Hysteresis in exports – Empirical evidence and policy conclusions for the Euro Area

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Hysteresis

- Relations between economic variables often characterised by initial conditions and the past realizations of economic variables matter.

- i.e. past (transient) exogenous disturbances and past states of the economic system do have an influence on the current economic relations.

- Typical examples are the dynamics of (un)employment in business cycles and the dynamics of the nexus between exchange rate and exports.

- Since the standard characteristics of hysteresis apply – i.e. permanent effects of a temporary stimulus, resulting in path-dependent multiple equilibria – these economic phenomena are correctly titled as “hysteresis”.
Hysteresis II

- Empirical research in economics is using **different methods** in order to capture path-dependent effects.
- First econometric approaches tried to describe these effects by simple time-series processes with **unit-(or zero)-root dynamics**.
- However, since unit-root-dynamics are not related to genuine multiple equilibria but on the order of integration of time series, these first attempts were **expanded by more sophisticated time-series models** integrating structural breaks, threshold-cointegration or non-linear autoregressive distributed lag-models.
Hysteresis III

- Another branch of empirical studies tries to keep closer to the original concept of the macro-loop, trying to apply an explicit Mayergoyz-Preisach aggregation procedure ...

- ... for heterogeneous firms – if microeconomic information is available based on panel-data – or by using simple algorithms analogous to mechanical-play in order to apply simple OLS-regression methods on a filtered/transformed input-output relation.

- Challenge: incorporating uncertainty
Motivation

• Frequent concern about the external value of the Euro
• It is important to assess whether and when the euro may be “too strong” for a specific euro area member.
  – Pain thresholds

➢ This paper focuses on Greece and the eminent question of the necessary internal devaluation (“weak enough”).
  – Export triggers

➢ Background: own studies on the “Efficiency of the Troika in Greece” for the European Parliament, the European Court of Auditors and the Mercator Foundation.
Motivation II

- In our extension, we intend to answer the question concerning the existence of **hysteretic effects under uncertainty** in foreign trade and assess their **empirical relevance** for Euro Area (EA) member countries’ exports.


Motivation (the Varoufakis graph)

Figure 1 – Real exchange rate and Greek chemical goods exports to the Euro Area

Source: Quarterly data, own calculation based on Eurostat (SITC 4) and OECD data.
Weak reaction of Greek exports

- Hedging of exchange rate uncertainty
- Greek export product line and price elasticity of exports
- Pricing-to-market by Greek exporting firms
- **Sunk market entry or/and exit costs**
- Financial constraints of exporting firms (and interplay with political uncertainty, correlated with financial uncertainty)
- **Structural problems** with upper secondary education (in Northern Greece, see Mercator study Belke/Gros/Christodoulakis)
Hysteresis – “Band of Inaction”

• Hysteresis occurs in a market with sunk **entry** costs (Baldwin 1989, 1990).

• Firms willing to enter the market have to make an **irreversible** investment.

• Expenses cannot be retrieved → sunk costs!

• If home currency is **depreciating**:
  – Entering markets becomes more profitable.
  – Later appreciation may still lead to profitable sales.

• And the other way round for **exit** costs and **appreciation**!
Discontinuous **micro** hysteresis loop: export activity of a single firm

- “Pain threshold” versus “export trigger”
- Non-ideal relay, analogous to the magnetism of a single iron crystal
- Adding uncertainty widens the “band of inaction”.
Exchange rate uncertainty: 'band of inaction' at microeconomic level

state of activity of an exporting firm $j$

- active
- inactive

$\beta_j$ (exit)

$\alpha_j$ (entry)

option value of delaying exit

option value of delaying entry

sunk exit costs

sunk entry costs

variable unit costs of firm $j$

band of inaction under certainty

under uncertainty

$e_t$

exchange rate (home currency price of foreign exchange)
Hysteresis in exports: ‘band of inaction’

- On a **microeconomic** level hysteresis occurs via a band of inaction, i.e. differences between both trigger/thresholds.

- Band-of-inaction will be **the wider, the lower the demand elasticity** is, the **higher** the absolute values of the are and the **higher the uncertainty** about the future situation of the exporter is.

- Belke and Goecke (2005) focus on shape and location of **macroeconomic** hysteresis loop, i.e. on aggregation problem.

- **Aggregation is not trivial** if heterogeneity regarding the value of sunk exit/entry costs and/or the level of uncertainty about the future market situation and/or the elasticity of demand is taken into account, ...
Hysteresis in exports: ‘band of inaction’ II

- i.e. if the entry and exit trigger exchange rates are different for a variety of exporting firms.

- In this (realistic) case of heterogeneity, the transition from the micro to the macro level leads to a change of the hysteresis characteristics: ...

- The aggregate hysteresis loop shows no discontinuities (as known from ferro-magnetics).

- However, a pattern not very different from a “band of inaction” remains.
Hysteresis in exports: ‘band of inaction’ III

- Belke and Goecke (2005) show that even the macro behaviour can be characterized by areas of weak reactions which are – corresponding to mechanical play – called “play”-areas.

- For play hysteresis, see Krasnosel'skii and Pokrovskii (1989).

- Persistent aggregate (export) effects do not result from small changes in the forcing (exchange rate) variables, as long as the changes occur inside a play area.

- However, if changes go beyond the play area, sudden strong reactions (and persistence effects) of the output variable (i.e. exports) occur.
Hysteresis in exports: ‘band of inaction’ IV

- The specific realization of the exchange rate which materializes instantly after the complete passing of the play area can be denoted as a “pain threshold” or (as in our case = devaluation) “export trigger”), ...

- ... since, having passed this realisation of the exchange rate, the reaction of exports to changes in the exchange rate becomes much stronger.
Macroeconomic play-hysteresis is in two aspects different to the micro-loop.

First, the play-loop shows no discontinuities.

Second, analogous to the play in mechanics (e.g. when steering a car) the play area is shifted with the history of the forcing variable (exchange rate): ...

... Every change in the movement of the forcing variable starts with traversing a play area. Only after the play is passed, a spurt reaction will result, if the forcing variable continues move in the same direction.
In the following, a straightforward **empirical framework** to test for a **play-type** impact of the exchange rate on exports is presented.

We adopt an **algorithm** developed in Belke and Goecke (2001) to describe play-hysteresis and implement it into a regression framework.
A linear approximation of exchange rate impacts on exports
To conclude ...

(1) Sunk entry (e.g., hiring) and exit (e.g., firing) costs result in a wedge between the exchange rate that leads to an entry or an exit of a potentially exporting firm

⇒ microeconomic response of a single firm to exchange rate changes is non-linear and discontinuous (entry/exit)
   (→ multiple equilibria and path-dependence)

⇒ aggregation to macroeconomic scope non-trivial with heterogenous firms

⇒ application of an adequate aggregation procedure
   (⇒ result: macro behaviour qualitatively different from micro reaction)

Introduction of uncertainty

(2) Uncertainty (i.e. volatility of XR or policy uncertainty) and option to decide (entry/exit) in the future
⇒ risk is limited by a "wait-and-see"-strategy
⇒ uncertainty generates an option value of waiting
⇒ wedge between entry and exit XR is widened

(1) & (2): Effects of uncertainty on the macroeconomic level under application of adequate aggregation procedure
⇒ modification of macroeconomic reaction to XR changes!
Exchange rate uncertainty and exports: 'band of inaction' at micro level gets larger

→ Certainty:
  • *Previously non-active firm* (potentially exporting)
    → depreciation (e↑)
    ⇒ unit revenue rises beyond variable unit costs
    ⇒ entry into foreign market
      if *sunk entry/hiring costs* are covered
  • *Previously active firm* / appreciation (e↓)
    ⇒ exit if losses exceed *sunk exit (e.g., firing)* costs
Exchange rate uncertainty and exports: 'band of inaction' at micro level

Figure 4: Microeconomic level (single firm j) - hysteresis-loop is a non-ideal relay state of activity of an exporting firm j

- Active state
- Inactive state
- Band of inaction
- Under certainty
- Under uncertainty
- Exit variable of unit costs of firm j
- Entry sunk entry costs
- Option value of delaying exit
- Option value of delaying entry

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Exchange rate uncertainty and exports: 'band of inaction' at micro level II

- Implications of uncertainty (generated by XR volatility)
  - **Uncertainty** and feasibility to delay an “investment”
    ⇒ firm owns an **option to wait** (enter/exit in the future)
    ⇒ limits risk downward
  - **Previously non-active firm** (potentially exporting):
    - currently: devaluation of the home currency
    - decision: **enter now** or stay inactive (option to **enter later**)
    - but XR may fall in the future
    - "wait-and-see" avoids danger of an overhasty action
      ⇒ generates **option value of waiting**
    - entry (e.g., hiring) in t "kills" this option value
    - for immediate entry:
      revenue must cover sunk costs plus option value
    ⇒ **entry-trigger \( \alpha_j \) rises**
Exchange rate uncertainty and exports: 'band of inaction' at micro level III

- *Previously active firm:*
  - current appreciation (chance of future depreciation)
  - exit kills option to exit later
  - for immediate exit:
    temporary period $t$ losses must exceed exit (e.g., firing) costs

$\Rightarrow$ exit-trigger $\beta_j$ falls
Macro level: an aggregation approach

- **Aggregation of heterogeneous firms**
  
  \[ \text{MAYERGOYZ} \ (1986); \text{AMABLE et al} \ (1991); \text{CROSS} \ (1994) \]

- Firms are represented by different $\alpha_j/\beta_j$-points in $\alpha/\beta$-plane ($\alpha_j > \beta_j$ for firms with sunk costs $\Rightarrow$ in triangle above 45°-line)

In accordance with:


Macro level: an aggregation approach II

Figure 5: Active (heterogenous) firms and volatile XR (AB and BC)

(a) ascending exchange rate  (b) descending exchange rate

entry trigger XR  exit trigger XR

\[ S_t^+ \]

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Macro level: an aggregation approach III

Figure 5: Active (heterogeneous) firms and volatile XR (CD and DE)

(c) again increasing XR

(d) again decreasing XR
Macro level: an aggregation approach (without uncertainty)

Figure 6: (Continuous) macro EXR-exports hysteresis-loop

Pattern similar to the well known hysteresis-loop of an entire piece of iron

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Aggregation, 'play' and uncertainty on the macro level

Figure 7: Stylised initial situation without uncertainty (S+ path-dependent)
Aggregation, 'play' and uncertainty on the macro level II

- **Introduction of uncertainty:**
  ⇒ **outward shift** of entry/hire ($\alpha_j \Rightarrow$ upward) and exit/fire ($\beta_j \Rightarrow$ leftward) triggers, dependent on the degree of uncertainty

  ⇒ ($\alpha_j,\beta_j$)-combinations are **north-west-projected**
  [exception: non-hysteretic firms without sunk costs on $\alpha=\beta$-line]
  (see Figs. 8 and 9)
Macro hysteresis under uncertainty

Figure 8: Active firms after introduction of uncertainty
Macro hysteresis under uncertainty II

**Figure 9:** Macro loop under uncertainty (includ. 'play')
Conclusions underlying empirical macro model

(1) **Micro level:** 'band of inaction':
passing triggers ⇒ discontinuous "jumps"

(2) **Uncertainty** effects on **micro level**:
(just) **widening of 'band of inaction'**
(no qualitative difference in hysteresis pattern)

(3) **Macro level**:
continuous macro reaction (no triggers, no "jumps")

(4) **Uncertainty** effect on **macro level**:
⇒ after **alternation** of the direction of XR movement:
• areas of weak reaction ('play') on XR changes and
• strong reaction ('spurt') after play-area is **passed**

⇒ under **uncertainty**, macro pattern displays
'more similarity' to the micro pattern
Estimating play-effects in Greek exports

• To test for the existence of play hysteresis, the following equations have to be considered:

\[ y_t = C + \alpha \cdot x_t + \beta \cdot st(\gamma) + \lambda \cdot z_t \quad \text{with: } |\alpha| < |\alpha + \beta| \]

\[ p_t = \gamma \quad \text{with: } \gamma \geq 0. \]

- Dependent variable \( y_t \) is determined by past spurts and current reaction.
- 
  Spurt variable \( st \) summarizes all preceding and present spurt movements leading to a shift of the current relation between \( x \) and \( y \) (“filtered \( x \)”).
- If we want to check whether play is relevant, we have to test the hypothesis \( (H1) \beta \neq 0 \) against the alternative \( \beta = 0 \).

• Our empirical application uses export data for some of the most important export destinations: US, Turkey, Euro Area.
Estimating play-effects in Greek exports

See paper, pp. 16f. for the econometrics

**Variables and time series used (paper, p. 18):**

- Nominal exports, deflated by the GDP deflator, as the dependent variable $y_t$
- Real exchange rates as forcing variable $x_t$
- Additionally, Real GDP, a mean shift dummy and seasonal dummies are included.
Econometrics

Model for “play regression” shows the following characteristics:

• It is based on **linear sections, where adjoining parts are linked** (by so called ‘knots’, in Figure 3 these knots are e.g. points B, D, E for the case of the path x1 → x3 → x4).

• The **current** position of the linear function and the **switchover** from one section to the other is defined by the **past** realizations of the input variable x.

• The model is a **peculiar case of a switching regression framework**, as adjoining sections are linked.

• The **magnitude of the estimated play area p** determines the **position of the knots** whose position is not known a-priori.
• The **parameters of our model are non-linear**, as knots are not known beforehand and since the spurt variable $s$ is determined by an estimated play width $p$.

• The **assumptions** made concerning the error term and regressors ensure that OLS-estimators are best linear unbiased estimators for a standard regression model; so the OLS-estimator can be considered as a maximum likelihood estimator.

• For knots that are **a-priori unknown**, **local maxima and breaks in the likelihood function** result.

• If, however, the adjacent parts are joined in a switching regression model, the **OLS-/ML-estimator will lead to consistent and asymptotically normally distributed estimates**.
Econometrics III

• Due to the **finite sample characteristics of the play regression** a straightforward estimation is still problematic: for estimations with small samples the estimates of the coefficients are **not approximately normally distributed** which may result in local maxima for the likelihood function.

• **Standard regression model assumptions may not be met.** For the case of non-stationary variables non-finite variances may occur.

• The **application of cointegration analysis is obstructed** as the play dynamics are characterized as a mixture of short- and long-term dynamics.

• Despite these shortcomings, we are **not aware** of a technique that delivers this (small sample) distribution and the critical values for the estimators directly applicable to our specific model.
To find the ideal play width which determines the value of the spurt variable and minimizes the residual sum of squares, a grid search over the width of an invariant play parameter $pt = p = \gamma$ is conducted (for a constant width $p$).

The spurt variable and transition knots are estimated for every value of $p$ using the data of the forcing variable (exchange rate). The realization of $\gamma$ is predetermined for every grid point.

The slopes alpha and beta representing the coefficients in the OLS estimation can now be determined straightforward by using the corresponding spurt variable in the regression resulting from the grid search.

The optimal OLS-estimate for the play variable results from the grid value with the highest R-squared (and therefore the minimum of the residual sum of squares) which is found in the grid search over $p$. 
Estimating play-effects in Greek exports

We estimate regressions for the following sectors:

• SITC 4: Animal and vegetable oils, fats and waxes
• SITC 5: Chemicals and related products
• SITC 6: Manufactured goods
• SITC 7: Machinery and transport equipment

Others not reliable or do not make sense.

What “hysteretic” sectors? Sunk costs, heterogeneous goods, relevant for Greece: sound data, employment intensive etc.
Example 1: Exports of SITC 7 (Machinery) to the Euro Area

• Grid Search indicating a max. R2 for $\gamma = 22$
Example 1: Exports of SITC 7 (Machinery) to the Euro Area

Real exchange rate and corresponding spurt variable:
Example 1: Exports of SITC 7 (Machinery) to the Euro Area

\[ \text{Greek machinery exports to the Euro Area} \]

Dependent Variable: EU_MACH  
Method: Least Squares  
Sample (adjusted): 1997Q1 2014Q4  
Included observations: 72 after adjustments

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<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
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R-squared 0.742633  Mean dependent var 2.13E+08  
Adjusted R-squared 0.709951  S.D. dependent var 51957646  
S.E. of regression 27982405  Akaike info criterion 37.24852  
Sum squared resid 4.93E+16  Schwarz criterion 37.53310  
Log likelihood -1331.947  Hannan-Quinn criter. 37.36181  
F-statistic 22.72330  Durbin-Watson stat 1.012477  
Prob(F-statistic) 0.000000
Overview of the regression results using constant play

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<th>SITC Group</th>
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<th>5</th>
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α = estimated coefficient for the original real exchange rate (RER)
β = estimated coefficient for the spurt exchange rate variable (SPURT)
γ = estimated play width
level of significance (student- t statistic): ***for 1%. ** for 5%. *for 10%
### Export Triggers (paper, p. 22)

<table>
<thead>
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<th>EU Machinery</th>
<th>Turkey Chemicals</th>
<th>Turkey Machinery</th>
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<td><strong>Lower Trigger</strong></td>
<td>273,6771</td>
<td>0,00346</td>
<td>0,005011</td>
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- **Note:** The triggers are calculated by using the play values for machinery exports to the Euro Area, exports of chemical goods to Turkey (expressed in weights) and machinery exports to Turkey (expressed in weights). Trigger correspond with necessary further depreciations = Proxy of adjustment needs in other areas (“reforms”).
Greek machinery exports into the Euro Area: lower threshold results as a real exchange rate of 273.6771, which means that the real exchange rate has to depreciate by a further 8% in order to cause a spurt in exports.

We additionally calculate the lower triggers for two specifications; exports in chemical products and exports in machinery to Turkey (both expressed in weights).

As a result we find a lower trigger of 0.00346 for exports in chemical products (corresponding to a further depreciation of 43% of the current real exchange rate) and a lower trigger of 0.005011 for exports in machinery (corresponding to a further depreciation of 17.3% of the current real exchange rate).

Of course, both percentage values should not be taken literally, but as equivalents of adjustment needs in other areas such as the reduction of uncertainty.
Further checks for robustness

We test our results for **robustness**:  

• Estimations limited to the **pre-crisis** period  
• Defining real exports in **weights**  
• Using political **uncertainty** to implement (financial) uncertainty in the regression framework. Larger “option value of waiting” with exports? “Breathing” play areas!

• economic policy uncertainty  
(http://www.policyuncertainty.com/europe_monthly.html)
Overview of the regression results excluding the crisis period

<table>
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<tr>
<th>Destination of Greek Exports</th>
<th>SITC Group</th>
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<table>
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<th>Euro Area</th>
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<th>7</th>
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<td>α = 6392258</td>
<td>α = 4975255</td>
<td>α = -4368115,5</td>
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<tr>
<td>γ = 17</td>
<td>γ = 5,5</td>
<td>γ = 1</td>
<td>γ = 1</td>
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</tr>
<tr>
<td>β = 5479963</td>
<td>β = -7912980</td>
<td>β = -5070346</td>
<td>β = -552291,7</td>
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</tr>
<tr>
<td>t = 2,8290***</td>
<td>t = -2,1134**</td>
<td>t = -0,7462</td>
<td>t = -0,1507</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turkey</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>α = -5.03E+08</td>
<td>α = -3.79E+08</td>
<td>α = -2.63E+08</td>
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</tr>
<tr>
<td>γ = 0.001275</td>
<td>γ = 0,0003755</td>
<td>γ = 0.0025</td>
<td>γ = -0.00875</td>
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</tr>
<tr>
<td>β = 8.06E+08</td>
<td>β = 5.97E+08</td>
<td>β = -2.90E+09</td>
<td>β = 7.90E+08</td>
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</tr>
<tr>
<td>t = 1.4645</td>
<td>t = 1.3589</td>
<td>t = -3.0298***</td>
<td>t = 2.0586**</td>
<td></td>
</tr>
</tbody>
</table>

α = estimated coefficient for the original real exchange rate (RER)
β = estimated coefficient for the spurt exchange rate variable (SPURT)
γ = estimated play width
level of significance (student- t statistic): ***for 1%, ** for 5%, *for 10%
## Overview of the regression results using real exports in kg

<table>
<thead>
<tr>
<th>Destination of Greek Exports</th>
<th>SITC Group</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>α = 46.16312</td>
<td>α = 600.2509</td>
<td>α = 77769.7</td>
<td>α = 496.1906</td>
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<tr>
<td></td>
<td>γ = 155</td>
<td>γ = 7</td>
<td>γ = 8</td>
<td>γ = 2</td>
<td></td>
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<tr>
<td></td>
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<td>β = -76064.8</td>
<td>β = -511.0102</td>
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<tr>
<td></td>
<td>t = -3.5995***</td>
<td>t = -0.4321</td>
<td>t = -1.8996*</td>
<td>t = -1.2139</td>
<td></td>
</tr>
<tr>
<td>Euro Area</td>
<td>α = -22173.61</td>
<td>α = 58814.39</td>
<td>α = 46272.96</td>
<td>α = 8563.97</td>
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</tr>
<tr>
<td></td>
<td>γ = 16</td>
<td>γ = 1</td>
<td>γ = 0.625</td>
<td>γ = 3</td>
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</tr>
<tr>
<td></td>
<td>β = 26369.16</td>
<td>β = -55145.08</td>
<td>β = -79050.38</td>
<td>β = -3852.476</td>
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</tr>
<tr>
<td></td>
<td>t = 4.0625***</td>
<td>t = -1.3363</td>
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</tr>
<tr>
<td>Turkey</td>
<td>α = -3659474</td>
<td>α = 37119239</td>
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<tr>
<td></td>
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<td>γ = 0.002625</td>
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<tr>
<td></td>
<td>β = 22929260</td>
<td>β = -1960000000</td>
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<tr>
<td></td>
<td>t = 1.6726*</td>
<td>t = -3.2504***</td>
<td>t = 1.8520*</td>
<td>t = -2.8356***</td>
<td></td>
</tr>
</tbody>
</table>

α = estimated coefficient for the original real exchange rate (RER)

β = estimated coefficient for the spurt exchange rate variable (SPURT)

γ = estimated play width

level of significance (student- t statistic): ***for 1%. ** for 5%. *for 10%
Implementing uncertainty

We implement uncertainty only for a limited number of previous regressions:

1. Greek machinery exports to the Euro Area, full sample period
2. Greek machinery exports to Turkey in kg
3. Greek vegetable exports to the United States in kg
4. Greek chemical exports to the Euro Area – period limited to 2008Q4
Implementing uncertainty

With the results:

• ad (1) play = 0.5 + 0.1*U
• ad (2) play = 0 + 6.25E-06*U
• ad (3) play = 0 + 2*U
• ad (4) play = 0.0975 + 0.0333*U

=> Uncertainty clearly enlarges “band of inaction”!
Implementing uncertainty

• The empirical results show that the inclusion of the political uncertainty variable significantly increases the goodness of fit of the Greek export equation, as measured, for instance, by the R-Squared.

• To put it more simply: political uncertainty matters for Greek exports and cannot be rejected empirically to be responsible for ...

• ... nearly flat export growth, although the external competitiveness has significantly turned to the better.

• Importance of ECB’s QE (Papandreou)?
Conclusion

• The existence of ‘bands of inaction’ (called ‘play’) in Greek exports should lead to a more objective discussion of peaks and troughs in the Greek real exchange rates and their impact (internal devaluation and external competitiveness).

• We show that the play/inaction area is path-dependent – and changes its position with extreme real exchange rate movements.

• Thus, a unique “export trigger”, for instance, of the real exchange rate does not exist. => Troika!
Further Research

- Progress in non-linear time series modeling and panel econometrics should provide **better tools** to model hysteretic behavior more adequately.

- Expanding our research to a **more global perspective**
  - Analyzing the performance under uncertainty of Germany, France, Italy and the UK
  - **Global export destinations**: US, Japan, Brazil, Russia, India, China (BRICs)
    - Total exports without sectoral differentiation
    - Sector-specific analysis of most important export sectors
OLS – Estimation of further specifications

\[ EX = C + \alpha \cdot EXR + \beta \cdot spurt + Y + dummy \]

With:

- \( EX \) = Total exports
- \( EXR \) = Real exchange rate
- \( Spurt \) = Estimated spurt variable
- \( Y \) = Production export destination
Results for constant play for all export destinations

<table>
<thead>
<tr>
<th>Country</th>
<th>USA</th>
<th>Japan</th>
<th>Brazil</th>
<th>Russia</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>$\alpha = -21835082^{***}$</td>
<td>$\alpha = -18.46^{***}$</td>
<td>$\alpha = -20151604$</td>
<td>$\alpha = 3041062$</td>
<td>$\alpha = 1280597^{***}$</td>
</tr>
<tr>
<td></td>
<td>$\beta = -16430655$</td>
<td>$\beta = -124.81$</td>
<td>$\beta = 20161917$</td>
<td>$\beta = -3032748$</td>
<td>$\beta = -8121858$</td>
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<tr>
<td></td>
<td>$\gamma = 0.272$</td>
<td>$\gamma = 70$</td>
<td>$\gamma = 0.075$</td>
<td>$\gamma = 0.4$</td>
<td>$\gamma = 3.84$</td>
</tr>
<tr>
<td></td>
<td>$t = -2.7596^{***}$</td>
<td>$t = -6.1064^{***}$</td>
<td>$t = 4.2784^{***}$</td>
<td>$t = -1.5244$</td>
<td>$t = -9.9078^{***}$</td>
</tr>
<tr>
<td>France</td>
<td>$\alpha = -18293469^{***}$</td>
<td>$\alpha = 48166.67^{***}$</td>
<td>$\alpha = 436672.4^{*}$</td>
<td>$\alpha = -464494.6^{***}$</td>
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<tr>
<td></td>
<td>$\beta = 6719294$</td>
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<tr>
<td></td>
<td>$\gamma = 0.3$</td>
<td>$\gamma = 8.4$</td>
<td>$\gamma = 1.23$</td>
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<td>$t = 2.4880$</td>
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<td>$t = -6.2156^{***}$</td>
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<tr>
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<td>$t = -3.1241^{***}$</td>
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<td>United Kingdom</td>
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<td>$t = -7.4662^{***}$</td>
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<td>$-6.0243^{***}$</td>
<td>$t = 1.8277^{*}$</td>
<td>$t = -9.8403^{***}$</td>
</tr>
</tbody>
</table>

* As of yet, India is omitted due to data availability.
Results for variable play

- All estimations yield significant results for the spurt variable.
- France is still omitted but will be analysed as a next step.
Hysteresis: further applications

Macro
• Mario Draghi: Two-handed approach, Jackson Hole
• Monetary policy under uncertainty
• Optimum Currency Area Approach: exit triggers under uncertainty
• Labour markets: Southern euro area
• Partisan political business cycles with electoral uncertainty (RPT) ...

Micro
• Industrial economics: branches, individual firms (Portugal)
• Marriage, suicide ...


References (starters) IV

Thank you for your attention!