Output stabilization in fixed and floating regimes: Does trade of new products matter?

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ABSTRACT

This paper studies the dynamics of output and export margins in the aftermath of global shocks in fixed and floating exchange rate regimes. Using a panel vector autoregressive model with exogenous factors, it traces the mean responses of output, terms of trade, extensive and intensive margins to real and nominal shocks in 22 developed economies over the period 1988–2011. We find remarkable differences in the transmission of shocks across exchange rate regimes. Adjustment takes place mainly at the extensive margin in fixed regimes, and implies a crowding out of intensive margins that is not present among floaters. Large movements at the extensive margin are associated with a weaker performance in terms of output stabilization. Our findings are robust to alternative sample selections and identification of the shocks. The evidence in the paper stresses a novel advantage of flexible exchange rates based on their ability to smooth the fluctuations in trade of new products.

1. Introduction

Two facts motivate the analysis in this paper. First, a large share of the growth in trade volumes occurs at the extensive margin, with exports of new products and previously non-traded goods (see Kehoe and Ruhl, 2013), while sectors with a higher share of new products experience more growth (Kehoe et al., 2015). Second, the creation (and destruction) of new products - including newly traded products - plays an important role for the fluctuations of output over the cycle. Only few studies consider these facts together and mainly from a theoretical vantage point. Recent dynamic stochastic general equilibrium (DSGE) models with firm entry have stressed the implications of the extensive margin of exports for the propagation of shocks worldwide. In these models, product creation (destruction) - proxied by firm entry (exit) - acts as a business cycle amplifier and helps replicate the main facts of the international business cycle (see in particular Ghironi and Mélitz, 2005 and Cavallari, 2013).

Yet evidence on the role of export margins for the transmission of shocks among interdependent economies is scant. This paper aims to shed some light on this issue. In particular, we are interested in the following questions: how do trade of new and mature products respond to shocks that originate abroad? Do they affect the extent to which output fluctuates over the cycle? Does the pattern of trade vary under fixed and flexible regimes? We will soon document remarkable differences in the transmission of shocks across exchange rate regimes. Specifically, adjustment at the extensive margin is stronger in fixed than in flexible regimes. In addition, extensive and intensive margins move in opposite directions in fixed regimes, suggesting the possibility of relocations between sectors that produce new products and newly traded goods and sectors that produce previously traded goods.3

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Bernard et al. (2010) show that the value of new products represents 34 percent of US output over a 5-year horizon and the lost value from product destruction over the same period is 30 percent. Bibbitt et al. (2012) are among the first to show the role of firm entry and product creation for the propagation of shocks. See Cavallari (2013) for a quantitative evaluation and Pavlov (2016) for the extension to news-driven cycles.

Since the seminal study of Mélitz (2003), a number of papers have investigated the implications of entry for the international business cycle. Open economy models with firm entry include, among others, Bergin and Glick (2007); Ghironi and Mélitz (2005); Cavallari (2007, 2010, 2013); Cavallari and D’Addona (2016), and Corsetti et al. (2007, 2013).

The extent to which exchange rate flexibility affects the incentive of firms to relocate production across sectors is at the center of recent work by Bergin and Corsetti (2015) and by Cavallari and D’Addona (2016). It is argued that exchange rate flexibility can affect the comparative advantage of a country, by affecting the profits of firms in the traded goods sector.

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Table 1
Im-Pesaran-Shin unit-root test for panel data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$W_{dmn}$</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta$ ToT</td>
<td>−62.0489</td>
<td>0.000</td>
</tr>
<tr>
<td>$\Delta$ GDP</td>
<td>−38.5504</td>
<td>0.000</td>
</tr>
<tr>
<td>IntensiveMargins</td>
<td>−18.0927</td>
<td>0.000</td>
</tr>
<tr>
<td>ExtensiveMargins</td>
<td>−11.7086</td>
<td>0.000</td>
</tr>
</tbody>
</table>

This table reports the unit-root test statistic for unbalanced panel introduced by Im et al. (2003). We test the null that all panels contain unit roots versus the alternative that some panels are stationary. The number of panels is 484 with an average number of periods of 18 years. Means are included while time trends are not included.

The paper explores empirically the dynamics of output and export flows in the aftermath of global shocks in fixed and floating regimes. In departing from previous studies, which have mainly focused on overall export flows, we distinguish exports of new products and previously non-traded goods (the extensive margin) and exports of previously traded goods (the intensive margin). The analysis complements earlier studies, which have mainly focused on overall export flows, we distinguish exports of new products and previously non-traded goods (the extensive margin) and exports of previously traded goods (the intensive margin). The analysis complements earlier work along these lines focused on the transmission of country-specific shocks (Cavallari and D’Addona, 2015).

The econometric methodology consists of a panel vector autoregression with exogenous factors (panel VARX for short). Data are measured on a country pair basis, and consider 22 developed economies over the period 1988–2011. The approach is based on pooling the information of different countries over time to derive the mean responses of the variables of interest to real and nominal shocks originating abroad. Specifically, the vector of endogenous variables includes output, the terms of trade and bilateral export margins. The exogenous variables vector, common to all units in the panel, comprises US output, US consumer prices, energy prices and the Federal funds rate. External shocks are identified by means of a recursive ordering of the exogenous variables, in which monetary policy has no contemporaneous effect on the other variables in the system. We show that the results are robust to an alternative identification strategy based on long-run restrictions. For the sake of imposing minimum restrictions and in accord with the scope of the analysis, which is focused on common shocks, country-specific shocks are left unidentified.

The model is estimated separately for countries that adopt a fixed exchange rate regime (110 country pairs for a total of 1597 yearly entries) and for countries with flexible exchange rates (374 country pairs for a total amount of 7076 yearly entries), using alternate criteria for the selection of these samples. To control for unobserved fixed effects in a dynamic panel data model, we use the bootstrap-bias corrected estimator, originally proposed by Pesaran and Zhao (1999) and Everaert and Pozzi (2007) and modified for use in our unbalanced panel as in Fomby et al. (2013). We then provide a formal test of the difference between the mean responses of peggers and floaters based on a bootstrap sampling as in Born et al. (2013).

The paper makes two main contributions. First, it provides new evidence in support of the stabilization properties of flexible exchange rates. Since Friedman (1953), an advantage typically attributed to flexible exchange rates is their ability to insulate the economy against real shocks. In a world with sticky prices, changes in the nominal exchange rate allow a quicker adjustment of relative prices and help smooth output. An empirical implication of this theory is that the responses to real shocks should differ across exchange rate regimes: flexible regimes should have smoother output responses and quicker adjustments in relative prices compared to fixed regimes. Advocates of

Fig. 1. Mean responses to a one-standard deviation US output shock in the model with extensive margins, for the sample of peggers (first row), the sample of floaters (second row), and the difference between the two samples (third row).
fixed exchange rates, on the other side, argue that exchange rate flexibility exacerbates macroeconomic volatility in the presence of nominal shocks. More importantly, it may discourage international trade. One of the major reasons for adopting fixed exchange rates, especially hard pegs, is their ability to promote trade. Recent studies document that fixed exchange rates have indeed a positive effect on trade of new products, i.e. on extensive margins. Fixed rates, however, may also increase the volatility of extensive margins (see Auray et al., 2012). This adds a new dimension to the old debate on exchange rate regimes, since the stabilization properties of a given regime may be affected by the extent to which trade adjusts at the extensive or at the intensive margin. We find that large movements at the extensive margin in the aftermath of shocks are associated with a weaker performance in terms of output stabilization. In fixed regimes, the responses of extensive margins are more than twice as large as in floating regimes, and the shocks have a stronger effect on output. A positive shock to external output, for example, leads to a cumulated increase in output of almost one percent higher in the sample of peggers than in the sample of floaters. The pattern is similar for all the shocks considered. Cavallari and D’Addona (2015) report a comparable elasticity in response to country-specific terms of trade shocks.

Second, the paper helps to bring to the data the predictions of models of the international business cycle based on firm entry. Cavallari (2013) shows that entry provides a channel for positive international comovements: a business cycle expansion in one country leads to the creation of new firms in the trading partner’s market. One should therefore observe a positive response of the extensive margin of trade to external output shocks. As far as we know, we are the first to document that this is indeed the case. In addition, these models suggest that exchange rate fluctuations may affect the extent to which exporters adjust trade at the extensive and the intensive margin. First-time entry in foreign markets and the creation of new products entail sunk costs that imply a much longer horizon and a greater exposure to exchange rate risk compared to investments at the intensive margin. Flexible exchange rate regimes should therefore be associated with smoother extensive margins. In the model of Bergin and Lin (2012), all of the adjustment occurs at the extensive margin when exchange rate uncertainty is completely and permanently eliminated. A comparison of responses in the samples of peggers and floaters confirms this prediction.

The remainder of the paper is organized as follows. Section 2 describes the data and presents the econometric methodology. Section 3 discusses the main results and Section 4 concludes. Appendix 4 contains detailed information on the data while Appendix 4 reports the responses estimated under the alternative strategy for the identification of shocks.

2. Empirical strategy

This section models the dynamics of output, the terms of trade and
export margins in a panel of 22 OECD economies over the period 1988-2011. Given the scope of the analysis, which is focused on the role of the exchange rate regime for the transmission of shocks, we contrast the mean responses of countries under fixed and under flexible regimes. We consider real and nominal shocks that originate abroad and hit all the countries at the same time. The hypothesis we want to verify is whether there are systematic differences in the extent to which output and trade margins react to global shocks depending on the exchange rate regime.

2.1. Data

We use annual data for 22×22 country pairs among OECD countries over the period 1988–2011. The frequency and the country selection reflect the limited availability of data on trade margins. The panel is unbalanced. It is split into two groups: peggers and floaters, where 110 country pairs are classified as peggers and the remaining 374 country pairs are floaters (see Table 3 in Appendix 4 for the list of peggers and floaters). For robustness purposes, we will refine the classification of floaters and peggers and consider country pairs where both countries are floaters, country pairs in the euro area, and country pairs that exclude energy producers.

Table 2 in Appendix 4 reports informations on the original series, the data source and the transformations applied. Macroeconomic data are from the OECD StatExtracts database. They comprise year-on-year GDP growth rates, inflation rates - measured by the GDP deflator - an index of US energy prices, and the Federal funds rate. The terms of trade are from the IFS-IMF database. These are defined as the price of a country’s exports towards the world divided by the price of its imports from the world. An increase in the terms of trade is therefore an appreciation.

Trade margins are from the UN Comtrade database. They are calculated from bilateral trade measures at the four-digit Standard International Trade Classification. Following Hummels and Klenow (2005), the extensive margin of exports from country j to country m is defined as:

\[ XM_{jm} = \frac{\sum_{i} I_{im} X_i^m}{X_m^w} \]

(1)

where \( X_i^m \) is the export value from the world to country m of category i, \( I_{im} \) is the set of observable categories in which country j has positive exports to country m, and \( X_m^w \) is the aggregate value of world exports to country m. The extensive margin is a weighted sum of country j’s exported categories relative to all categories exported to country m, where categories are weighted by their importance in world’s exports to country m. By construction \( XM_{jm} \) is comprised between 0 and 1, with higher values reflecting a larger variety of categories exported.

The intensive margin of exports from country j to country m is
GDP CPI Energy

is the vector of errors in the system. 

\[ \text{IM}_m = \frac{X_{mj}}{X_{m,j}} \]  

(2)

where \( X_{mj} \) is the total export value from country \( j \) to country \( m \). The intensive margin is the value of \( j \)'s exports to country \( m \) relative to the weighted categories in which country \( j \) exports to country \( m \). \( \text{IM}_m \) is defined between 0 and 1, where 0 means that country \( j \) has not previously exported to country \( m \), and higher values reflect a larger volume of exports within previously traded goods. By definition, the country \( j \)'s share of world exports to country \( m \) is given by the product of the intensive and extensive margins:

\[ S_{mj} = \frac{X_{mj}}{X_{m}} = XM_{mj} / \text{IM}_m \]  

(3)

The measurement implies that for a given level of a country \( j \)'s share in world exports to country \( m \), the extensive margin would be higher if country \( j \) exports many different categories of products to country \( m \) whereas the intensive margin would be higher if it only export a few categories of products.

2.2. The model

Consider the fixed-effect panel VARX model:

\[ Y_{j,m,t} = \delta_{j,m} + \beta(L)Y_{j,m,t-1} + \gamma(L)X_t + \epsilon_{j,m,t} \]  

(4)

where \( j \) = 1, 2, ... 22 denotes the exporting country, \( m \) = 1, 2, ... 22 with \( m \neq j \) denotes the destination country including the United States, and \( t \) is time. The 3×1 vector of stationary endogenous variables \( Y_{j,m,t} \) contains the terms of trade and output of the exporting country together with any one of the extensive or the intensive margin measured on a country pair basis, \( Y_{j,m,t} = (\Delta \log \text{TOT}_{jt}, \Delta \log \text{GDP}_{jt}, \text{XM}_{jt} / \text{IM}_{jt}) \), where \( \Delta \) denotes the first-difference operator. \( \alpha_{j,m} \) is a vector of country pair fixed effects; \( \beta(L) \) and \( \gamma(L) \) are matrix polynomials in the lag operator; \( X_t \) is a vector of external shocks that will be defined soon and \( \epsilon_{j,m,t} \) is the vector of errors in the system.

As mentioned above, the endogenous on which we focus our attention are output and trade margins. The terms of trade are included to control for heterogeneity among countries that have different capacity to affect prices in global markets.\(^8\) In addition, the terms of trade represent global factors that might influence the other endogenous in the system and omitting them can lead to serious estimation bias (see Forni and Reichlin, 1998). In our approach, they are meant to capture country-specific characteristics that may affect the way global shocks are transmitted: for example, the impact of energy price shocks may depend on whether a country is an oil exporter.

External shocks are obtained from a parsimonious VAR model of US macroeconomic variables:

\[ y_t = a + b(L)y_{t-1} + \epsilon_t \]  

(5)

where \( y_t \) includes US output, US consumer prices, energy prices and the Federal funds rate, i.e. \( y_t = (\Delta \log \text{GDP}_{jt}, \Delta \log \text{CPI}_{jt}, \Delta \log \text{Energy}) \),

\(^8\) Other measures of international competitiveness, as the CPI or GDP-based real exchange rates, have a non-tradable component which may be hard to relate with the export margins.
\( FFR_t \); \( \alpha \) is a vector of intercepts; \( b(L) \) is a matrix polynomial in the lag operator; and \( e_t \) is the vector of exogenous errors with variance \( \Sigma \) for all \( t \). Energy prices are included in vector \( y_t \) to capture variables that belong to the information set of the central bank and provide useful predictors of future inflation rates. It is well-known that omitting relevant information about expected inflation rates might cause a price puzzle, namely a counter-factual positive response of inflation after a rise in the policy rate.

The external shocks are identified by assuming a contemporaneous recursive ordering where exogenous variables are ordered as given in the definition of \( y_t \). This entails the assumption that US output does not react to a contemporaneous innovation in the Federal funds rate either directly or through the effect of the policy rate on energy and consumer prices. The Federal funds rate, on the contrary, reacts to a contemporaneous change in any other variable in the system. Zero contemporaneous restrictions are standard in structural VAR models (see Christiano et al., 1999). They are based on the premise that monetary transmission involves long and variable lags, in the range between one and six months. In our setup, the contemporaneous lag of one year may appear excessive. To address the problem, we consider an alternative identification strategy, based on long-run restrictions à la Blanchard et al. (1989). Specifically, we assume that only supply shocks have a persistent effect on output growth: an innovation to the Federal funds rate has no long-run effect on GDP growth either directly or through its effect on energy and consumer prices. A shock in any other variable in the system, on the contrary, has a persistent effect on the Federal funds rate. Three additional restrictions imply that inflation shocks have no long run effects on energy prices and output growth while both energy price and output shocks may have a persistent effect on inflation.

For the sake of imposing minimum restrictions and in accord with the scope of the analysis, which is focused on common external shocks, we leave country-specific shocks unidentified.

The model (4) is estimating assuming an homogeneous error structure where \( E(\epsilon_{jx,m,\epsilon_{jx,m}}) = \Omega \) for all \( j, m \) and \( t \) together with independence of the errors within and across equations, i.e. \( E(\epsilon_{jx,m,\epsilon_{jx,m}}' \epsilon_{jx,m,\epsilon_{jx,m}}) = 0 \) for \( s \neq t \) and \( E(\epsilon_{jx,m,\epsilon_{jx,m}}' \epsilon_{jx,m,\epsilon_{jx,m}}') = 0 \) for any \( s \) and \( t \) when \( j \times m \neq h \times n \). These assumptions are less restrictive than it might appear at first. Both variance homogeneity, i.e. the assumption that shocks of equal magnitude hit all the units in the sample, and the assumption that shocks are not correlated across countries are inconsequential for the scope of the analysis, which is focused on common shocks. On the methodological ground, the eventual bias in the estimated variance and covariance matrix is addressed by relying on bootstrap-based confidence intervals.

In our analysis, it is more important to allow for slope heterogeneity, so that countries may respond differently to the common shocks. In principle, each country pair might respond differently to each shock, implying \( 22 \times 22 \times 4 \) parameters to be estimated. A common solution to the curse of dimensionality considers heterogeneous slopes for groups of countries, while restricting slopes to be homogeneous within each group. The exchange rate regime provides a reasonable benchmark in the context of our study: a major advantage of floating exchange rates is that they help absorb external shocks. One

Fig. 5. Mean responses to a one-standard deviation shock to energy prices in the model with extensive margins, for the sample of peggers (first row), the sample of floaters (second row), and the difference between the two samples (third row).

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The exogenous VAR model is estimated over the period 1970–2011 for reasons of efficiency. We have checked that restricting the time span to 1988–2011 as in the VARX model, although providing less accurate estimates of the external shocks, does not affect the sign and significance of the responses. Results and diagnostic tests are available upon request.
might expect countries in floating regimes to adjust more quickly compared to countries with fixed exchange rates. We therefore divide our sample into peggers and floaters (see Appendix A for the list of peggers and floaters).

In the baseline regression, the group of “peggers” includes country pairs with a fixed exchange rate regime, i.e. to be included among the peggers both origin and destination countries must adopt fixed exchange rates according to the IMF de facto classification (see Born et al., 2013), which we extend to match our sample period. Specifically, we consider an exchange rate regime of “pegged within horizontal bands” or tighter as a fixed exchange rate (values of 1-7 in the fine classification). All remaining regimes are classified as floating exchange rates. The group of peggers contains European country pairs and reflects intra-EMU trade. The sample of “floaters” includes pairs with a flexible exchange rate, i.e. to be included among the floaters at least one country must adopt a flexible exchange rate regime in the IMF de facto classification. Note that for our sample the de facto classification gives an identical split as the IMF de jure classification.

The classification of the exchange rate regimes deserves further consideration. The dichotomous classification we use can be criticised on the ground that it overlooks intermediate regimes and possible non-linear effects of exchange rate variability. Unfortunately, the structure of our panel, which is based on country pairs, does not lend itself easily to a finer classification. How would one consider a country pair where one country adopts, say, a hard peg and the other country a soft peg? A solution would be to construct country pairs where both countries adopt the same regime (hard peg, soft peg, or dirty float and so on) vis à vis a reference currency. Using the classification proposed by Levy-Yeyati and Sturzenegger (2005), we have constructed samples where both countries adopt a given regime vis à vis the same reference currency. In our panel, only 14 entries are classified as dirty floats, 32 are classified as crawling peg and 48 entries peg their currency vis à vis a currency basket. All remaining pairs are either purely floats or hard peggers. The fact that country pairs with intermediate regimes represent a small proportion in our panel raises our confidence that the bias eventually introduced by non-linear effects is reasonably small.

In addition to intermediate regimes, concerns might be raised about the dichotomous classification itself. One might question in fact that not all country pairs classified as floaters (peggers) are genuinely floaters (peggers). For example, we have classified as peggers all countries in the European monetary system, even if some of these countries have devalued their currency to a large extent. To address these concerns, we propose a thorough sensitivity analysis. First, we refine the sample of floaters so as to include only country pairs where both countries are floaters. In this way, we tackle the ambiguity in the classification of a country pair in which one country pegs with a third country. For example, when the pegger is the exporting country, exporters might use the third country as an export platform to insulate bilateral trade from exchange rate variability. Analogously, in the destination country importers can hedge against exchange rate risk by using the third country as an import platform. Second, we restrict the sample of peggers to hard pegs by considering country pairs where both countries adopt the euro.

Eq. (4) can be re-written as follows:

\[ Y_{r,j+1} = \alpha_{r,j} + \beta_{r,j}(L)Y_{r,j-1} + \gamma_{r,j}(L)X_{j} + \epsilon_{r,j+1} \]

where \( r = P \) or \( F \) indicates a regime of pegged or floating exchange rates. For each regime \( r \), we estimate the model with country pair fixed
effects. Over a short time span, this framework provides a convenient balance between pooling diverse information from all countries and controlling for heterogeneity across country groups. We test the null of parameter homogeneity assumed in Eq. (4) against the alternative assumed in Eq. (6) with a bootstrap sampling of the difference between the mean responses of peggers and floaters as in Born et al. (2013).

After controlling for fixed effects, i.e. \( Y_{it} = \sum_{j=1}^{J} \alpha_i X_{jt} + \epsilon_{it} \), the multiplier form of the model can be written as:

\[
Y_{j,1,t; \beta; L; \gamma; L} = (I - \beta' L)^{-1} \gamma' (I - \beta' L)^{-1} \epsilon_{j,1,t}. \tag{7}
\]

We are interested in the mean responses in regime \( r \), given by the lag polynomials \( (I - \beta' (L))^{-1} \gamma' (L) X_t \). These polynomials are estimated with the bootstrap-bias corrected estimator (BSBC) proposed by Pesaran and Zhao (1999) and Everaert and Pozzi (2007) and modified for application to our unbalanced panel as in Fomby et al. (2013). The correction is necessary to address the inconsistency of the least-squares dummy variable (LSDV) estimator, or within (fixed-effect) estimator, which is a well-known problem in dynamic models with small \( t \) (see Nickell, 1981). The bootstrap strategy is appealing for a number of reasons. First and foremost, it does not require assumptions about the data generation process as it would be the case with analytical corrections. Specifically, the analytical corrections assume a priori knowledge about the short-run coefficients of the model that may be hard to justify. Second, the bootstrap approach provides a direct correction of the mean responses, with no need to rely on the estimators of the short-run coefficients.

2.3. Diagnostic tests

The model in the previous section rests on the assumption of stationarity. We therefore need to determine the stationary form of the variables that will be used. To this end we perform individual and panel unit root tests on the following variables: the log of output, the log of the terms of trade, the level of external and internal margins, the level of the Federal funds rate and the log of energy and consumer prices. We use the log transformation whenever possible for two reasons. The first is its variance stabilizing property. The second is that if a logged variable has a unit root, its first difference has a straightforward interpretation as percentage change.

The individual unit root tests are the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test applied on a series-by-series basis. The panel unit root test is the Im et al. (2003) test based on ADF regressions in a panel fixed-effect model as in Levin et al. (2002). All these tests depend on the specification of the deterministic part of the autoregressive equations. We verify the presence of a trend by testing the significance of the intercept in the following AR(2) equation for each variable \( Z \), country by country:

\[
\Delta Z_t = \alpha + \phi Z_{t-1} + \phi_i \Delta Z_{t-1} + \epsilon_t.
\]

When the null \( H_0: \alpha = 0 \) is not rejected, we conclude that the data do not have a time trend. This is true for extensive margins, intensive margins and the Federal funds rate. The null is rejected for the remaining variables. Therefore, in applying the unit root tests we include a trend for output, terms of trade and prices. In the other cases, the ADF equations include an intercept.

Individual unit root tests could not reject the existence of a unit root for output, the terms of trade and prices in almost all countries, while the hypothesis of a unit root is rejected when the first difference of these variables are considered. The panel unit root tests confirm these indications (see Table 1).
We therefore conclude that output, terms of trade and prices are I(1). Individual and panel unit root tests allow to reject the null hypothesis of a unit root in all remaining data. We conclude that extensive margins and intensive margins are I(0). For the Federal funds rate the tests are inconclusive and we cannot exclude the unit root.

The presence of non-stationary variables raises the question whether an error correcting specification, i.e. a VECM model, might be appropriate for describing the dynamics in the data. A linear combination of output and the terms of trade, the cointegrating vector, might be stationary implying the existence of a long-run relation between these variables. We provide a formal test of cointegration for output and the terms of trade in the VARX model based on the Westerlund ECM panel cointegration test (Westerlund, 2007). The null hypothesis of no cointegration could not be rejected against the alternative hypothesis that a cointegrating relation between output and the terms of trade exists for at least one country in the sample\(^{10}\). Consequently, estimating the VARX model in first differences for output and the terms of trade without imposing any cointegrating relation between these variables is a good approximation of the data generation process. The presence of variables in both levels (the trade margins) and differences (output and the terms of trade) requires caution in the interpretation of the results. A value of the coefficient in the mean response of output equal to, say, unity implies a one percent change in output in response to the shock. The same value for the coefficient of the trade margin, instead, means a change in the level of the margin.

Finally, we use the Akaike Information Criterion (AIC) and the Schwartz’s Bayesian information criterion (SBC) to determine how many lags of the dependent and the exogenous variables need to be included. In all panels, these criteria suggest including either one or two lags. We use a parsimonious one-lag specification for our VARX model, though we checked that using two lags would not lead to different conclusions. For the exogenous VAR model, standard criteria suggest including 2 lags.

3. Results

We now discuss the main results on the impact of external shocks. The presentation is organized by type of shock: a real shock is a one-standard deviation increase in US output growth, a monetary policy shock is a one-standard deviation increase in the Federal funds rate and the energy price shock is a one-standard deviation increase in energy inflation (we overlook US inflation shocks). For each of them, we consider the dynamic effect on output, terms of trade and export margins separately for the samples of peggers and floaters.

Since we are interested in tracing out the dynamic path of adjustment in the aftermath of the shocks, we consider the mean responses for each year since the shock occurred. As explained before, these responses combine the conditional effects of the shocks on the dependent variables - given by the polynomials \( r(L) \) - and the

\(^{10}\) The \( G_c \) statistic of \(-8.22\) strongly supports the null of no cointegration for at least one of the cross-sectional units. The \( P_c \) statistic of \(-27.22\), which pools information over all the cross-sectional units, provides evidence in favor of the absence of cointegration for the entire panel.
variables’ own autoregressive process - the polynomials $\beta^t(L)$. Since the effects of the shocks die out in approximately 6 years we consider the responses for years 0 to 6. In addition, we report the 10th and 90th percentiles of the distribution of the responses generated by Monte Carlo simulations with 1000 replications, to indicate a 90% confidence interval.

Figs. 1 and 2 show the mean responses to real shocks together with 90% bands for the model with, respectively, extensive and intensive margins. Fig. 3 and 4 and Figs. 5 and 6 do the same for shocks to, respectively, monetary policy and energy price. In each figure, the first row refers to the sample of peggers, the second row to the sample of floaters while the third row shows the difference between the responses of peggers and floaters.

External output shocks are expected to have positive spillovers through the trade channel: a business cycle expansion in the US leads to higher US imports, which in turn boost demand and output in US trading partners. In principle, output spillovers may be associated with any combination of extensive and intensive margins. In models with a fixed number of firms, all of the adjustment takes place at the intensive margin, with exporters increasing the volume of previously traded goods. We should therefore observe a positive response of intensive margins. Entry models predict that exporters will react to a favourable business environment by creating new products and trading previously non-traded goods. The expected response of extensive margins is positive. In these models trade of new products may come at the expense of previously traded goods: when a large number of new firms enters the market the average size of incumbents may decline. As a consequence, the response of intensive margins may turn negative. As it will be clear soon, adjustment to output shocks seems to take place mostly along the extensive margin and particularly so in fixed exchange rate regimes.

The response of the terms of trade is in principle ambiguous as it depends on the extent to which US output shocks affect the price of US imports, the price of substitutes of US exports and US dollar exchange rates. All these effects in turn depend on the structure of trade of each country with respect to the US and the rest of the world. In general, lower prices in the US tend to depreciate the terms of trade of countries that export substitutes of US exports while having the opposite effect for countries that mostly import from the US. In flexible regimes, an appreciation of the US currency may exacerbate or dampen the movements in the terms of trade depending on the degree of exchange rate pass-through. Consider for instance a situation where prices are set in the currency of consumers and are independent of exchange rate changes. The nominal appreciation will have no effect on the price of imports from the US once these are expressed in a country’s domestic currency, while decreasing the domestic-currency price of exports toward the US. Hence, the appreciation tends to amplify (dampen) the fall (rise) in the terms of trade of US competitors. The opposite is true when prices are set in the currency of producers and exchange rate pass-through is complete.

US monetary policy shocks have two opposing effects on the trade channel. First, a monetary tightening in the US reduces US imports (the income effect), thereby generating negative spillovers abroad. Large spillovers can materialize in countries for which the US represent a major export market. Second, the appreciation of the US dollar makes US products less competitive in global markets and switches world demand towards the products of US trading partners (the substitution effect). Spillovers may well be positive in this case. Which one of these two effects prevails depends on the elasticity of demand for US imports and for the substitutes of US exports as well as on the relevance of US products in a country’s overall trade. For given elasticities, the larger the share of substitutes of US products in a country’s trade the larger the substitution effect. As we will see, there are remarkable differences in the transmission of US monetary policy shocks in our samples of peggers and floaters.

An increase in the price of energy has negative macroeconomic effects for all countries, except for energy producers. Since a limited number of country pairs involving energy producers are included among the floaters, we expect their presence will have a negligible impact on the mean responses across samples. Later on, we will investigate the impact of energy producers for the mean responses within the sample of floaters.

In what follows, we report the impulse responses obtained under the recursive identification of the shocks. We have checked that using the alternative identification based on long-run restrictions does not affect the quality and significance of the responses (Appendix 4 reports the impulse responses under the alternative identification).

### 3.1. Real shocks

An increase in US output has positive output spillovers as expected. The mean responses of output in Figs. 1 and 2 are high on impact, then they gradually decline and die out completely after three years. The cumulative increase in output is about 2 percent on average in both models.

The mean responses of extensive margins are positive and fairly persistent for both peggers and floaters. A positive coefficient of the impulse response indicates an increase in trade of new products over the average level that prevailed before the shock. Qualitatively, the responses are similar across the samples, and all of them are hump-shaped with a peak after 18 months. The dynamics portrayed in Fig. 1 is consistent with the predictions of international business cycle models with firm entry. As pointed out by Cavallari (2013), entry of new firms generates positive comovements across countries: a business cycle expansion in one country leads to export of new products (i.e., a rise in the extensive margin) in the trading partner’s market. Moreover, the presence of a hump accords with the idea suggested in these models that adjustments at the extensive margin entail time-varying trade-offs.

Comparing the samples of peggers and floaters reveals a number of interesting features. First, the mean response of output is higher among peggers than among floaters: the difference in the cumulative response is as large as 0.78 (0.79) percent in the model with extensive (intensive) margins. This accords with the Friedman’s hypothesis that flexible exchange rates help to smooth output in the wake of real shocks.

Second, adjustment seems to occur mainly at the extensive margin in fixed regimes. The mean response of the extensive margin in the sample of peggers is more than twice as large as the response among floaters. In addition, the intensive margin falls below the pre-shock level in the sample of peggers, indicating a fall in the average size of trade of previously traded goods. The combined effect of more trade of new products and less trade of mature products is consistent with the notion emphasized in Cavallari and D'Addona (2016) that fixed rates may favour relocations toward sectors producing new varieties. We cannot, however, say which sectors are involved and what are the consequences for the composition of trade and the comparative advantage of a country. For this purpose, data on trade margins at the sectoral level are needed.

Other studies have argued that trade grows mostly along the extensive margin in fixed regimes, because the absence of exchange rate risk reduces the sunk costs of first-time entry in foreign markets and provides a strong incentive to invest in new trade relations (Bergin and Lin, 2012). A novel contribution of our analysis is to clarify that this may come at the expense of output stabilization. A, say, business cycle expansion abroad implies positive output spillovers in any exchange rate regime. Yet in the sample of peggers, the effect is larger because trade adjusts mainly at the extensive margin and implies a switch away from previously traded goods that is absent in floating regimes. Adjustment at the extensive margin, in fact, involves invest-
ments in new production capacity and has by its own nature more persistent effect than investments within a given capacity. The finding that exchange rate flexibility smooths the fluctuations of trade of new products strengthens the traditional argument in favour of the stabilization property of flexible regimes.

Now consider the responses of the terms of trade. In the sample of peggers, the terms of trade depreciate on impact, then gradually appreciate before reverting to the trend in approximately 2 years. The terms of trade of floats move in the opposite direction. Since all countries in our dataset have flexible exchange rates with the US dollar, these responses reflect the pattern of trade that characterizes the countries included in the samples of peggers and floats. In order to see the point, consider an appreciation of the US dollar. US products become less competitive in global markets and the terms of trade of countries that export substitutes of US products will tend to improve. By the same token, the appreciation will deteriorate the terms of trade of countries that import substitutes of US products. Which one of these opposing effects prevails on average (i.e., the sign of the mean response) depends on the structure of trade of the countries included in a given sample. In the sample of peggers, for instance, a negative response of the terms of trade indicates that European countries mainly import goods that are substitutes of US products and export goods that are complements of US products.

In order to gauge the relevance of the exchange rate regime for the estimated dynamics, the last rows in Figs. 1 and 2 depict the difference in the mean responses of peggers and floats together with the corresponding confidence intervals. The bands are computed using the 90th and 10th percentiles of the distribution of the difference in the impulse responses in 1000 replications. The dynamics vary significantly across regimes. As regards the terms of trade, the responses of peggers and floats are heterogeneous on impact, then they rapidly converge and become almost indistinguishable after 18 months. This is far from a surprise: the advantages of flexible exchange rates hinge on their ability to affect relative prices when nominal prices are sticky. Over time, as prices adjust, the impact of exchange rate flexibility becomes negligible. The differences in the responses of output and trade margins, on the contrary, are persistent up to 5 years.

3.2. Nominal shocks

To start with, consider monetary policy shocks (Figs. 3 and 4). A monetary restriction in the US - i.e. an unexpected increase in the Federal funds rate - has positive output spillovers in the model with extensive as well as in the model with intensive margins. As already discussed, this reflects a shift of world expenditure towards substitutes of US products (the substitution effect) that outweighs the fall in US imports (the income effect).

Comparing the mean responses across exchange rate regimes reveals interesting insights on monetary transmission. Output spillovers are higher in the sample of peggers than for floats. This stands in contrast with the view that fixed exchange rates help to smooth the effects of nominal shocks: since Poole (1970) an advantage typically attributed to fixed exchange rates is their ability to insulate the economy from external nominal shocks. As it will be clear soon, we suggest an alternative explanation based on the capacity of flexible exchange rates to smooth trade at the extensive margin.

As a matter of fact, Figs. 3 and 4 show remarkable differences in the pattern of trade across the two samples. First, the US monetary restriction depreciates the terms of trade of peggers vis-à-vis the rest of the world, making their products more competitive in global markets. This in turn switches world expenditure towards the exports of peggers and contributes to increase their output spillovers. The opposite occurs for floaters.

Second, the responses of both margins in the sample of floaters are not significantly different from zero for most of the transition. In the sample of peggers, on the contrary, there is a sharp and persistent decline in trade of new products and previously non-traded goods (Fig. 3) and a moderate fall in the volume of previously traded goods (Fig. 4). Considering that the sample of peggers includes countries in the Euro area, these findings suggest a shift away from new products in intra-EMU trade. In other terms, a US monetary restriction generates a negative variety effect in intra-EMU trade. The fact that monetary policy may alter the attractiveness of investing in new products compared to producing existing goods is a well-established result in models with firm entry. Moreover, these models predict strong effects in fixed regimes. In line with this argument, we document that trade of new products provides an important channel of international monetary transmission in fixed exchange rate regimes.

As before, the responses in the last row of Figs. 3 and 4 show that the dynamics of the model under fixed and floating regimes are significantly different.

Finally, consider energy price shocks (Figs. 5 and 6). All variables respond negatively as is expected. Output spillovers are as large as -0.15% in the sample of peggers while they are not significantly different from zero in the sample of floats. As before and for the motives already discussed, large output spillovers are associated with an extreme reactivity of the extensive margin of trade.

3.3. Alternative samplings

To shed further light on the impact of our classification of the exchange rate regime, we estimate the model in subSection 2.2 under three alternative sample selections.

The first group, labelled "European Union", refines the baseline sample of peggers by considering only country pairs where both countries adopt the euro. The sample starts in 1999 and contains 1133 entries. The refinement is meant to capture a strict interpretation of a fixed regime, and explore the behavior of trade margins after the adoption of the euro. We should observe an even stronger response of the extensive margin among euro-zone countries.

The second group, labelled "full floaters", excludes from the original sample of floaters any pair where one of the two countries is classified as a "pegger" (the sample contains 2592 entries). The purpose is to verify the robustness of our results to a finer classification of floaters. In particular, we want to verify whether the exclusion of peggers vis-à-vis a third country has the expected effect of smoothing the responses to global shocks.

Finally, the group "no energy" tackles the concern that the terms of trade of energy exporters - which are particularly volatile - may influence the mean responses and make their interpretation ambiguous, especially in our original sample of floaters that includes both energy exporters and importers. The group "no energy" therefore excludes country pairs where one of the country is a major energy exporter, identified on the basis of the ranking of the U.S. Energy Information Administration. It contains 5748 entries.

The mean responses of extensive and intensive margins are reported in Figs. 7 and 8, respectively, where shocks are organized by columns while country groupings are reported by rows.

Under all alternative groupings, we find that adjustment to real shocks occurs mainly at the extensive margin in fixed regimes. The

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11 These confidence intervals reflect differences in the variance of the estimated coefficients equation per equation (i.e., differences in the structure of variance between floaters and peggers) as well as across equations (i.e. difference in the covariance structure between floaters and peggers). See Born et al. (2013) for details on the bootstrapping method.

12 We exclude Australia, Canada, Mexico, and Norway. Data are available at http://www.cia.gov/

13 To save space, we only show the responses of trade margins. The responses of the other variables are available upon request.
mean response of the extensive margin in the euro-area sample is by far the largest: it is more than twice as large than in the “no energy” group, while that of the full floaters is almost zero. In addition, the level of the mean response, 0.56 on average, is almost three times higher than in the original sample of peggers, 0.19. These facts confirm the intuition given before that fixed regimes, and very hard pegs in particular, induce large movements at the extensive margin because they reduce the exchange rate risk over the long horizon. We can also confirm that more variability of the extensive margin is associated with more output variability: the mean response of output in the euro-area is 1% higher than in the samples of “full floaters” and “no energy” (not shown in the Figures). In departing from the baseline sampling, we find no evidence of relocation effects: the intensive margin increases in the euro area, albeit much less than the extensive margin. In addition, the response is stronger than in the other groupings considered.

Qualitatively, the responses are similar to those in the baseline classification also for what concerns nominal and energy price shocks. Excluding energy exporters from the floaters has the effect of amplifying the responses of both extensive and intensive margins, while not affecting the ranking of these responses across regimes.

4. Conclusions

This paper has studied the dynamics of output and export margins in the wake of external shocks in fixed and floating exchange rate regimes. The objective of the analysis is twofold. First, it verifies the predictions of international business cycle models with firm entry about the behaviour of export margins over the cycle and across exchange rate regimes. Second, it re-assesses the stabilization properties of flexible exchange rates when trade adjusts at the extensive and at the intensive margin.

Using a panel VARX model, the paper traces the mean responses of output, terms of trade and export margins to real and nominal external shocks in twenty-two developed economies over the period 1988–2011. We find remarkable differences in the transmission of shocks depending on the exchange rate regime. The mean responses of output are larger in the sample of peggers than in the sample of floaters, in accord with the Friedman hypothesis, and independently of the type of shock considered. Moreover, adjustment takes place mainly at the extensive margin in fixed regimes. These finding are robust to alternative samplings of the peggers and floaters.

The evidence in the paper has important implications for the desirability of exchange rate flexibility. The fact that adjustment at the extensive margin is accompanied by large output fluctuations in fixed regimes strengthens the case for exchange rate flexibility. In this sense, we stress a novel advantage of flexible rates based on their ability to smooth the fluctuations in trade of new products. Adjustment at the extensive margin, however, may have consequences that go well beyond the short and medium run, and imply production relocations toward sectors that produce new products and previously non-traded goods. The opposite behavior of intensive and extensive margins that we find in fixed regimes is in principle consistent with these relocations, although we cannot say which sectors are involved nor what are their long term consequences. Providing evidence along these lines and gauging the effect of exchange rate flexibility for the composition of trade are promising avenues for future research.

Appendix A

A.1. Data

See Table 2.

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<thead>
<tr>
<th>Original series</th>
<th>Source</th>
<th>Data transformation</th>
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<tbody>
<tr>
<td>Nominal GDP, all countries</td>
<td>OECD.StatExtracts</td>
<td>Log difference after deflating with the GDP Deflator</td>
</tr>
<tr>
<td>GDP Deflator, all countries</td>
<td>OECD.StatExtracts</td>
<td>None</td>
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<tr>
<td>Export Price index, all countries</td>
<td>IFS-IMF database</td>
<td>Used to calculate the Terms of Trade</td>
</tr>
<tr>
<td>Import Price index, all countries</td>
<td>IFS-IMF database</td>
<td>Used to calculate the Terms of Trade</td>
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<tr>
<td>Trade Margins, all countries</td>
<td>UN Comtrade database</td>
<td>None</td>
</tr>
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<td>FRED, Federal Reserve Economic Database</td>
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</tr>
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<td>US CPI Index</td>
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<td>Log difference</td>
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<tr>
<td>US Energy Price Index</td>
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<td>Federal Fund Rate</td>
<td>FRED, Federal Reserve Economic Database</td>
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A.2. Peggers and floaters

See Table 3.
Appendix B VARX with long run restrictions

B.1. Real shocks

Fig. 9 Fig. 10.

Table 3

<table>
<thead>
<tr>
<th>Peggers</th>
<th>Floaters</th>
</tr>
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<tbody>
<tr>
<td>Belgium</td>
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<tr>
<td>Denmark</td>
<td>Canada</td>
</tr>
<tr>
<td>Finland</td>
<td>Czech Republic (After 1993)</td>
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<td>France</td>
<td>Iceland (After 2001)</td>
</tr>
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<td>Germany</td>
<td>Japan</td>
</tr>
<tr>
<td>Iceland Before 2001</td>
<td>Mexico</td>
</tr>
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<td>New Zealand</td>
</tr>
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<td>Spain</td>
<td>Switzerland</td>
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<tr>
<td>United Kingdom</td>
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</tr>
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</table>

Fig. 9. Mean responses to a one-standard deviation US output shock in the model with extensive margins and long run restrictions. The first row refers to the sample of peggers, the second row to the sample of floaters and the third row is the difference between the two samples.
Fig. 10. Mean responses to a one-standard deviation US output shock in the model with intensive margins and long run restrictions. The first row refers to the sample of peggers, the second row to the sample of floaters and the third row is the difference between the two samples.
B.2. Nominal shocks

Fig. 11 Mean responses to a one-standard deviation increase in the FFR in the model with extensive margins and long run restrictions. The first row refers to the sample of peggers, the second row to the sample of floaters and the third row is the difference between the two samples.
Fig. 12. Mean responses to a one-standard deviation increase in the FFR in the model with intensive margins and long run restrictions. The first row refers to the sample of peggers, the second row to the sample of floaters and the third row is the difference between the two samples.
B.3. Price shocks

Fig. 13 Mean responses to a one-standard deviation shock to energy prices in the model with extensive margins and long run restrictions. The first row refers to the sample of peggers, the second row to the sample of floaters and the third row is the difference between the two samples.
Fig. 14. Mean responses to a one-standard deviation shock to energy prices in the model with extensive margins and long run restrictions. The first row refers to the sample of peggers, the second row to the sample of floaters and the third row is the difference between the two samples.

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