

4.3 Effects of a Sudden Stop

I define a sudden stop as a one-time unexpected increase in the interest rate R . The shock is a purely transitory MIT deleveraging shock that forces an expansion of net exports and an improvement in international competitiveness. The following proposition considers its effect on productivity under the two alternative exchange rate regimes.

²⁵The shape parameter k also governs how strongly N itself responds to a sudden stop, an effect I take up in the next subsection.

²⁶This decomposition can equivalently be expressed in relative prices (Online Appendix B.1); analogous cutoff decompositions under CES preferences and imported intermediate inputs are derived in Online Appendix B.2.

Proposition 2. *Given a sudden stop,*

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

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

2. *In a currency union, all three channels operate and the effect on productivity is ambiguous:*

$$d \ln N < 0, d \ln W < 0 \text{ and } d \ln \lambda > 0 \text{ so that } d \ln z^H \geq 0.$$

A higher interest rate must be matched by an expected appreciation of the domestic currency, stronger future demand growth, or both. Holding future variables constant, this implies a depreciation of the currency today (higher e) and/or a contraction in current demand (higher λ). Suppose that the nominal exchange rate depreciates just enough to fully offset the increase in the interest rate. Under this assumption, both the cost and demand channels are muted, as the marginal utility of income, and thus the wage level, through the union's optimality condition, remains unchanged. However, there is a decline in the number of active firms in the domestic economy, driven by a fall in the number of importers. The depreciation makes foreign firms less competitive, shifting expenditure toward domestic varieties. This negative pro-competitive channel leads to an unambiguous decline in aggregate productivity.

Suppose instead that the nominal exchange rate remains unchanged, so the adjustment occurs entirely through an increase in λ . This corresponds to a negative demand channel. At the same time, wages fall following the optimal wage-setting condition, reducing production costs and triggering a negative cost channel. The pro-competitive channel remains negative, following the logic above. All three channels are active but exert opposing forces on the productivity threshold: the demand channel raises it, while the cost and pro-competitive channels push it downward. As a result, the overall impact of a sudden stop on productivity in a currency union is ambiguous and depends on parameter values.

The currency union and the pure float are the two extremes of the exchange rate rule introduced in Section 3. For intermediate cases with $\phi_w \in (0, 1)$, the exchange rate absorbs only part of the shock, so the marginal utility of income and the wage still move, though by less than in the currency union, and all three channels operate at once. The result that a float activates only the pro-competitive channel is therefore specific to the knife-edge $\phi_w = 1$, in which the exchange rate exactly replicates the flexible-wage allocation; a managed float with partial rigidity behaves qualitatively like the currency union. What differs is how readily the demand channel dominates, and hence whether the sudden stop raises aggregate productivity. The following corollary makes this precise.

Corollary 1. *For a small enough ϵ^R , a sufficient condition for $d \ln z^H > 0$ is that*

$$(1 - \theta) \sigma(k + 1) + (1 - \theta) k \frac{\phi_w}{1 - \phi_w} < 1.$$

Cleansing requires the demand channel to overturn the cost and pro-competitive channels combined. With the cutoff elasticities in Proposition 1 in hand, what governs the balance is how far the sudden stop moves each driver. Consider first the currency union ($\phi_w = 0$), where the condition reduces to $(1 - \theta) \sigma(k + 1) < 1$. Wage rigidity determines how much of the demand shock moves the wage: the stickier are wages (higher θ), the smaller the fall in wages and the weaker the cost channel, so the demand channel dominates more easily. The shape parameter k shapes how strongly the number of active firms responds: a more concentrated distribution (higher k) produces larger swings in the mass of importers for a given change in competitiveness, strengthening the pro-competitive channel.²⁷

Away from the currency union, the exchange rate depreciates as the wage moves but not fully, and the more flexible the regime, the more the pro-competitive channel gains ground on the demand channel net of cost. This enters the condition as the term $(1 - \theta) k \frac{\phi_w}{1 - \phi_w}$, absent under a currency union and growing without bound as the regime approaches a float. A more flexible regime is thus less likely to raise productivity, and the pure float never does.

4.4 Other Macroeconomic Variables and Welfare

I now turn from productivity to the response of the other main macroeconomic aggregates, consumption, C , and output, Y , and to how it differs across exchange rate regimes.

Proposition 3. *A sudden stop leads to:*

- (i) *Consumption falls under both regimes, and strictly more under the currency union:*

$$d \ln C^{cu} < d \ln C^{float} < 0.$$

- (ii) *Output rises under the float and is ambiguous under the currency union, but is always lower under the latter: $d \ln Y^{float} > 0$, $d \ln Y^{cu} \geq 0$, $d \ln Y^{cu} < d \ln Y^{float}$.*

Proposition 3 shows that the model reproduces a classic result in open-economy macroeconomics, going back to [Mundell \(1963\)](#): under nominal rigidities, a flexible exchange rate cushions the response of consumption and output to external shocks, while a fixed rate amplifies it. A sudden stop requires an improvement in the trade balance, brought about by a real depreciation. In

²⁷Here k works through two opposing forces. A more concentrated distribution lowers the per-competitor elasticity s in Proposition 1, since a homogeneous pool leaves the typical firm small and close to the cutoff; but the same concentration bunches firms at the margin, so the mass of active firms swings more for a given change in competitiveness. The pro-competitive channel operates through the product of the two, the elasticity s times the response of N , which rises with k : the stronger response of the mass of firms outweighs the weaker per-competitor elasticity.

both regimes the real depreciation makes imports more expensive, so imports fall and consumption declines. Under a currency union the adjustment does not stop there: with the exchange rate fixed, the burden falls on domestic demand: the marginal utility of income rises, a contraction that lowers consumption of domestic goods as well, so both consumption and output end up lower than under a float. The float avoids this second effect: the depreciation leads to an expected appreciation that offsets the higher interest rate in the household's Euler equation, keeping the marginal utility of income unchanged, so consumption falls only through the drop in imports. This is precisely the shock absorbing role of flexible exchange rates emphasized by [Schmitt-Grohé and Uribe \(2016\)](#).

The one prediction that deserves closer scrutiny is the sign of output under the float, which the model predicts to rise. In a frictionless small open economy the depreciation is expansionary: it makes domestic goods competitive, so expenditure switches toward them, exports boom, and output rises. Under a currency union the demand contraction weighs on production, so output need not rise and may fall, closer to the pattern in the data. Generating an output contraction alongside rising net exports, as observed in the data, is well known to require additional frictions, and the quantitative model of Section 6 supplies an alternative: a common productivity shifter whose negative realization during the sudden stop helps produce the output decline.

On consumption and output, then, the model sits squarely in the Mundellian tradition: the float dominates the currency union. Whether this ranking survives once welfare is evaluated is a separate question. It depends not only on how much the economy produces but on which firms produce, a margin on which the market allocation is inefficient. Comparing the household's first-order conditions for $q(z)$ and L with those of a planner who values each variety at its social marginal cost $\psi(z)$, the cost of producing a unit at undistorted prices, yields the wedges

$$1 + \tau^H(z) = \mu(z) (\sigma \lambda W)^\sigma, \quad 1 + \tau^X = (\sigma \lambda W)^\sigma, \quad 1 + \tau^L = (\sigma \lambda W)^{1-\sigma}, \quad (10)$$

where $\mu(z) = \frac{1}{2}(1 + z/z^H)$ is the domestic firm's markup and $\sigma \lambda W$ is the effective wage wedge, endogenous under sticky wages and equal to $\sigma \varepsilon_w / (\varepsilon_w - 1)$ only in the initial stationary equilibrium, where $W = W^*$. This wage wedge enters the output wedges as $(\sigma \lambda W)^\sigma$, since labor is a share σ of marginal cost, and the labor wedge as $(\sigma \lambda W)^{1-\sigma}$, the complementary share. Exports carry no firm-specific markup, since the marginal export is valued at the revenue it earns rather than at a domestic consumer's willingness to pay, and imports, bought at the foreign price, are undistorted, so $\tau^M = 0$. What is new is that $\mu(z)$ rises with productivity: the domestic wedge is heterogeneous, and the most productive firms are the most under-supplied.²⁸

The welfare effect of a sudden stop is a wedge-weighted sum of the quantity changes it induces. Collecting the output and labor margins of the planner Lagrangian's differential at the

²⁸See Appendix for the planner's problem and the derivation of the wedges.

feasible market allocation gives

$$d\mathcal{W} = M \int_{z^H}^{\infty} [\mu(z)(\sigma\lambda W)^\sigma - 1] \psi(z) dq^H d\Gamma + M [(\sigma\lambda W)^\sigma - 1] \int_{z^X}^{\infty} \tau \psi dq^X d\Gamma + [(\sigma\lambda W)^{1-\sigma} - 1] dL. \quad (11)$$

The domestic term is the only one with a z -dependent wedge; exports and labor carry the wage wedge alone, common to every firm. This distinction governs the welfare ranking.

Consider first an economy without firm-specific markups. The wage wedge reflects the familiar distortion of monopolistic wage setting, and a conventional employment subsidy that offsets it, so that the subsidy-adjusted wage W^p (the wage net of the subsidy) satisfies $\sigma\lambda W^p = 1$, sets $\tau^X = \tau^L = 0$ and $\tau^H(z) = \mu(z) - 1$. If markups are common, $\mu(z) \equiv \bar{\mu}$, the remaining uniform product distortion is removed by a uniform subsidy to domestic sales, and every wedge vanishes. The flexible-wage allocation is then constrained efficient. A float implements that allocation, while a currency union, whose sticky-wage constraint binds during the sudden stop, does not, so $\mathcal{W}^{\text{float}} \geq \mathcal{W}^{\text{cu}}$, with strict inequality whenever the constraint binds. This is the classic case for a flexible exchange rate: correct the aggregate distortions and the float delivers the constrained optimum.

Heterogeneous markups break this implementation. No uniform subsidy can undo the cross-firm variation in $\mu(z)$: once the wage and any common markup are corrected, a firm-specific wedge $\mu(z)/\bar{\mu} - 1$ remains, where $\bar{\mu}$ is the ψ -weighted average markup. This wedge rises with productivity and has zero ψ -weighted mean. To first order around the corrected allocation, the within-period welfare change of a sudden stop then reduces to this residual,

$$d\mathcal{W} = M \int_{z^H}^{\infty} \left[\frac{\mu(z)}{\bar{\mu}} - 1 \right] \psi(z) dq^H d\Gamma, \quad (12)$$

proportional to the covariance between a firm's markup and its output change. A currency union can make it positive: the same contraction that strengthens selection, a higher marginal utility of income and a lower wage, bears hardest on the least productive firms and shifts production toward the high-markup firms furthest from their efficient scale. That allocative gain can offset the float's conventional stabilization advantage. Which force dominates cannot be signed analytically; it depends on the dispersion of markups and on how unevenly the sudden stop hits across the productivity distribution. I take up this question in the quantitative model of Section 6.

5 Spain: Firm Selection in Two Sudden Stops

The model shows that the exchange rate regime shapes productivity during a sudden stop through its effect on firm selection. This section provides empirical evidence that is consistent with the mechanism.

5.1 The Two Spanish Sudden Stops and the Firm-Level Data

Spain provides a useful setting to examine the model's predictions, having experienced two sudden stops in its recent economic history: the 1992–93 Exchange Rate Mechanism (ERM) crisis and the 2010–13 European sovereign debt crisis.²⁹ There are clear parallels between the two episodes. Both were preceded by periods of increasing capital inflows, declining international competitiveness and widening current account deficits, followed by an abrupt reversal of foreign capital flows and a sharp external adjustment. Spain's current account balance moved from -3.5% to -1.2% of GDP between 1991 and 1994, and from -4.3% to 1.0% between 2009 and 2014, an average annual adjustment of about 0.8 and 1.1 percentage points, respectively.

The response of exchange rate policy to these events, however, diverged significantly. While the *peseta* was devalued on three occasions during the 1992–93 crisis, Spain underwent a process of internal devaluation during the 2010–13 episode.³⁰ Consistent with this distinction, the real exchange rate adjustment took very different forms across the two episodes. An Engel (1999) decomposition shows that nominal exchange rate fluctuations account for more than 95% of the variance in real exchange rate changes during the earlier episode, whereas movements during the later episode are entirely due to relative price adjustments.³¹ Wages moved in line with this pattern: nominal pay per worker grew at 6–10% a year during 1991–93 but at less than 2% a year during 2010–13, consistent with competitiveness being regained through wage restraint once the nominal exchange rate was no longer available.³² I therefore take the two episodes as examples of sudden stops under flexible and fixed exchange rate arrangements, respectively.³³

The different exchange rate responses were accompanied by sharply different domestic adjustments. In 1992–93, output and consumption were remarkably stable, changing by -0.1% and $+0.2\%$, even as employment fell by 5.4%. In 2010–13, by contrast, output fell by 5.0%, consumption by 8.1%, and employment by 10.2%.³⁴ These patterns are consistent with the model primarily

²⁹These are the conventional historical windows of the two crises. They overlap with, but do not coincide exactly with, the dates identified by the algorithm of Section 2.

³⁰It can be argued that Spain does not strictly classify as a float in 1992–93 as it remained a member of the ERM. However, the repeated realignments of its central rate against the *deutsche mark* and the substantial widening of the exchange rate fluctuation bands meant that the exchange rate effectively behaved as flexible.

³¹See Figure A.7 in the Online Appendix.

³²Annualized growth in nominal compensation per worker; see Section 2 for sources. Rates are annualized because the two episodes differ in length. Nominal wages kept growing in 2010–13, whereas the model predicts a fall under a currency union. Since the model describes deviations from a steady state, the relevant comparison is with trend. Relative to its pre-crisis trend, the IFS nominal wage index ended 1992–93 roughly on trend, as the model predicts under a float, and 2010–13 about 12% lower.

³³As with any fixed exchange rate arrangement, membership in the euro does not imply that Spain's exchange rate is fixed vis-à-vis all of its trading partners. Movements of the euro against currencies outside the currency union can therefore generate changes in Spain's nominal effective exchange rate. In practice, however, these movements were small during the later episode. Spain's nominal effective exchange rate depreciated by about 2% between 2009 and 2013, compared with about 12% between 1991 and 1993.

³⁴These are cumulative changes in levels between the year preceding each episode and its final year (1991–93 and 2009–13), without detrending, using the same underlying data as in Section 2.

in relative terms. Proposition 3 predicts a larger contraction in consumption and output when the nominal exchange rate cannot absorb the shock, as observed in 2010–13. The sharp fall in consumption is also the observable counterpart of the rise in the marginal utility of income that drives the demand channel. The comparison is less straightforward in levels: under a pure float the model predicts output to rise and consumption to fall, whereas both were essentially flat in 1992–93.

To examine whether the firm-selection mechanism highlighted by the model is present in the data, I turn to firm-level evidence from the two episodes. I use data from the Survey on Business Strategies (*Encuesta sobre Estrategias Empresariales*, ESEE, in Spanish) managed by the SEPI Foundation, a public entity linked to the Spanish Ministry of Finance and Public Administrations. The ESEE surveys all manufacturing firms operating in Spain with more than 200 workers and a sample of firms between 10 and 200 workers, providing a rich panel dataset with over 1,800 firms for the period 1990–2014.³⁵ It covers roughly 10 to 20% of value added in Spanish manufacturing, depending on the year, and provides information on each firm’s balance sheet together with its profit and loss statement.³⁶ The primary advantage of the ESEE dataset is its long temporal coverage, which extends back to the early 1990s and enables a consistent firm-level analysis of both episodes. A second key advantage is the clean measurement of firm exit. The survey explicitly distinguishes between temporary non-response, permanent exit, and organizational changes such as mergers, acquisitions, or split-ups. Firms that later resume production or survey participation are re-included and appropriately tracked, substantially reducing spurious exit.

Details on the cleaning procedure and the deflation of nominal variables are provided in Online Appendix C.2. I estimate industry output elasticities for capital and labor using [Akerberg, Caves and Frazer \(2015\)](#)’s algorithm and then compute firm-level productivity as a Solow residual.³⁷ A well-known shortcoming of the ESEE dataset is its over-representation of large firms. To address this issue, I exploit dynamic sampling weights constructed by the SEPI Foundation based on Census data. The weighted sample closely matches the actual firm size distribution as documented by Eurostat and, along the extensive margin, entry and exit rates for firms with ten or more employees closely track those in the Spanish Business Registry (DIRCE). Online Appendix C.3 provides further details.³⁸ As an additional robustness exercise, Online Appendix C.7 uses ORBIS, which provides substantially better coverage of small and micro firms, to replicate

³⁵The same size-based sampling design applies to newly entering firms: all new firms above 200 employees are included, together with a random sample of approximately 5% of new firms with 10 to 200 employees each year.

³⁶Table A.3 shows that while the coverage of the ESEE data relative to different releases of the EU KLEMS data for the Spanish manufacturing sector is modest, it rises moderately between the two episodes, from about 10% of employment in the early 1990s to about 15% in 2009–13.

³⁷Because output is obtained by deflating value added with industry-level price indices, this Solow residual measures revenue productivity (TFPR) rather than physical productivity (TFPQ). Online Appendix C.4 uses the model to relate the two and examines how the distinction affects the empirical results.

³⁸Micro firms, those with nine employees or fewer, account for over 80% of firms in Spanish manufacturing but only around 9% of production and 11% of the wage bill, so their limited coverage matters more for the extensive margin than for aggregate magnitudes.

the 2010–13 results for Spain and compare them with a contemporaneous sudden stop under a relatively flexible exchange rate regime in the Czech Republic, where selection at exit weakens rather than strengthens.

The firms exposed to the two episodes are broadly similar along observable dimensions, although some differences arise given the nearly two decades separating the two sudden stops. In particular, firms in the later episode are older and more frequently engaged in international trade, while industry composition also differs to some extent. The first two differences are not surprising given the panel structure of the survey and Spain’s deeper integration into European and international markets over this period. Online Appendix C.3 documents these similarities and differences in detail. When appropriate, the analysis below accounts for firm size and age and includes industry-year fixed effects.

5.2 TFP Growth Decomposition

In the ESEE data, aggregate TFP, defined as the employment-weighted average of firm-level productivity, fell by 12.96% during the 1992–93 episode but rose by 2.24% during 2010–13. This contrast mirrors the qualitative prediction of the model. The firm-level productivity distributions also point to an important role for the lower tail: it lengthens as TFP decreases in the former crisis and shortens as TFP increases in the latter. Online Appendix C.5 documents these patterns in detail.

Firms at the lower end of the productivity scale are often small in size and, thus, may have negligible effects on the aggregate. A more formal assessment of growth patterns requires considering weighted measures and disentangling the role of incumbent, entering and exiting firms in shaping TFP changes. I study this by performing a TFP growth decomposition using the formulation of [Dias and Marques \(2021\)](#):

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

where Z_t denotes employment-weighted aggregate productivity and $Z_{i,t}$ is the productivity of firm i . The term $s_{i,t}$ is its employment share, and $s_{i,t}^C = s_{i,t}/s_t^C$ rescales these shares within the incumbent group. The superscripts C , N , and X indicate incumbents, entrants, and exiters, with s_t^j and Z_t^j denoting the corresponding group-level employment shares and aggregate productivity. Further details are provided in Online Appendix C.6.

Results for the two sudden stops are summarized in Table II.³⁹ The decline in TFP in the 1992–93 crisis is entirely driven by incumbents. In fact, net entry contributes to positive growth, although the magnitude is small as the positive contribution of exiters narrowly outweighs the negative contribution of entrants. Among incumbents, the between-firm and cross terms jointly

³⁹Online Appendix C.7 shows that results are robust to alternative decomposition approaches such as [Foster, Haltiwanger and Krizan \(2001\)](#) and [Melitz and Polanec \(2015\)](#) and the use of value-added or sales weights.

contribute positively to productivity through reallocation. Nevertheless, the pronounced decline in within-firm productivity dominates, generating a large negative overall effect.

In contrast, the increase in TFP experienced during 2010–13 is fully driven by net entry, in particular, by unproductive firms exiting the market. The size of the effect is remarkable, especially given that small and medium firms are underrepresented in the sample. During the 2010–13 episode, exiting firms accounted for a larger share of employment (7.44% versus 6.10%) and had a productivity shortfall relative to incumbents about 47% larger than in 1992–93 (30.18% versus 20.57%). Moreover, the annualized exit rate more than doubled from 4.63% to 9.83%.⁴⁰ To alleviate potential industry composition concerns, Figure A.13 shows this holds broadly at the three-digit industry level too. In sum, there is more and better exit.⁴¹

Back to Table II, the contribution of incumbents remains negative for the 2010–13 sudden stop. It is still the case that, on average, the productivity of incumbents is procyclical. There is a positive effect of the between and cross terms that cushions the negative effect of the within-firm component. The increase in market share reallocation and a stronger correlation between productivity and market share changes at the individual firm, together with the positive contribution of exiting firms, are consistent with a cleansing effect during the 2010–13 sudden stop that is absent in the 1992–93 episode.⁴²

5.3 The Cleansing Hypothesis: A Formal Test

The decomposition is consistent with cleansing, but does not directly test whether selection on productivity strengthens during a sudden stop. In models of firm dynamics, low-productivity firms are more likely to exit, while high-productivity firms are expected to grow by more. The cleansing hypothesis of [Caballero and Hammour \(1994\)](#) predicts that recessions strengthen these relationships. I therefore test whether the link between productivity and firm exit and growth changes during the two sudden stop episodes, adapting the empirical specification proposed by [Foster, Grim and Haltiwanger \(2016\)](#):

$$y_{i,t+1} = b_0 TFP_{it} + b_1 ss_{t+1}^1 * TFP_{it} + b_2 ss_{t+1}^2 * TFP_{it} + X'_{i,t} b_X + \epsilon_{i,t+1},$$

⁴⁰The corresponding averages for other years are the following: the annualized exit rate is 7.78%, the employment share of exiting firms is 6.65% and the difference in TFP between exiting firms and incumbents is 9.09%.

⁴¹Firms entering the market during the 2010–13 episode are, on average, smaller in terms of market share (6.4% versus 11.57%) and slightly less unproductive relative to incumbents (1.65% versus 1.84%). This explains the negative contribution of entrants to aggregate TFP growth during both sudden stops, with a more pronounced effect in the earlier episode. Entry rates are 4% in 1992–93 and 5.55% in 2010–13. In normal times, entrants are more unproductive relative to incumbents (2.21%), and the entry rate is notably higher at 7.7%. Thus, my analysis confirms the main finding in [Ates and Saffie \(2021\)](#): both sudden stops are characterized by fewer but better entrants.

⁴²A valid concern is that if firms are forward-looking, they might backload the decision to exit, and, thus, the duration of a crisis might be an important driver of results. I refer the reader to Online Appendix C.7, where I show that exit in the 2010–13 episode is not concentrated on the later years.

TABLE II: DECOMPOSITION OF PRODUCTIVITY GROWTH

	Sudden Stops	
	1992–93	2010–13
Productivity Growth (%)	-12.96	2.24
Contribution to Productivity Growth		
Incumbents' Contribution	-13.37	-4.54
Within-firm Contribution	-13.89	-7.36
Between-firm Contribution	-1.83	0.32
Cross-term Contribution	2.34	2.50
Net Entry Contribution	0.41	6.79
Entrants' Contribution	-1.81	-0.40
Exiters' Contribution	2.23	7.19

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

where $y_{i,t+1}$ stands for a set of dependent variables. In the exit specification, it is a dummy variable equal to one if a firm is active in period t but reports no activity in period $t + 1$ strictly due to market exit as identified by the status indicator. In the regressions for input growth, the dependent variable is the log change in employment between t and $t + 1$. Firms that exit are included, with growth measured up to their last year of observation. The regressor ss_{t+1}^1 is a dummy variable for the 1992–93 sudden stop, ss_{t+1}^2 is a dummy variable for the 2010–13 sudden stop and TFP_{it} captures the log of firm-level productivity. To abstract from underlying sector-specific trends, the above specification includes industry-year fixed effects at the three-digit level. In addition, $X_{i,t}$ controls for firm characteristics. For the baseline specification, I follow [Foster, Grim and Haltiwanger \(2016\)](#) in accounting for firm size and age effects.⁴³ However, the role of other firm characteristics is also explored in the section that follows.

For the exit specification, the relationship between survival probability and productivity is expected to be positive and, thus, $b_0 < 0$. Under the cleansing hypothesis, this correlation should strengthen during a sudden stop episode and one would anticipate $b_1 < 0$ and $b_2 < 0$. For the input growth specification, the exact opposite applies.

Results of these regressions are summarized in Table III. 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

⁴³For firm size effects, I use a categorical variable: firm size class =1 if firm employment < 20 ; =2 if $20 \leq$ firm employment ≤ 50 ; =3 if $50 \leq$ firm employment ≤ 200 ; =4 if firm employment > 200 . To control for the life cycle of the firm, I use a dummy variable $Young_{it}$ that equals one if the firm is five years old or younger.

is evidence of a cleansing effect only during the second episode. In terms of quantitative significance, the predicted difference in probability of exit between a firm one standard deviation below and a firm one standard deviation above average is 4.7 percentage points in normal times but almost 11.3 percentage points during the latter sudden stop.

Column (7), which reports the corresponding labor growth regression, supports further the predictions of the cleansing hypothesis for the 2010–13 episode. First, note that there is a positive impact of productivity on labor growth as predicted by the literature. Of greater interest, this correlation is even higher during the second sudden stop. In fact, the predicted difference in labor growth between a firm one standard deviation above and a firm one standard deviation below average increases from 4.7 percentage points in normal times to 7.5 percentage points in 2010–13.

I view these results as supportive evidence for the mechanism developed in the model, rather than as establishing a causal effect of the exchange rate regime on firm selection.

Alternative Explanations I next consider other differences between the two episodes that could also account for the contrast in firm dynamics. While it is unfeasible to fully rule out all alternative explanations, I examine the role of the banking crisis, effects associated with the real depreciation, and differences in the geographic scope of the crisis. Columns (2) to (6) of Table III augment the exit specification with firm-level controls and interactions; columns (8) to (12) report the corresponding labor growth specifications. The main question is whether the productivity interactions remain stable once these alternative channels are accounted for.

The most important difference across the two sudden stops, besides the exchange rate, is that Spain simultaneously experienced a banking crisis only during the latter. Columns (2) and (3) of Table III examine this credit channel. Column (2) considers the role of leverage explicitly, augmenting the empirical model with the bank debt-to-assets ratio and the corresponding interactions. As expected, leverage is positively correlated with exit, and this correlation strengthens during the banking crisis, in line with findings in [Bornstein and Castillo-Martinez \(2026\)](#) for other European countries. Column (3) complements this with a price-based measure of default risk, the interest rate a firm pays on its bank debt. This measure is inspired by [Hegarty et al. \(2026\)](#), who show that the increase in firms' borrowing costs during sudden stops is driven largely by risk premia. These premia fall disproportionately on firms with higher default risk, which are also closer to exit. I flag such firms with an indicator for paying an interest rate on bank debt in the top quartile of the year's distribution among indebted firms, $highrate_{it}$. They are indeed significantly more likely to exit during 2010–13. The corresponding labor growth specifications in columns (8) and (9) point in the same direction, although the interactions with leverage and high borrowing costs are imprecisely estimated. Thus, while the disruption of credit contributed to firm exit during 2010–13, it does not account for the stronger selection on productivity.

Other well-known effects of a real exchange rate depreciation include (i) an expenditure switching effect on imported intermediate inputs and (ii) balance sheet effects resulting from liability

TABLE III: REALLOCATION AND PRODUCTIVITY

	Exit				Labor Growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
TFP_{it}	-0.038*** (0.005)	-0.033*** (0.005)	-0.040*** (0.005)	-0.037*** (0.005)	-0.038*** (0.005)	-0.032*** (0.005)	0.037*** (0.005)	0.037*** (0.005)	0.037*** (0.005)	0.036*** (0.004)	0.036*** (0.005)	0.034*** (0.005)
$ss^1_{t+1} * TFP_{it}$	0.007 (0.013)	-0.002 (0.014)	0.006 (0.013)	0.007 (0.013)	0.007 (0.012)	-0.005 (0.014)	-0.002 (0.011)	0.005 (0.012)	0.000 (0.012)	-0.003 (0.011)	-0.002 (0.011)	0.005 (0.013)
$ss^2_{t+1} * TFP_{it}$	-0.052*** (0.011)	-0.040*** (0.011)	-0.046*** (0.011)	-0.051*** (0.011)	-0.050*** (0.011)	-0.033*** (0.011)	0.022** (0.010)	0.022** (0.010)	0.022** (0.010)	0.019** (0.010)	0.017* (0.010)	0.017 (0.011)
$leverage_{it}$		0.052*** (0.013)				0.044*** (0.013)		0.021*** (0.009)				0.023*** (0.010)
$ss^1_{t+1} * leverage_{it}$		-0.008 (0.037)				0.013 (0.037)		0.028 (0.037)				0.011 (0.038)
$ss^2_{t+1} * leverage_{it}$		0.054* (0.032)				0.033 (0.031)		-0.032 (0.027)				-0.031 (0.027)
$highrate_{it}$			0.020*** (0.006)			0.016** (0.007)			-0.012*** (0.005)			-0.008** (0.004)
$ss^1_{t+1} * highrate_{it}$			-0.025 (0.022)			-0.029 (0.023)			-0.023 (0.013)			-0.029 (0.017)
$ss^2_{t+1} * highrate_{it}$			0.054*** (0.015)			0.047*** (0.015)			-0.007 (0.013)			-0.010 (0.013)
$importer_{it}$				-0.012*** (0.003)		-0.012*** (0.004)			0.021*** (0.003)			0.017*** (0.003)
$ss^1_{t+1} * importer_{it}$				0.002 (0.013)		0.010 (0.014)			0.011 (0.013)			0.022 (0.017)
$ss^2_{t+1} * importer_{it}$				-0.010 (0.009)		0.004 (0.010)			0.022*** (0.007)			0.005 (0.009)
$exporter_{it}$					-0.001 (0.003)	0.003 (0.004)				0.014*** (0.004)		0.007** (0.004)
$ss^1_{t+1} * exporter_{it}$					-0.020** (0.009)	-0.026* (0.012)				0.008 (0.012)		-0.003 (0.015)
$ss^2_{t+1} * exporter_{it}$					-0.020** (0.007)	-0.014* (0.009)				0.038*** (0.006)		0.034*** (0.008)
Observations	36,252	34,279	34,808	36,252	36,252	33,759	32,262	30,562	30,883	32,262	32,262	30,098
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Columns (1) to (6) report linear probability models where $exit=1$ if a firm that operates in period t exits the market in period $t+1$. Columns (7) to (12) report regressions for labor growth, measured from period t to period $t+1$. TFP_{it} is the log firm-level TFP at time t , ss^1_{t+1} is a dummy equal to one for years 1992-93 and ss^2_{t+1} is a dummy equal to one for years 2010-13. $leverage_{it}$ is the bank debt-to-assets ratio. $highrate_{it}$ is a dummy equal to one if the firm's average interest rate on long-term bank debt is in the top quartile of the distribution among indebted firms in that year, a proxy for a high borrowing cost or default risk. $importer_{it}$ ($exporter_{it}$) is a dummy equal to one if the firm reports imports (exports) above 50,000€. Firm controls in period t account for age and size effects. Standard errors (in parentheses) are calculated using bootstrapping methods; significance levels are based on bootstrap percentile confidence intervals; *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

currency mismatches. While in the absence of a model it is ex-ante unclear whether these effects should differ across episodes, most economists tend to expect a greater impact whenever the currency depreciates. This would involve more exit in the first episode, which does not hold in the data. Although the ESEE dataset does not provide information on debt denomination, columns (4) and (10) of Table III provide evidence on the role of imported intermediate inputs by featuring the import status of the firm. As theory predicts, importers have a lower propensity to exit and higher labor growth. The exit advantage remains unchanged during both sudden stops, while the labor growth advantage increases during 2010–13. If anything, the latter runs against a mechanism in which exposure to imported inputs drives the stronger contraction in the later episode.

Next, I explore the role of export status—not only for completeness but also as a way to account for the geographic scope of each sudden stop. A global crisis implies a larger contraction of foreign demand, which could increase firm exit rates relative to a more localized or regional crisis.⁴⁴ As extensively documented in the literature, exporters are, on average, significantly more productive (138.15%) and, consequently, less likely to exit (19.05%) than non-exporters.⁴⁵ However, once I control for firm productivity, the primary channel through which exporter status influences firm dynamics is foreign demand. The extent to which a crisis is global determines how insulated exporters are from local downturns relative to non-exporters, thereby shaping their lower propensity to exit ([Almunia et al., 2021](#)).

Columns (5) and (11) of Table III show that exporters are less likely to exit during both sudden stops and experience stronger labor growth during 2010–13. Along the exit margin, the magnitude of the exporter interaction is nearly identical across the two episodes, suggesting that differences in the geographic scope of the crises, as proxied by export status, do not account for the stronger selection documented in 2010–13. The labor growth results reinforce this conclusion: if anything, exporters fare relatively better during the later episode.

Finally, columns (6) and (12) include all of these controls jointly. The interaction between productivity and the 2010–13 sudden stop remains negative and statistically significant in the exit specification, at -0.033 compared with -0.052 in the baseline. In the labor growth specification, the corresponding coefficient remains positive and economically similar, 0.017 compared with 0.022 in the baseline, although it is no longer statistically significant. In both specifications, the interaction between productivity and the 1992–93 sudden stop remains small and insignificant. Taken together, the additional controls reduce the precision and magnitude of some estimates but leave the contrast between the two episodes largely intact.

⁴⁴The 2010–13 sudden stop clearly occurred during a global crisis. However, the first episode was also part of a broader economic upheaval: the Exchange Rate Mechanism crisis triggered a recession across the continent. For context, annual GDP growth for the Euro area during 1992–93 was only 0.57%, compared to 1.09% during the 2010–13 period.

⁴⁵During both episodes, firm-level data show an increase in the propensity to export (9.51% in the first episode; 17.65% in the second) and a decline in the average productivity of exporters (23.31% in the first episode; 4.45% in the second). This pattern aligns with the model’s prediction of a lower productivity threshold for exporting during sudden stops.

TABLE IV: 2010–13 PRODUCTIVITY GROWTH DECOMPOSITION

	All Sectors	High Tradability Sectors	Low Tradability Sectors
Productivity Growth (%)	2.24	0.18	2.41
Contribution to Productivity Growth			
Incumbents' Contribution	-4.54	-3.73	-6.07
Within-firm Contribution	-7.36	-4.10	-9.80
Between-firm Contribution	0.32	-1.76	1.59
Cross-term Contribution	2.50	2.13	2.15
Net Entry Contribution	6.79	3.91	8.47
Entrants' Contribution	-0.40	0.76	-0.59
Exiters' Contribution	7.19	3.14	9.06

Notes: Productivity growth refers to accumulated TFP growth for the 2010–13 sudden stop. Column (1) corresponds to the baseline decomposition as explained in the main text. Column (2) restricts the sample to sectors with a tradability index above the median, while Column (3) restricts the sample to sectors with a tradability index below the median. The data used is collected from the ESEE dataset.

Online Appendix C.7.3 discusses additional contrasts between the two episodes that may concern the reader, such as long-run shifts in the manufacturing sector, the aftermath of the 2009 construction bust, the presence or absence of European-wide policy support, and the evolution—both in level and composition—of Spain’s net foreign asset position.⁴⁶

5.4 The Demand Channel

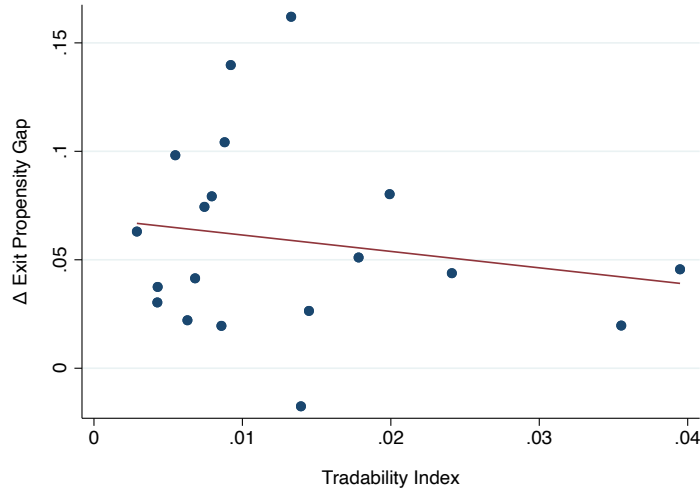
I next look for direct support for the demand channel. Rather than comparing the two episodes, I exploit variation across industries within the 2010–13 sudden stop. The demand channel should be stronger in industries that rely more heavily on domestic consumers and are therefore more exposed to the contraction in domestic demand. Accordingly, less tradable industries should experience stronger cleansing and larger productivity gains.

I adopt the tradability index from [Mian and Sufi \(2014\)](#), which classifies industries based on geographic concentration under the idea that industries dependent on national demand (more tradable) tend to be more spatially concentrated, while those serving local markets (less tradable) are more uniformly distributed. It is key to distinguish between traded goods, whose classification is endogenous in this model and can shift in response to a sudden stop, and tradability, which I take as a structural characteristic that remains stable over time and across countries.

Using this classification, I conduct two exercises to examine whether less tradable sectors fea-

⁴⁶A popular complementary channel through which reallocation contributes to productivity growth is increased allocative efficiency. In fact, [Gopinath et al. \(2017\)](#) and [García-Santana et al. \(2020\)](#) have shown that increasing capital misallocation is responsible for the slowdown of productivity growth prior to the 2010–13 crisis. Figure A.12 explores whether a reversal in factor misallocation underlies the recent improvement in aggregate TFP. The evidence suggests that this is not the case. That said, accurately measuring dispersion in marginal revenue products requires comprehensive coverage of small firms, which the ESEE dataset underrepresents, even when using sampling weights.

FIGURE II: CHANGES IN EXIT SELECTION BY INDUSTRY



Notes: This figure plots the relationship between a sector's difference in the exit propensity gap between a high- and low-productivity firm during the 2010–13 sudden stop relative to normal times and the tradability index. Each point represents a sector, with the red line depicting the fitted relationship. The data used is collected from the ESEE dataset.

ture a larger increase in selection at exit in 2010–13. First, I repeat the TFP decomposition for industries with high and low tradability. Results are summarized in Table IV. The first column repeats the baseline decomposition for 2010–13 to ease comparison. The key patterns that emerge are as follows: firm-level productivity declines across all three samples, and while the magnitude of the incumbents' contribution varies, it is consistently negative. This implies that observed differences in overall productivity growth are primarily driven by net entry dynamics—specifically, the contribution of exiting firms. Consistent with the model, exit contributes most positively to productivity growth in low-tradability sectors and least in high-tradability sectors.

Second, I reestimate the empirical specification for cleansing effects of a sudden stop separately for each industry and visualize the results in Figure II. In particular, I plot the difference in the exit propensity gap between a high- and low-productivity firm during the 2010–13 sudden stop relative to normal times against my measure of sectoral tradability. The fitted line (in red) shows a negative relationship, with a slope of -0.8, consistent with stronger selection at exit in less tradable sectors, although the relationship is imprecisely estimated across industries.

6 Quantitative Analysis

In this section, I turn to a quantitative version of the model to assess the importance of the selection mechanism developed in Section 4. I first describe the extensions needed to take the model to the data. I then discuss the parameterization and the model's aggregate dynamics. Finally, I simulate

the 2010–13 sudden stop in Spain and evaluate the quantitative performance of the mechanism.

6.1 Taking the Model to the Data

The simple model of Section 3 was designed for analytical tractability. To bring it closer to the data, I extend it along three dimensions: (i) forward-looking wage setting; (ii) richer firm productivity; and (iii) firm entry and stochastic exit. In addition, I replace the exogenous interest rate of the simple model with a debt-elastic one. I describe each extension and its associated functional forms below. The updated equilibrium definition, value functions, and additional optimality conditions are relegated to the Appendix.

Debt-elastic interest rate. To ensure stationarity of the net foreign asset position, I assume that the interest rate is given by

$$R_t = R \exp\left(\varepsilon_t^R - \vartheta \frac{B_t - \bar{B}}{\bar{P}\bar{Y}}\right), \quad (13)$$

where $\bar{B}$ and $\bar{P}\bar{Y}$ are the steady-state bond position and nominal output, and $\vartheta > 0$ is the sensitivity of the interest rate to the net foreign asset position, so that borrowing becomes more expensive as the net foreign asset position deteriorates. The exogenous component ε_t^R remains the shock that generates the sudden stop.

Wage setting. I replace the one-period rigidity of the simple model with conventional Calvo staggered wage setting: in each period, each union can reset their wage with probability $1 - \theta$. Since resetting unions internalize the probability θ of being unable to reset in future periods, the wage-setting problem becomes forward-looking.

Firm productivity. Firm productivity is augmented to $Z_{jt} = Z_t^A z_j^P z_{jt}^T$: the product of a common shifter Z_t^A , an idiosyncratic permanent component z_j^P , and an idiosyncratic transitory effect z_{jt}^T . The common shifter evolves according to $Z_t^A = \exp(\varepsilon_t^A)$, where ε_t^A is a mean-zero productivity shock. I assume a discrete process for the transitory idiosyncratic component that approximates

$$\log z_{it}^T = -\frac{\sigma_z^2}{2(1 + \rho_z)} + \rho_z \log z_{it-1}^T + \sigma_z u_{it}^z, \quad u_{it}^z \sim N(0, 1),$$

where ρ_z captures persistence and σ_z is the standard deviation of innovations. The constant term normalizes the unconditional mean of transitory idiosyncratic productivity to one for any (ρ_z, σ_z) . The permanent component takes two values:

$$z_j^P = \begin{cases} z^L & \text{with probability } \pi, \\ z^H & \text{with probability } 1 - \pi. \end{cases}$$

Firm entry and exit. To allow the mass of operating domestic firms, M_t , to evolve endogenously, I introduce free entry of new firms and augment the exit margin with a stochastic exit value. Each period there is an endogenous mass M_t^s of potential entrants. Entry is a two-step procedure realized after aggregate uncertainty is resolved. First, a potential entrant pays a fixed cost $c_s > 0$ to generate an idea. The quality of the idea, $s_j \sim S(s)$, is informative of the entrant's productivity: conditional on entering, first-period productivity is drawn from $H^s(z_t | s_t)$, strictly decreasing in s . Potential entrants with sufficiently good signals pay an additional cost $c_e > 0$ to enter; the measure of actual entrants is denoted $\mathcal{E}_t$. I specify the signal distribution as $S(s) = B \exp(-s)$ over the lowest half of the discretized transitory productivity grid, where B normalizes the discrete probabilities to sum to one. The entry transition function is assumed identical to that of incumbents: $H^s(z | s) = H(z' | z)$. Firms discount future profits at the constant factor β .⁴⁷

On the exit side, while exit in the data is concentrated among less productive firms, it does not follow a strict productivity cutoff: some productive firms also exit. To capture this, I introduce a stochastic exit value x_{jt} : at the start of each period, once aggregate uncertainty is resolved but before idiosyncratic productivity is realized, each incumbent observes its draw of x_{jt} from a time-invariant distribution $\zeta(x_t)$. The firm exits if the exit value exceeds the expected value of producing; otherwise it stays, learns its current productivity and, if production is profitable, sets prices, chooses labor, and produces. With probability e_0 , the exit value is zero; with the complementary probability, it is drawn from a Pareto distribution with shape parameter k_e .

6.2 Calibration

I parameterize the model using a combination of values from the literature and a moment-matching exercise. To implement the moment-matching, I use the steady state of the model with constant $Z_t^A = 1$ and $R_t = \beta^{-1}$. Details on the algorithm that solves the stationary competitive equilibrium are relegated to Online Appendix D.1.

Panel (a) of Table V provides a summary of the model parameters that are externally calibrated, their baseline values and the source or the empirical target. This first set of parameters are standard and, thus, values are chosen in line with the literature and, when possible, consistent with Spanish statistics taking the 2002-08 period as a reference. The time period of the model is a year. Accordingly, the discount factor β is chosen to be 0.96, consistent with an annual real return on bonds of 4%. 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. The sensitivity of the interest rate to the net foreign asset position, ϑ , is set to a small value, 10^{-4} , in the spirit of [Schmitt-Grohé and Uribe \(2003\)](#). For the elasticity of substitution for labor types, ε_w , and the index of wage rigidities, θ , val-

⁴⁷As in partial-equilibrium firm-dynamics models ([Hopenhayn, 1992](#); [Clementi and Palazzo, 2016](#)). Household valuation would use $\beta \lambda_{t+1} / \lambda_t$, which equals β in steady state and under the float, where λ_t is constant, but not along the currency-union transition. Constant β removes the direct effect of the interest-rate shock on firms' discount rate, a channel absent from the simple model of Sections 3–4.

TABLE V: PARAMETER VALUES

Panel (a): Externally Calibrated Parameters					
Parameter	Description	Value	Source		
β	Discount factor	0.96	Annual real return on bonds is 4%		
σ	Labor share	0.64	National Accounts Spain		
θ	Interest rate debt elasticity	10^{-4}	Schmitt-Grohé and Uribe (2003)		
ε_w	Elasticity of substitution (labor)	4.3	Galí and Monacelli (2016)		
θ	Index of wage rigidity	0.6	Galí and Monacelli (2016)		
τ	Iceberg trade cost	1.3	Ghironi and Melitz (2005)		
ρ_z	Transitory productivity - persistence	0.59	Gopinath et al. (2017)		
σ_z	Transitory productivity - st. dev. of innovations	0.13	Gopinath et al. (2017)		
Panel (b): Internally Calibrated Parameters					
Parameter	Description	Value	Moment	Data	Model
z_L	Permanent productivity parameter	0.610	Firm size - average	15.2	16.8
z_H	Permanent productivity parameter	0.792	Firm size - st. dev.	46.0	47.6
π	Permanent productivity parameter	0.99994	Employment share: <10 (%)	16.0	18.0
γ	Preference parameter	0.00040	Employment share: 10-249 (%)	53.5	58.7
α	Preference parameter	1.218	Average size of entrants	5.2	5.6
e_0	Prob. of zero exit value	0.906	Average size of exiters	4.9	3.6
k_e	Exit shape parameter	5.000	Exit rate (%)	8.1	8.0
c_e	Fixed cost of entry	2.55×10^{-8}	Exit rate: <10 (%)	9.5	9.4
c_s	Fixed cost of ideas	4.26×10^{-6}	Export intensity (%)	26.8	29.7
A	Foreign demand parameter	5162	Export intensity: 250+ (%)	50.7	47.4
B	Foreign demand parameter	3856	W/W^{row}	1.3	1.3

ues are in line with Galí and Monacelli (2016), which are based on empirical studies on European countries conducted by the OECD.⁴⁸ In terms of trade costs, τ is equal to 1.3 following Ghironi and Melitz (2005) and many others. Finally, for the parameters that govern the evolution of firm productivity, I borrow from Gopinath et al. (2017) that exploit ORBIS data for Spanish manufacturing firms. In particular, ρ_z and σ_z , are estimated by fitting a firm fixed-effects model on firm idiosyncratic productivity to be 0.59 and 0.13 respectively.

I calibrate the rest of the parameters to match informative moments of the data. I target a total of eleven moments. The first six moments include the mean and standard deviation of firm size; the employment shares of firms with fewer than 10 employees and those with 10–249 employees; and the average size of entering and exiting firms, all based on the Structural Business Statistics from Eurostat. The next two moments are the average exit rate and the exit rate among micro firms, drawn from the Spanish Business Registry (Directorio Central de Empresas, DIRCE). The last two moments are the exports to sales ratio of exporting firms, for all exporters and for those with 250 or more employees, calculated using the 5th vintage of the CompNet dataset and restricted to manufacturing firms from 1998 to 2008.⁴⁹ The final moment is the relative wage level, W/W^{row} , where the foreign wage W^{row} is normalized to one, measured as the ratio of the unit labor cost in Spain vis-à-vis Germany, according to the ECB.

The model is highly nonlinear, and all parameters affect all moments. However, some param-

⁴⁸Since the model period is a year, θ is an effective annual parameter. The value of 0.6 is consistent with the degree of wage stickiness documented for European economies in Galí and Monacelli (2016), once quarterly rigidity is aggregated to the annual frequency.

⁴⁹The CompNet dataset is an initiative by the Competitiveness Research Network, established by the ECB, to compile detailed firm-level data across several European countries.

ters are more determinant for certain statistics. The relative wage level is pinned down by the free entry condition and, thus, largely driven by the fixed cost of ideas. Selection in entry, as reflected by the average size of entrants, is mostly governed by the fixed cost of entry. Exit in the model is due to the choke price or the arrival of the exit shock. As the choke price is largely determined by the preference parameter α , there is a close relationship between this parameter and the exit rate of micro firms. Holding this constant, the overall exit rate is then determined by the probability of a non-zero exit value. The average size of exiters is governed by the shape of the exit-value distribution, k_e . The export to sales ratios are affected by the foreign demand parameters A and B . Finally, the mean and standard deviation of firm size, as well as the employment shares, are predominantly affected by the preference parameter γ and the parameters governing permanent productivity.

Panel (b) of Table V reports the estimated parameter values as well as the target moments in the data and the model. In addition, note that the preference parameter η is normalized to one without loss of generality, the steady-state net foreign asset position is set to ensure that trade is balanced in steady state, $\bar{B} = 8.7 \times 10^{-5}$, and the distribution of foreign firms Γ^* is assumed equal to the stationary distribution of domestic operating firms.⁵⁰

Model Fit As a measure of model fit, Figure III compares the population and employment shares by firm size in the model and in the data. The calibration captures key features of the firm size distribution. While the employment shares are directly targeted, the population shares are not—yet the model closely replicates them. Most firms are micro, with fewer than 10 employees, but they account for only a modest share of total employment. In contrast, medium and large firms, though fewer in number, employ the bulk of the workforce.

6.3 Adding Aggregate Dynamics

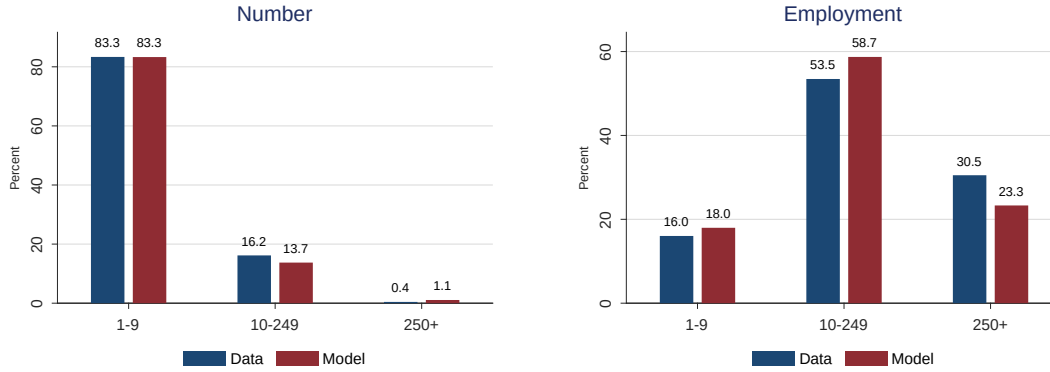
Before I turn towards studying the quantitative relevance of the mechanism, I explore the dynamic properties of the quantitative model. I model a sudden stop as the result of a positive shock to the interest rate and a decline in the common productivity shifter in the spirit of [Mendoza \(2010\)](#).⁵¹ The latter serves as a reduced-form approach to capturing the decline in the within-firm productivity component that is common to both the 1992–93 and 2010–13 sudden stop episodes, as shown in Table II.⁵²

⁵⁰ B_t denotes households' holdings of foreign-currency bonds, so $\bar{B} > 0$ implies that the domestic economy is a net creditor in steady state. A nominal depreciation therefore raises the domestic-currency value of this position. Given the linearity in leisure, however, this valuation gain does not operate through the usual household wealth channel and only affects the equilibrium through the path of foreign assets and the debt-elastic interest-rate premium.

⁵¹Note that [Mendoza \(2010\)](#) also features a shock to the price of imported intermediate inputs, which are absent from my model.

⁵²While endogenizing the common productivity shifter is beyond the scope of this paper, incorporating imported inputs and variable capacity utilization alongside credit constraints would establish a financial link between the common productivity shifter and the risk premium shock. This financial link would operate similarly across regimes, as

FIGURE III: FIRM SIZE DISTRIBUTION - DATA AND MODEL



Notes. Each panel compares data and model shares across firm size classes. The left panel shows the distribution of firms, where each bar represents the share of firms in that size category. The right panel reports employment shares by firm size. In both panels, the values represent fractions of the total—each bar group (Data and Model) adds up to one across size classes. Data moments are based on the Structural Business Statistics from Eurostat.

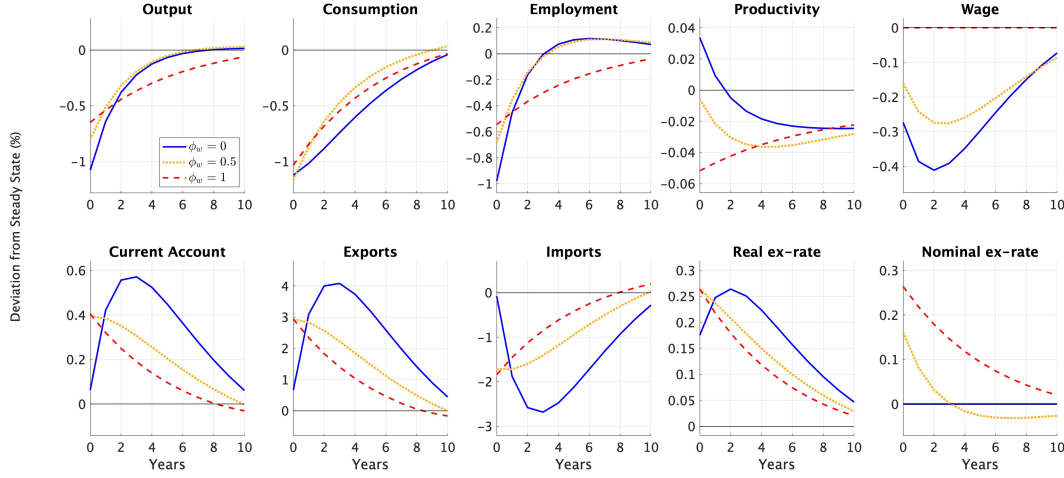
When the economy is out of steady state, the value functions, the distribution of operating firms, and all aggregate variables change over time. Hence, I solve for the sequences $\{V_t, V_t^c, V_t^e, V_t^p, \Gamma_t\}_{t=0}^T$ and $\{W_t, W_t^*, \lambda_t, p_t^{\max}, R_t, B_t, N_t\}_{t=0}^T$ consistent with (i) household, labor union and firm (incumbent, entrant and importer) optimization, (ii) aggregate wage dynamics and the debt-elastic interest rate, (iii) the law of motion for the net foreign asset position, (iv) the law of motion for the distribution of operating firms, and (v) goods market clearing, where $t = 0$ is the period in which shocks hit and agents learn about them, and T is a truncation horizon chosen long enough that the responses over the periods of interest do not depend on it. Online Appendix D.2 describes the numerical algorithm.

Figure IV summarizes the model-implied responses of key macroeconomic variables to a simultaneous increase in the interest rate and a decline in the common productivity shifter. The shocks are initially specified under a currency union ($\phi_w = 0$) as a 1% cumulative increase in the interest rate and a 1% cumulative decrease in the productivity shifter. Both shocks follow AR(1) paths with persistence 0.85, so that the impact innovation is about 0.15% in each case. For the float ($\phi_w = 1$) and an intermediate case ($\phi_w = 0.5$), the interest rate shock is rescaled so that the peak real exchange rate depreciation matches that of the currency union. This normalization mirrors the empirical design of Table I, which compares exchange rate regimes conditional on the size of the real depreciation, and isolates how the regime shapes the response to a given external adjustment.⁵³ The purpose of these impulse responses is to assess whether the analytical results in

firms substitute foreign intermediate inputs with domestic alternatives following the real exchange rate depreciation, leading to a decline in measured productivity at the firm level.

⁵³ As a robustness check, Figure A.15 in the Online Appendix rescales the interest rate shock under the float to deliver the same peak current account adjustment as in the currency union. The float then features a larger real depreciation,

FIGURE IV: MACROECONOMIC EFFECTS OF A SUDDEN STOP



Notes. These figures plot the impulse response functions of key macroeconomic variables to a simultaneous increase in the interest rate and a decline in the common productivity shifter under different exchange rate regimes, as predicted by the model described in Section 6. Under the currency union ($\phi_w = 0$), the shocks correspond to a 1% cumulative increase in the interest-rate shock and a 1% cumulative decrease in the common productivity shifter. For the float ($\phi_w = 1$) and the intermediate case ($\phi_w = 0.5$), the interest rate shock is recalibrated such that the peak real exchange rate depreciation matches that of the currency union case. The real exchange rate is e_t / W_t^c , the nominal exchange rate relative to domestic marginal cost at a common level of productivity. All variables except the current account are expressed in log deviations from steady state. The current account is expressed as a share of output and shown in percentage point deviations from steady state. Exports and imports are denominated in domestic currency; output and consumption are expressed in real terms.

Section 4.3 continue to hold in the richer quantitative model, rather than to reproduce the dynamics of a particular historical episode. All variables, except the current account, are expressed in log deviations from steady state.

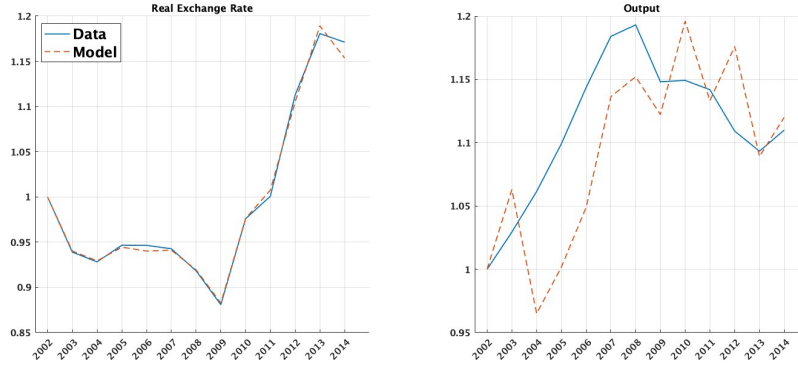
As expected, a sudden stop is characterized by a depreciation of the real exchange rate and a current account surplus. The model predicts a slight delay in the adjustment within a currency union.⁵⁴ The path of TFP clearly diverges across the two polar cases. On the one hand, under the baseline calibration, the positive effect of lower aggregate demand offsets the negative effect of lower production costs and fewer competing firms on the domestic productivity cutoff. TFP improves in the currency union even though the common productivity shifter falls, since the threshold rises and employment shifts toward more productive firms. On the other hand, productivity falls unambiguously in the float.

Output and consumption are measured in real terms. The model predicts a fall in both variables under a currency union and under a float. Consistent with the relative ranking in Proposi-

while the remaining results hold, with the exception of consumption, which falls slightly more under the float on impact.

⁵⁴This is entirely driven by nominal rigidities as the model disregards additional policy instruments available under a currency union, such as public capital inflows, that might directly cushion the adjustment in the data.

FIGURE V: TARGETS FOR MODEL SIMULATION - SPAIN, 2002–2014



Notes. This figure plots the data (solid blue) and model-implied series (dashed red) for the real exchange rate (left panel) and output (right panel) in Spain over the period 2002–2014. The real exchange rate is based on relative unit labor costs, constructed using National Accounts data from Eurostat. Output corresponds to real GDP at constant prices, taken from the World Bank’s World Development Indicators. Most series are expressed as indices normalized to 1 in the initial year.

tion 3 and with the aggregate evidence in Section 2, the contraction in both variables is more pronounced under the currency union. Following output fluctuations, employment also falls under both regimes, with a larger decline in the currency union. The current account surplus, expressed in domestic currency, reflects a combination of rising exports and falling imports.

The intermediate regime is included to illustrate how macroeconomic responses vary with the degree of nominal exchange rate adjustment, since actual floating regimes typically do not fully offset domestic nominal rigidities. As more of the real exchange rate depreciation is absorbed through the nominal exchange rate, the contraction in aggregate demand is weaker, and the productivity response is essentially flat, between the increase observed in the currency union and the decline under the float. A similar intermediate pattern holds in the response of output, consumption, and employment.

6.4 Simulating the 2010-13 Sudden Stop

With the calibrated model in hand, I simulate the dynamics of the Spanish economy during the 2010–2013 sudden stop episode. Specifically, I filter the interest rate shock, ε_t^R , and the productivity shifter, ε_t^A , such that the model-generated paths for the real exchange rate and output replicate the actual Spanish data over the 2002–2014 period. Agents are assumed to have perfect foresight but are continuously surprised by the realization of these two aggregate shocks, which they interpret as following AR(1) processes.

Figure V plots the time series for the real exchange rate and output in the data (solid blue) alongside the model-implied series (dashed red). The real exchange rate is based on relative unit labor costs and constructed using National Accounts data from Eurostat. Output corresponds to real GDP at constant prices, as reported in the World Bank’s World Development Indicators. The

TABLE VI: PRODUCTIVITY GROWTH DECOMPOSITION 2010-13 - DATA AND MODEL

	Data	Baseline (CU)	Counterfactual (Float)
Productivity Growth (%)	2.24	6.52	-2.29
Contribution to Productivity Growth:			
Incumbents' Contribution	-4.54	4.45	-4.12
Within-firm Contribution	-7.36	-5.65	-5.13
Between-firm Contribution	0.32	10.94	-2.35
Cross-term Contribution	2.50	-0.84	3.37
Net Entry Contribution	6.79	2.07	1.83
Entrants' Contribution	-0.40	-1.85	-0.41
Exiters' Contribution	7.19	3.92	2.24

Notes: This table reports the decomposition of productivity growth in Spain over the period 2010–2013. Column 1 repeats the empirical results shown in Table II. Column 2 shows the model's baseline simulation under a currency union. Column 3 reports a counterfactual scenario in which Spain operates under a flexible exchange rate regime and is exposed to the same sequence of shocks as in the baseline. All figures are expressed in percentage points.

model matches the real exchange rate dynamics almost perfectly, including the sharp depreciation observed between 2010 and 2013. It is less precise in replicating output, with sizable misses in some years, but the decline from 2008 to 2013 is of a similar order of magnitude in the model and in the data (about 5.5% and 8.4%, respectively). The fitted time series for the underlying shocks are shown in Figure A.14 in the Online Appendix.

Having simulated the Spanish economy, I return to the aggregate productivity decomposition exercise to evaluate the quantitative performance of the model. For convenience, the first column of Table VI reproduces the 2010–2013 productivity growth decomposition based on the Spanish data while the second column summarizes the results generated by the model under the baseline calibration.

The model captures several central features of the empirical decomposition of productivity growth. In particular, it generates a substantial cleansing effect through firm exit: exiters contribute 3.92 percentage points to productivity growth in the model, compared with 7.19 percentage points in the data, so the model reproduces about 55% of the empirical exit contribution. It also closely replicates the negative within-firm component, which is -5.65 percentage points in the model compared with -7.36 in the data, while entrants contribute negatively in both cases. The main quantitative discrepancy arises from reallocation among incumbent firms. The model generates a considerably stronger positive between-firm contribution than observed in the data, which more than offsets the negative within-firm component and leads the total incumbent contribution, and hence aggregate productivity growth, to be overstated.⁵⁵

⁵⁵In the model, employment adjusts freely across surviving firms and firm size is closely tied to productivity. This generates a stronger reallocation effect than is observed in the data. Labor adjustment frictions and other idiosyncratic forces, currently absent from the model, are likely to dampen this effect.

6.4.1 A Flexible Exchange Rate Counterfactual

Extending the simulation backward to explicitly capture the 1992–1993 sudden stop is not feasible due to data limitations prior to 1995. Instead, I construct a counterfactual scenario in which Spain retains a flexible exchange rate regime, i.e., does not join the euro, but is exposed to the same sequence of interest-rate and common productivity shocks as in the baseline simulation.

In this flexible regime, productivity declines rather than rises, driven by worsening incumbent performance. Both the within-firm and between-firm components are negative, while net entry partially offsets the decline. Exit continues to make a positive contribution to productivity, but this contribution is smaller than in the currency union and is not accompanied by sufficiently strong incumbent reallocation toward more productive incumbent firms. The broader cleansing mechanism is therefore considerably weaker. Although this simulation does not directly replicate the conditions of the 1992–1993 crisis, the patterns it generates are broadly consistent with the firm-level evidence for that period, as reported in Table II.

From productivity to welfare Productivity gains are not always welfare-enhancing. To assess the broader implications of the counterfactual, I compare household discounted utility across the two regimes. Over the 2002–2014 simulation, welfare is higher under the currency union. This result is consistent with the analytical findings: stronger selection and reallocation under a currency union can generate an allocative gain that must be weighed against the conventional stabilization advantage of a flexible exchange rate.

7 Conclusion

This paper shows, with theory and data, that exchange rate regimes can shape productivity dynamics during sudden stops through firm selection. Across countries, productivity contractions following sudden stops are larger under more flexible exchange rates. A simple model rationalizes this pattern: a flexible exchange rate cushions the contraction in output and consumption but weakens cleansing through firm exit, whereas the stronger domestic adjustment required under a currency union can strengthen selection and raise aggregate productivity. Evidence from two Spanish sudden stops under contrasting regimes is consistent with this mechanism. A quantitative simulation of the 2010–13 Spanish episode generates an increase in aggregate productivity driven by firm exit and accounts for a substantial share of the cleansing observed in the data. Under a counterfactual float, the cleansing effect is considerably weaker and aggregate productivity declines.

These productivity effects matter for welfare. In the absence of firm-specific markup distortions, the model recovers the conventional stabilization advantage of exchange rate flexibility. With heterogeneous markups, stronger selection generates an additional allocative gain that can

offset this advantage. Characterizing optimal policy when stabilization and firm-selection considerations interact is a natural direction for future research.

Appendix: Proofs

The proofs below rely on a set of closed-form expressions for the equilibrium objects of the simple model under the Pareto productivity distribution. I collect them here for reference.

Operating thresholds. The zero-profit conditions $\pi^i(z^i) = 0$ for $i \in \{H, X, M\}$ deliver $z^H = W^\sigma / p^{max}$, $z^X = \tau W^\sigma B / (eA)$, and $z^M = e\tau / p^{max}$. Equivalently, $p^{max} = W^\sigma / z^H$ and $z^M = (e\tau / W^\sigma) z^H$.

Policy functions. Substituting $p^{max} = W^\sigma / z^H$ into the optimal pricing and quantity rules gives

$$p^H(z) = \frac{1}{2} W^\sigma \left(\frac{1}{z^H} + \frac{1}{z} \right), \quad q^H(z) = \frac{\lambda}{2\gamma} W^\sigma \left(\frac{1}{z^H} - \frac{1}{z} \right),$$

$$p^M(z) = \frac{1}{2} e\tau \left(\frac{1}{z^M} + \frac{1}{z} \right), \quad q^M(z) = \frac{\lambda}{2\gamma} e\tau \left(\frac{1}{z^M} - \frac{1}{z} \right).$$

Domestic labor and revenues follow as $l^H(z) = W^{\sigma-1} q^H(z) / z$ and $r^H(z) = (\lambda / \gamma) (W^\sigma / 2)^2 [(1/z^H)^2 - (1/z)^2]$. Substituting z^X into the optimal pricing and quantity rules gives

$$p^X(z) = \frac{1}{2} \frac{\tau W^\sigma}{e} \left(\frac{1}{z^X} + \frac{1}{z} \right), \quad q^X(z) = \frac{B}{2} \frac{\tau W^\sigma}{e} \left(\frac{1}{z^X} - \frac{1}{z} \right).$$

Exporting labor follows as $l^X(z) = \tau W^{\sigma-1} q^X(z) / z$.

Number of varieties. Under Pareto,

$$N = M[1 - \Gamma(z^H)] + M^*[1 - \Gamma^*(z^M)] = \left(\frac{1}{z^H} \right)^k \left[M + M^* \left(\frac{W^\sigma}{\tau e} \right)^k \right].$$

Aggregation. Integrating $p^i(z)$ across operating firms under Pareto yields the aggregate price index

$$\int_0^N p_j dj = \frac{2k+1}{2k+2} \frac{W^\sigma N}{z^H}.$$

Integrating the quantity schedules yields the aggregate quantities

$$Q^H = \frac{\lambda W^\sigma}{2\gamma(k+1)} (z^H)^{-(k+1)} M, \quad Q^M = \frac{\lambda \tau e}{2\gamma(k+1)} (z^M)^{-(k+1)} M^*, \quad Q^X = \frac{B \tau W^\sigma}{2e(k+1)} (z^X)^{-(k+1)} M,$$

and integrating labor demand yields employment in home and export production

$$L^H = \frac{k\lambda W^{2\sigma-1}}{2\gamma(k+1)(k+2)} (z^H)^{-(k+2)} M, \quad L^X = \frac{Bk\tau^2 W^{2\sigma-1}}{2e(k+1)(k+2)} (z^X)^{-(k+2)} M.$$

Implicit equation for the threshold. Substituting the aggregated price index into the choke-price definition from equation (6) and using $p^{max} = W^\sigma / z^H$ delivers

$$z^H = \frac{\lambda W^\sigma}{\alpha \gamma} \left[\gamma + \frac{\eta}{2k+2} N \right]. \quad (14)$$

Proof of Lemma 1

The unweighted average productivity among operating domestic firms is

$$\tilde{Z}^H = \frac{1}{1 - \Gamma(z^H)} \int_{z^H}^{\infty} z \gamma(z) dz = \frac{k}{k-1} z^H.$$

Using the policy functions from the preliminary derivations, the output-, revenue-, and labor-weighted averages can be computed in closed form, yielding

$$\hat{Z}^H = \frac{k+1}{k} \tilde{Z}^H, \quad \check{Z}^H = \frac{k+2}{k+1} \tilde{Z}^H, \quad \bar{Z}^H = \frac{(k-1)(k+2)}{k^2} \tilde{Z}^H.$$

All four expressions are proportional to z^H , so Z^H is strictly increasing in z^H regardless of the weighting scheme. ■

Proof of Proposition 1

The implicit equation (14) from the preliminary derivations links the threshold to the marginal utility of income λ , the wage W , and the mass of varieties N . Totally differentiating the threshold condition yields

$$dz^H = F_N dN + F_W dW + F_\lambda d\lambda,$$

with

$$F_N = \frac{\lambda W^\sigma}{\alpha \gamma} \cdot \frac{\eta}{2k+2} > 0, \quad F_W = \sigma \frac{\lambda W^{\sigma-1}}{\alpha \gamma} \left[\gamma + \frac{\eta}{2k+2} N \right] > 0, \quad F_\lambda = \frac{W^\sigma}{\alpha \gamma} \left[\gamma + \frac{\eta}{2k+2} N \right] > 0.$$

Dividing by z^H and using the closed form gives the partial elasticities $\partial \ln z^H / \partial \ln N = s \equiv (\frac{\eta}{2k+2} N) / (\gamma + \frac{\eta}{2k+2} N) \in (0, 1)$, $\partial \ln z^H / \partial \ln W = \sigma$, and $\partial \ln z^H / \partial \ln \lambda = 1$, which delivers the log decomposition stated in Proposition 1. ■

Proof of Proposition 2

A sudden stop is a one-time, unexpected increase $\varepsilon^R > 0$ in the interest rate. The Euler equation (7), $\lambda e = \beta R \mathbb{E}[\lambda' e']$, then requires λe to rise on impact; log-linearizing gives $d \ln \lambda + d \ln e = \varepsilon^R$. How the shock splits between the marginal utility of income and the exchange rate depends on the regime.

Pure float. The central bank implements the flexible-wage equilibrium, so $W = W^*$ and the exchange rate fully absorbs the shock. The union's optimality condition (8) then pins down λ at its stationary value, so $d \ln \lambda = 0$ and $d \ln W = 0$; the linearized Euler then gives $d \ln e = \varepsilon^R$. Differentiating the closed form for the mass of varieties and using Proposition 1 to eliminate $d \ln z^H$ delivers the regime-free relation

$$(1 + ks) d \ln N = -k [d \ln \lambda + \sigma(1 - \omega) d \ln W + \omega d \ln e], \quad \omega \equiv N^M / N, \quad (15)$$

where ω is the import share; the same relation is used again in the proof of Proposition 3. At the float values, (15) reduces to $(1 + ks) d \ln N = -k \omega \varepsilon^R < 0$, and (14) with λW^σ held fixed then gives $d \ln z^H < 0$.

Currency union. The exchange rate is fixed at $e = 1$, so the adjustment falls on the marginal utility of income, $d \ln \lambda = \varepsilon^R$. The union's FOC then implies $d \ln W^* = -\varepsilon^R$, and equation (3) gives $d \ln W = -(1 - \theta) \varepsilon^R$. All three channels in Proposition 1 are active. Evaluating (15) at these values gives

$$(1 + ks) d \ln N = -k [1 - \sigma(1 - \theta)(1 - \omega)] \varepsilon^R < 0,$$

since $\sigma(1 - \theta)(1 - \omega) \leq 1$, strictly whenever the import share is positive, so $d \ln N < 0$. The threshold, by contrast, nets the demand channel against the cost and pro-competitive channels, and its sign depends on parameter values. ■

Proof of Corollary 1

Substituting the closed-form for N into the implicit equation (14) yields

$$z^H - \frac{\eta}{2k+2} \frac{\lambda W^\sigma}{\alpha \gamma} \left(\frac{1}{z^H} \right)^k \left[M + M^* \left(\frac{W^\sigma}{\tau e} \right)^k \right] = \frac{\lambda W^\sigma}{\alpha}.$$

A sufficient condition for $d \ln z^H > 0$ is then $d(\lambda W^{\sigma(k+1)} / e^k) > 0$ since $d(\lambda W^{\sigma(k+1)} / e^k) > 0$ also implies $d(\lambda W^\sigma) > 0$. Under a regime with flexibility ϕ_w , the exchange rate offsets the wage

according to $d \ln e = -\frac{\phi_w}{1-\phi_w} d \ln W$, so the condition becomes

$$d \ln \lambda + \left[\sigma(k+1) + \frac{k\phi_w}{1-\phi_w} \right] d \ln W > 0.$$

Combining (3) and (8) yields

$$d \ln W = (1-\theta) \left(\frac{W^*}{W} \right)^{1-\varepsilon_w} d \ln W^* = -(1-\theta) \left(\frac{W^*}{W} \right)^{1-\varepsilon_w} d \ln \lambda.$$

Substituting and using $d \ln \lambda > 0$ delivers the sufficient condition

$$(1-\theta)\sigma(k+1) + (1-\theta)k \frac{\phi_w}{1-\phi_w} < \left(\frac{W}{W^*} \right)^{1-\varepsilon_w}.$$

Since $W/W^* \rightarrow 1$ as $\varepsilon^R \rightarrow 0$, this inequality holds for sufficiently small ε^R under the parameter restriction stated in the corollary. ■

Proof of Proposition 3

From the proof of Proposition 2, the float sets $d \ln \lambda = d \ln W = 0$ and $d \ln e = \varepsilon^R$, while the currency union sets $d \ln e = 0$, $d \ln \lambda = \varepsilon^R$, and $d \ln W = -(1-\theta) \varepsilon^R$.

Consumption. Aggregate consumption is $C = Q^H + Q^M$; substituting $W^\sigma = p^{max} z^H$ and $e\tau = p^{max} z^M$ collapses both terms to $C = \lambda p^{max} N / [2\gamma(k+1)]$. The household's demand (6) at the choke price gives $\lambda p^{max} = \alpha - \eta C$, so

$$C = \frac{\alpha}{\eta} s,$$

with s the pro-competitive elasticity in Proposition 1; hence $d \ln C = (1-s) d \ln N$.

The mass of varieties responds according to (15), with $\omega \equiv N^M/N$ the share of imported varieties. Substituting it into $d \ln C = (1-s) d \ln N$,

$$d \ln C = -\frac{k(1-s)}{1+ks} (d \ln \lambda + \sigma(1-\omega) d \ln W + \omega d \ln e).$$

Evaluating at the regime responses,

$$d \ln C^{float} = -\frac{k\omega(1-s)}{1+ks} \varepsilon^R < 0, \quad d \ln C^{cu} = -\frac{k[1-\sigma(1-\theta)(1-\omega)](1-s)}{1+ks} \varepsilon^R < 0,$$

and, since $[1-\sigma(1-\theta)(1-\omega)] - \omega = (1-\omega)[1-\sigma(1-\theta)] > 0$, then $d \ln C^{cu} < d \ln C^{float}$.

Output. Domestic production is $Y = Q^H + \tau Q^X$, since delivering q^X abroad requires producing τq^X under the iceberg cost; it suffices to sign each component. Differentiating the closed forms,

$$d \ln Q^H = d \ln \lambda + \sigma d \ln W - (k+1) d \ln z^H, \quad d \ln Q^X = k (d \ln e - \sigma d \ln W),$$

where solving the two relations from the consumption step for $d \ln z^H$ gives

$$d \ln z^H = \frac{d \ln \lambda + \sigma(1 + ks\omega) d \ln W - ks\omega d \ln e}{1 + ks}.$$

Under the float,

$$d \ln Q^{H, float} = \frac{k(k+1)s\omega}{1 + ks} \varepsilon^R > 0, \quad d \ln Q^{X, float} = k \varepsilon^R > 0, \quad \text{so} \quad d \ln Y^{float} > 0.$$

Under the currency union exports still rise, $d \ln Q^{X, cu} = k\sigma(1 - \theta) \varepsilon^R > 0$, but domestic production is ambiguous,

$$d \ln Q^{H, cu} = \frac{k[\sigma(1 - \theta)(k+1)s\omega - (1 - s)(1 - \sigma(1 - \theta))]}{1 + ks} \varepsilon^R \geq 0.$$

To sign aggregate output, write the export share $\chi^X \equiv \tau Q^X / Y$, so that $d \ln Y^{cu} = (1 - \chi^X) d \ln Q^{H, cu} + \chi^X d \ln Q^{X, cu}$. When wages are rigid ($\theta \rightarrow 1$, so $\sigma(1 - \theta) \rightarrow 0$) the export response vanishes and $d \ln Q^{H, cu} \rightarrow -\frac{k(1-s)}{1+ks} \varepsilon^R < 0$, so $d \ln Y^{cu} < 0$; when wages are flexible and σ near one both components are positive, so $d \ln Y^{cu} > 0$. Hence $d \ln Y^{cu} \geq 0$.

Taking the regime difference of each component,

$$d \ln Q^{H, cu} - d \ln Q^{H, float} = -\frac{k(1 - \sigma(1 - \theta))[(1 - s) + (k+1)s\omega]}{1 + ks} \varepsilon^R < 0,$$

$$d \ln Q^{X, cu} - d \ln Q^{X, float} = -k(1 - \sigma(1 - \theta)) \varepsilon^R < 0,$$

so both component responses are strictly lower under the currency union, hence $d \ln Y^{cu} < d \ln Y^{float}$.

■

Welfare Analysis

Consider a planner that maximizes the representative household's period utility by choice of quantities and factor allocations, subject to each domestic firm's technology $q^H(z) + \tau q^X(z) = z(\sigma l(z))^\sigma m(z)^{1-\sigma}$ (multiplier $\psi(z)$) and a balance of payments in which imports are financed by export revenue at foreign prices (multiplier ν); $l(z)$ is the employment measure used throughout the paper, so that $Wl(z)$ is the firm's variable cost, aggregate labor is $L = M \int l(z) d\Gamma$, and, as in footnote 19, the concave cost is interpreted as arising from a second factor supplied by households

at the constant price κ , an interpretation used only to define the planner's resource costs. Minimizing factor use at the shadow prices—the marginal disutility of labor (equal to one per unit of l) and the second factor's social cost ρ —gives the shadow marginal cost

$$\psi(z) = \frac{1}{z} \left(\frac{1}{\sigma^2} \right)^\sigma \left(\frac{\rho}{1-\sigma} \right)^{1-\sigma},$$

the counterpart of the market marginal cost W^σ/z with the wage and κ replaced by their shadow values. The planner's shadow value of one unit of the second factor is therefore $\rho = \lambda\kappa$. As a small open economy the planner takes foreign prices as given, so imports are bought at their social cost and $\nu = \lambda$.

Each wedge is the ratio of the private to the social value of an extra unit. Home demand (6) sets the marginal utility of variety z equal to $\lambda p^H(z)$, while the planner sets it equal to $\psi(z)$; with $p^H(z) = \mu(z) W^\sigma/z$ and $\rho = \lambda\kappa$,

$$1 + \tau^H(z) = \frac{\lambda p^H(z)}{\psi(z)} = \mu(z) \sigma^\sigma \frac{\lambda W^\sigma \kappa^{1-\sigma}}{\rho^{1-\sigma}} = \mu(z) (\sigma \lambda W)^\sigma.$$

An export is worth to the domestic economy the revenue it brings back; at the margin this is marginal revenue, which the firm equates to marginal cost, so the marginal export is valued at λmc and its markup drops out: $1 + \tau^X = \lambda mc/\psi = (\sigma \lambda W)^\sigma$. Labor enters through $l(z)$: at the market allocation $\sigma y/l = \sigma W/mc$, so its shadow marginal product is $\psi \sigma y/l = \sigma \psi W/mc = (\sigma \lambda W)^{1-\sigma}$, relative to a unit disutility, giving $1 + \tau^L = (\sigma \lambda W)^{1-\sigma}$. Imports, bought at the foreign price with $\nu = \lambda$, are undistorted, $\tau^M = 0$: the planner takes the foreign import-price schedule as given, so the foreign markup is a transfer abroad rather than a domestic wedge.

Equation (11) collects the output and labor margins of the planner Lagrangian's differential at the market allocation, which is feasible. The full differential has one further term, the second-factor margin, $\rho [(\sigma \lambda W)^{-\sigma} - 1] M \int dm(z) d\Gamma$, which vanishes when $\sigma \lambda W = 1$, as under the correction used in the text, and so does not enter the results that follow. The import term drops out, since imports are bought at the foreign price. The integrals run over continuing firms, the extensive margin being second order: the marginal firm produces $q^H(z^H) = 0$, so a shift in the cutoff adds no boundary term and enters only through the induced $dq^H(z)$. The expression is a within-period allocative differential, conditional on the external transfer and the continuation path.

Appendix: Quantitative Model

This appendix collects the additional details needed for the quantitative model of Section 6: the union's forward-looking wage-setting problem, the value functions for incumbents and entrants, and the updated equilibrium definition.

Wage setting. Resetting unions choose W_t^* to maximize $\mathbb{E}_t \left[\sum_{k=0}^{\infty} (\beta\theta)^k U(q_{j,t+k|t}, L_{t+k|t}) \right]$, where $q_{j,t+k|t}$ and $L_{t+k|t}$ denote consumption and labor at time $t+k$ for a household whose union last reset at time t . The optimization is subject to the sequence of budget constraints effective while W_t^* remains in place, together with the labor demand schedules $L_{t+k|t} = (W_t^*/W_{t+k})^{-\varepsilon_w} L_{t+k}$. The associated first-order condition is

$$\sum_{k=0}^{\infty} (\beta\theta)^k \mathbb{E}_t \left[\lambda_{t+k} L_{t+k} \left(\frac{W_t^*}{W_{t+k}} \right)^{-\varepsilon_w} \left(W_t^* - \frac{\varepsilon_w}{\varepsilon_w - 1} \frac{1}{\lambda_{t+k}} \right) \right] = 0. \quad (16)$$

The resetting union targets a discounted sum of expected wedges between the actual wage and the flexible-wage benchmark.

Incumbent's recursive problem. At each date t , the distribution of operating firms is $\Gamma_t(z_t)$ with mass $M_t = \int d\Gamma_t$. Let $\mu_t \in \mu$ denote the aggregate state, with $\mu_t = \{W_{t-1}, e_t, \Gamma_t, B_t, \varepsilon_t^R, Z_t^A\}$, and $J(\mu_{t+1}|\mu_t)$ its transition operator. Within a period, aggregate uncertainty is resolved first; each incumbent then observes its exit value x_{jt} and decides whether to keep operating; surviving firms learn the current realization of their idiosyncratic productivity, set prices, choose labor, and produce. Write $z^{T'}$ for the current realization of the transitory productivity component, so that $z = z^P z^{T'}$ denotes the idiosyncratic productivity of a firm operating in the current period. The start-of-period value of an incumbent is

$$V(\mu, z^P, z^T) = \int \max \left\{ \mathbb{E}_z \left[V^c(\mu, z^P, z^{T'}) \mid z^T \right], x \right\} d\tilde{\zeta}(x),$$

where the expected value of a continuing firm is

$$\mathbb{E}_z \left[V^c(\mu, z^P, z^{T'}) \mid z^T \right] = \int V^c(\mu, z^P, z^{T'}) dH(z^{T'}|z^T),$$

and

$$V^c(\mu, z^P, z^{T'}) = \begin{cases} \pi(\mu, z^P, z^{T'}) + \beta \int V(\mu', z^P, z^{T'}) dJ(\mu'|\mu) & \text{if } \pi(\mu, z^P, z^{T'}) > 0, \\ 0 & \text{otherwise.} \end{cases}$$

V^c is the value of a firm that produces, and it is zero when the productivity draw does not allow production. An incumbent exits if the exit value exceeds the expected value of producing.⁵⁶

⁵⁶Incumbents that do not exit remain in the firm pool even when their realized productivity implies zero current production. Such firms earn zero flow profits in that period but may produce again in the future. New entrants are included only when their initial productivity draw allows production.

Entry. For an aggregate state μ , the value of a new firm with permanent component z^P that enters after receiving signal s is

$$V^e(\mu, z^P, s) = \int V^c(\mu, z^P, z^{T'}) dH^s(z^{T'}|s).$$

Only potential entrants with sufficiently high signals $s \geq s^*(z^P)$ find it profitable to enter, where $s^*(z^P)$ solves $V^e(\mu, z^P, s^*(z^P)) = c_e$. The free-entry condition $V^p(\mu) = c_s$ exhausts gains from generating new ideas, with

$$V^p(\mu) = \int \int \max\{V^e(\mu, z^P, s) - c_e, 0\} dS(s) dF(z^P).$$

Equilibrium. The law of motion for the distribution of operating domestic firms is, for all Borel sets $\mathcal{Z}^P \times \mathcal{Z}^T \in \mathbb{R}_+ \times \mathbb{R}_+$,

$$\Gamma'(\mathcal{Z}^P \times \mathcal{Z}^T) = \int \int_{B(\mu, x)} \int_{\mathcal{Z}^T} dH(z^{T'}|z^T) d\zeta(x) d\Gamma(z^P, z^T) + \mathcal{E}'(\mathcal{Z}^P \times \mathcal{Z}^T),$$

where $B(\mu, x) = \{x : \mathbb{E}_z[V^c(\mu, z^P, z^{T'}) | z^T] \geq x\}$ and the measure of actual entrants is

$$\mathcal{E}'(\mathcal{Z}^P \times \mathcal{Z}^T) = M^s \int_{s^*}^{\infty} \int_{B_p(\mu, z^P, z^{T'})} F(z^P) dH^s(z^{T'}|s) dS(s),$$

with $B_p(\mu, z^P, z^{T'}) = \{z^{T'} \in \mathcal{Z}^T : V^c(\mu, z^P, z^{T'}) > 0\}$. Goods market clearing requires

$$e_t (B_t - R_{t-1} B_{t-1}) = e_t \int p_t^X(\mu, z) q_t^X(\mu, z) d\Gamma'(z) - \int p_t^M(\mu, z) q_t^M(\mu, z) d\Gamma^*(z) - (M_t^s c_s + M_t^e c_e - X_t),$$

where $M_t^e = \int d\mathcal{E}'$ is the number of actual entrants and $X_t = \int \int \mathbf{1}\{\mathbb{E}_z[V^c(\mu, z^P, z^{T'})|z^T] < x\} x d\zeta(x) d\Gamma(z)$ is the total value of exit. The left-hand side is net foreign lending; the right-hand side is the trade balance net of net entry costs.

Definition 2. A *Recursive Stationary Competitive Equilibrium* consists of value functions $V(\mu, z)$, $V^c(\mu, z)$, $V^e(\mu, s)$, and $V^p(\mu)$; firm policy functions $\pi^k(\mu, z)$ and $p^k(\mu, z)$ for $k \in \{H, X, M\}$; a consumer demand schedule $q(z)$; a vector of aggregate prices $\{W^*, W, R\}$; foreign bonds B ; the number of varieties N ; the number of potential entrants M^s ; and a distribution of operating domestic firms $\Gamma'(z)$ such that:

1. $V, V^c, \pi^H, \pi^X, p^H, p^X$ solve the incumbent's problem;
2. V^e and V^p solve the entrant's problem;
3. π^M and p^M solve the importer's problem;
4. q and B solve the household's problem;

5. The interest rate rule (13) holds;
6. W^* solves the union's problem and W satisfies (3);
7. The exchange rate rule (4) holds;
8. $N = \int \mathbf{1}\{\pi^H(\mu, z) > 0\} d\Gamma'(z) + \int \mathbf{1}\{\pi^M(\mu, z) > 0\} d\Gamma^*(z)$;
9. Free entry: $V^p(\mu) = c_s$;
10. Goods market clears;
11. The distribution of operating domestic firms is stationary.

References

- Akerberg, Daniel A, Kevin Caves, and Garth Frazer. 2015. "Identification Properties of Recent Production Function Estimators." *Econometrica*, 83(6): 2411–2451.
- Alessandria, George, and Horag Choi. 2007. "Do Sunk Costs of Exporting Matter for Net Export Dynamics?" *The Quarterly Journal of Economics*, 122(1): 289–336.
- Alessandria, George, Joseph P Kaboski, and Virgiliu Midrigan. 2010. "Inventories, Lumpy Trade, and Large Devaluations." *American Economic Review*, 100(5): 2304–2339.
- Almunia, Miguel, Pol Antràs, David Lopez-Rodriguez, and Eduardo Morales. 2021. "Venting Out: Exports during a Domestic Slump." *American Economic Review*, 111(11): 3611–3662.
- Ates, Sina T, and Felipe E Saffie. 2021. "Fewer but Better: Sudden Stops, Firm Entry, and Financial Selection." *American Economic Journal: Macroeconomics*, 13(3): 304–356.
- Benigno, Gianluca, and Luca Fornaro. 2014. "The Financial Resource Curse." *The Scandinavian Journal of Economics*, 116(1): 58–86.
- Bornstein, Gideon, and Laura Castillo-Martinez. 2026. "Firm Exit and Financial Frictions." NBER Working Paper 35479.
- Caballero, Ricardo J., and Mohamad L. Hammour. 1994. "The Cleansing Effect of Recessions." *American Economic Review*, 84(5): 1350–1368.
- Calvo, Guillermo A. 1983. "Staggered Prices in a Utility-Maximizing Framework." *Journal of Monetary Economics*, 12(3): 383–398.
- Calvo, Guillermo A. 1998. "Capital Flows and Capital-Market Crises: the Simple Economics of Sudden Stops." *Journal of Applied Economics*, 1(1): 35–54.
- Calvo, Guillermo A., Alejandro Izquierdo, and Luis-Fernando Mejía. 2004. "On the Empirics of Sudden Stops: the Relevance of Balance-Sheet Effects." NBER Working Paper 10520.
- Cavallo, Eduardo A, and Jeffrey A Frankel. 2008. "Does Openness to Trade Make Countries More Vulnerable to Sudden Stops, or Less? Using Gravity to Establish Causality." *Journal of International Money and Finance*, 27(8): 1430–1452.

- Chodorow-Reich, Gabriel, Loukas Karabarbounis, and Rohan Kekre.** 2023. "The Macroeconomics of the Greek Depression." *American Economic Review*, 113(9): 2411–2457.
- Clementi, Gian Luca, and Berardino Palazzo.** 2016. "Entry, Exit, Firm Dynamics, and Aggregate Fluctuations." *American Economic Journal: Macroeconomics*, 8(3): 1–41.
- Dias, Daniel A., and Carlos Robalo Marques.** 2021. "Every Cloud Has a Silver Lining: Micro-Level Evidence on the Cleansing Effects of the Portuguese Financial Crisis." *Oxford Bulletin of Economics and Statistics*, 83(2): 352–376.
- Engel, Charles.** 1999. "Accounting for US Real Exchange Rate Changes." *Journal of Political Economy*, 107(3): 507–538.
- Farhi, Emmanuel, Gita Gopinath, and Oleg Itskhoki.** 2013. "Fiscal Devaluations." *Review of Economic Studies*, 81(2): 725–760.
- Foster, Lucia, Cheryl Grim, and John Haltiwanger.** 2016. "Reallocation in the Great Recession: Cleansing or Not?" *Journal of Labor Economics*, 34(S1): S293–S331.
- Foster, Lucia, John C Haltiwanger, and Cornell John Krizan.** 2001. "Aggregate Productivity Growth: Lessons from Microeconomic Evidence." In *New Developments in Productivity Analysis*. 303–372. University of Chicago Press.
- Galí, Jordi, and Tommaso Monacelli.** 2016. "Understanding the Gains from Wage Flexibility: the Exchange Rate Connection." *American Economic Review*, 106(12): 3829–3868.
- García-Santana, Manuel, Enrique Moral-Benito, Josep Pijoan-Mas, and Roberto Ramos.** 2020. "Growing like Spain: 1995–2007." *International Economic Review*, 61(1): 383–416.
- Ghironi, Fabio, and Marc J. Melitz.** 2005. "International Trade and Macroeconomic Dynamics with Heterogeneous Firms." *The Quarterly Journal of Economics*, 120(3): 865–915.
- Gopinath, Gita, Şebnem Kalemli-Özcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez.** 2017. "Capital Allocation and Productivity in South Europe." *The Quarterly Journal of Economics*, 132(4): 1915–1967.
- Guidotti, Pablo E., Federico Sturzenegger, Agustin Villar, José de Gregorio, and Ilan Goldfajn.** 2004. "On the Consequences of Sudden Stops." *Economia*, 4(2): 171–214.
- Hegarty, Caitlin, Matias Moretti, Pablo Ottonello, and Diego J. Perez.** 2026. "Firms' Investment and the Real Transmission of the Global Financial Cycle."
- Hopenhayn, Hugo A.** 1992. "Entry, Exit, and Firm Dynamics in Long Run Equilibrium." *Econometrica*, 1127–1150.
- Ilzetzki, Ethan, Carmen M. Reinhart, and Kenneth S. Rogoff.** 2019. "Exchange Arrangements Entering the 21st Century: Which Anchor Will Hold?" *The Quarterly Journal of Economics*, 134(2): 599–646.
- Kehoe, Timothy J., and Kim J. Ruhl.** 2009. "Sudden Stops, Sectoral Reallocations, and the Real Exchange Rate." *Journal of Development Economics*, 89(2): 235–249.
- Melitz, Marc J.** 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695–1725.
- Melitz, Marc J., and Gianmarco I.P. Ottaviano.** 2008. "Market Size, Trade, and Productivity." *The Review of Economic Studies*, 75(1): 295–316.

- Melitz, Marc J., and Sašo Polanec.** 2015. "Dynamic Olley-Pakes Productivity Decomposition with Entry and Exit." *The Rand Journal of Economics*, 46(2): 362–375.
- Mendoza, Enrique G.** 2010. "Sudden Stops, Financial Crises, and Leverage." *American Economic Review*, 100(5): 1941–66.
- Meza, Felipe, and Erwan Quintin.** 2007. "Factor Utilization and the Real Impact of Financial Crises." *The BE Journal of Macroeconomics*, 7(1): 1–41.
- Mian, Atif, and Amir Sufi.** 2014. "What Explains the 2007–2009 Drop in Employment?" *Econometrica*, 82(6): 2197–2223.
- Mundell, Robert A.** 1963. "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates." *The Canadian Journal of Economics and Political Science*, 29(4): 475–485.
- Neumeyer, Pablo A., and Fabrizio Perri.** 2005. "Business Cycles in Emerging Economies: the Role of Interest Rates." *Journal of Monetary Economics*, 52(2): 345–380.
- Olley, G Steven, and Ariel Pakes.** 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry." *Econometrica*, 64(6): 1263–1297.
- Reis, Ricardo.** 2013. "The Portuguese Slump and Crash and the Euro Crisis." *Brookings Papers on Economic Activity*, 2013(1): 143–210.
- Schmitt-Grohé, Stephanie, and Martín Uribe.** 2003. "Closing Small Open Economy Models." *Journal of international Economics*, 61(1): 163–185.
- Schmitt-Grohé, Stephanie, and Martín Uribe.** 2016. "Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment." *Journal of Political Economy*, 124(5): 1466–1514.
- Schumpeter, Joseph A.** 1939. *Business Cycles*. McGraw-Hill New York.