EXCHANGE RATE PASS-THROUGH: THE CASE OF THE PORTUGUESE IMPORTS AND EXPORTS*

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1. INTRODUCTION

The purpose of this study is to analyse how the changes of the Portuguese exchange rate have affected the prices of the Portuguese imports and exports.

The traditional theories of exchange rate determination have not yet been able to deliver a satisfactory explanation for recorded deviations from the “law of one price”. Recently, however, theories have been developed using concepts and instruments from microeconomics and in industrial economics. This study follows this approach, modifying the “Purchasing Power Parity” theory by encompassing the possibility of different market structures.

According to the model developed in Hooper and Mann (1989), the analysis assumes that oligopolist firms maximise their profits in a partial equilibrium environment. Here, firms face constant marginal costs. The model concludes that the pass-through coefficients (i.e., those coefficients measuring the impact of exchange rate changes on exports and import prices) depend upon the markup capacity of firms — i.e., to fix their own market prices, hence determining their profit margins. Two factors generally determine these margins. The first deals with the difference between prices in the destination markets and production costs. The second relates to demand pressures on production, measured by capacity utilization.

This study starts by defining the theoretical framework and by specifying the model (section 2.1).

The second part presents the empirical analysis, assessing how the changes in the Portuguese escudo were passed-through into the Portuguese export and import prices measured in domestic currency, over the period 1985-1992 (section 3.2). This study focuses on the prices of exported manufactured goods and the prices of imported manufactured goods, on a quarterly basis. The analysis shows that in the long-run, Portuguese exporters become price-takers in foreign markets, holding little power to fix prices. Conversely, foreign producers that maintain trade bonds with Portugal fix prices in their currency, reflecting changes in the exchange rates on prices practised in the Portuguese market. Section 4 draws the main findings and concludes.

2. THEORETICAL ANALYSIS

2.1 The model

Any theory of real exchange rate determination should be able to interpret two phenomena observed in international relative prices. First, in aggregate terms changes in the real exchange rate tend to persist in time; second, agents tend to resist to price changes when denominated in national currency. As a result, deviations from the “law of one price” occur. Some studies suggest that the pricing to market phenomenon explains the systematic violation of this “law”. The pass-through analysis provi-
des an alternative explanation. The present study opts for the latter.

We assume imperfect competition, where firms maximise profit and face a negatively sloped demand curve. As a result firms make non-zero profits\(^3\). This framework is broad enough to comprise different theoretical models. However, it should be noted that our model is a partial equilibrium one, since both cost and productive capacity utilisation are exogenous in the determination of the exchange rate.

The pass-through of the exchange rate to export prices consists of the impact of changes in the exchange rate on the escudo-denominated prices of exports. Symmetrically, the pass-through of the exchange rate to import prices is the impact of exchange rate changes on the escudo-denominated import prices.

This section specifies the theoretical model that determines the exchange rate pass-through coefficient as regards export prices. An identical — but symmetric — procedure is developed in obtaining the pass-through coefficient for import prices.

With respect to the Portuguese exports, total pass-through occurs when exporters adjust their prices in escudos in the same proportion as the exchange rate change. As a result exchange rate changes are not reflected in export prices in the destination markets. Conversely, if escudo-denominated export prices remain unchanged in the presence of exchange rate fluctuations, the pass-through is null. In this case, Portuguese exporters are able to influence prices in the destination markets. The interpretation of the exchange rate pass-through to import prices is the opposite.

We assume that the firm sets its export prices \((PX)\) as a mark-up \((\pi)\) over marginal production costs \((C)\). Analytically, we have:

\[
PX = \pi C \tag{1}
\]

The mark-up of Portuguese exporters is given by \((\pi = 1 + \lambda)\), where \((\lambda)\) stands for the profit margin. The latter is variable, and depends first on pressures of overall demand directed towards the good; and second, on competitive pressures in the destination market. Demand pressures are quantified by the level of productive capacity utilisation \((UC)\); competition is measured by the ratio of the escudo-denominated prices of products competing with Portuguese exports \((P^*)\) to the Portuguese production cost \((C)\).

The exporters’ profit is given by:

\[
\pi = \left[ER.P^* / C \right](UC) \tag{2}
\]

where \(ER\) is the exchange rate of the escudo.

Substituting equation (1) in (2), and re-writing in logarithms yields:

\[
px = \varepsilon er + \varepsilon p^* + (1 - \varepsilon)e + \varepsilon uc, \tag{3}
\]

where \((\varepsilon)\) is the pass-through coefficient \((0 \leq \varepsilon \leq 1)\).

If the Portuguese exporter is a price-taker, then \(\varepsilon = 1\), and exchange rate movements are totally reflected in the escudo-denominated prices of exported goods. As a result, the prices of Portuguese exports denominated in escudos remain unchanged. If the productive capacity utilisation remains constant, the changes in international prices will determine the changes in \(px\), and the changes in production costs will be totally absorbed by profit margins. As a result the price of Portuguese exports in the destination markets will not be affected.

On the other hand, if Portuguese exporters hold a substantial market power — thereby fixing prices in the destination markets — the changes in the exchange rate will have no impact on escudo-denominated prices \((\varepsilon = 0)\). In this case, changes in

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\(^3\) The model of profit maximisation in imperfect competition is based on a study by Hooper P. and Mann C. (1989). These authors assume that the profit margin is the variable responding to both the competition conditions in the domestic market, and the pressures of overall demand. As a results, neither the supply curve nor the demand curve are infinitely elastic. Fisher (1989) uses the Bertrand assumption for oligopolistic competition as the simplest way to include the competitors’ price in the profit maximisation process. Dornbusch (1985) presents a complete survey of the literature, exploring the interaction between exchange rate and prices in an subsequent oligopolistic context. Some other studies have contributed using alternative methods of incorporating competitive pressure in the international market in the optimal price determination. For instance, Froot and Klemperer (1989) analyse price strategies that ensure the maintenance of the market share. Krugman (1989) presents an intuitive explanation for the assumption of imperfect competition in international trade and its impact on exchange rate movements.
production costs will be fully reflected in the prices of exports (holding the assumption that UC is constant).

Up to this point, the model specification is static — which means that agents’ behaviour to achieve the chosen long-run position is not yet taken into account. However, one may want to analyse the adjustment path of Portuguese export prices to exchange rate changes. Such an analysis could indicate what kind of expectations agents hold as regards the persistence in time of the observed exchange rate movements.

The distinction between short-run and long-run pass-through allows for an empirical verification of the hypothesis that different exchange rate systems result (or not) in distinct pass-through patterns. The theory predicts that a change in the value of a currency in a credible fixed-rate system will yield expectations of a permanent change in the exchange rate. Consequently, the pass-through is expected to be high in the short-run, slowly stabilising around its equilibrium value afterwards. A similar pattern can be expected in a crawling-peg system, or in the presence of a change in the central rate of a monetary system like the EMS. Conversely, in a flexible exchange rate system, agents will have a tendency to be cautious in adjusting prices. This is so because they do not know whether a given change in the exchange rate is temporary or permanent. They will only adjust prices in the destination market when they observe that the change is permanent, as to maintain an optimal mark-up.

Therefore, we shall consider the following dynamic model (4):

\[ px_i = \sum_{i=0}^k \mu_{i,x} + \sum_{i=0}^k \zeta_i p_{i,x} + \sum_{i=0}^k (1-\phi) c_{i,x} + \sum_{i=0}^k \phi uc_{i,x} \]  

Similarly, the imports pass-through is given by equation (5):

\[ pm \sum_{i=0}^k \zeta_i^r er_{i,x} + \sum_{i=0}^k \delta c_{i,x} + \sum_{i=0}^k \gamma p_{i,x}^\text{ESC} + \sum_{i=0}^k \beta uc_{i,x} \]  

where \( pm \) is the price of Portuguese imports, \( er \) is the escudo exchange rate, \( c^* \) stands for the production costs of the foreign producers exporting to Portugal, \( p^\text{ESC} \) is the average price of those goods competing with Portuguese imports and \( uc^* \) the productive capacity utilisation of foreign producers exporting to Portugal. All variables are in logarithms.

2.2 Limitations of the analysis

The model has several limitations. First, it excludes changes in import and export taxes and other obstacles to free international trade (e.g., transport and distribution costs) and insurance. This simplification may distort the analysis, as the set of relevant prices is reduced. It also disregards discontinuities.

Second, the model is a partial equilibrium one. It excludes changes in production costs and in the productive capacity utilisation that result from movements of imports or export prices. This limitation may be particularly relevant as regards the exports of a small open economy, as is the case of Portugal. In fact, the fluctuations of the escudo tend to affect Portuguese agents’ production costs in a systematic manner, and hence are reflected in the costs of intermediate goods, and consequently in final prices.

3. ESTIMATION

3.1 The data

This study used quarterly data for the period running from the first quarter of 1985 up to the last quarter of 1992. Data referring to the period after 1992 were not used in the econometric analysis, because of the unsatisfactory quality of the available statistics of intra-community trade in 1993. The indirect tax harmonisation put into force by the EU in 1993 (namely the change in the pro-
cess of accounting and collection of the VAT on the intra-community trade) makes the analysis of the international price indices for that year difficult.

In addition, the estimation used aggregate price indices for manufactured exports and imports(5), which do not individualise the behaviour of price indices in each sector of manufacturing industry. Although some studies stress the need to disaggregate these indices(6)— so as to attain a higher statistical quality and to possibly detect distinct sectoral pass-through coefficients — the specificity of the data required for the analysis impedes that kind of research.

Unit labour costs in the manufacturing industry provide a measure for Portuguese production costs. The production cost index for the foreign agents exporting to Portugal was constructed using the unit labour costs of our leading trade partners(7) and weighting these by the share of each trade partner in total trade with Portugal. A similar procedure was adopted for all external variables in the model. In order to make export and import prices compatible with production costs, energy prices and agriculture foodstuff prices were excluded from the overall price indices.

The price index of products competing with Portuguese exports is a geometric mean of the consumer price indices of our leading trade partners(8). The Portuguese consumer price index(9) was used to measure the behaviour of prices of those Portuguese goods competing with imports. The exchange rate is the nominal effective exchange rate(10).

Finally, the productive capacity utilisation was measured by the difference between the growth of real GDP and the growth of real trend GDP(11).

### 3.2 The Error-Correction Mechanism

In order to estimate the model, the unit root test was used (see Appendix 1). This shows that all variables are I (1). As a result, the use of ordinary least squares may lead to spurious results. Two alternatives exist to this method. Either the model can be estimated directly in first differences, or we can estimate a static relation between variables (i.e., the cointegration regression). We chose to estimate the model by using the dynamic formulation provided by the Error Correction Model (ECM)(12).

In specifying the ECM we used the Båsken formulation. Not only does this formulation enable us to apply the ordinary least squares, but it also encompasses the short-run dynamics of the model. To test for the existence of cointegration in the ECM, the Boswijk test was used(13), since it allows to test the stability of the model in a dynamic context. It should be noted that in this analysis it is assumed that only one cointegrating vector exists in each equation, and that the explanatory variables are (at least) weakly exogenous.

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(5) Source: Direção-Geral de Comércio Externo.

(6) See Melick (1994).

(7) For Portugal data was made available by the INE and by the Ministério do Emprego e Segurança Social. For the external costs data was drawn from the IMF.

(8) Series built over data draw from the AMECO database of the European Commission.

(9) Source: European Commission, AMECO database.

(10) Source: Banco de Portugal.

(11) Source: European Commission, AMECO database.

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(12) This estimation method is commonly known as the “one-step method”, where the dynamic specification of the estimation is directly used. Banerjee et al (1994) presents a detailed discussion of its advantages, as an alternative to the “two-step methodology”. Furthermore, the Representation Theorem of Granger shows that if a set of variables is bound to be represented through an ECM, then these variables is cointegrated. See Engle and Granger (1987).

(13) In short, the Boswijk test is as follows. Given the general formulation of the one-equation ECM:

\[
\Delta y_t = \beta_0 D(\varepsilon_i) + \lambda y_{-1} - \theta z_{-1} + \sum_{j=1}^{l} \beta_j D(y_j) + \Delta z_t + \varepsilon_t
\]

we wish to test the null hypothesis of (λ = 0) (instability of the model), i.e., we test the hypotheses according to which \( y_t \) and \( z_t \) only appear in the ECM in first differences, against the alternative hypothesis (λ = 0). For this purpose a Wald test (WD) is used. This test is specified as follows:

\[
WD = \left[ T - \left( p \times (k+1) \times k \right) \right] \frac{RSSL - RSSL_F}{RSSL} = (k+1) F
\]

where \( T \) is the number of observations used in the estimation, \( k+1 \) is the number of constraints impact with \( \lambda = 0 \), \( RSSL \) the sum of square residuals of the model with constraints, \( RSSL_F \) stands for the sum of square residuals in the free model, and \( F \) is the usual statistic. The asymptotic distribution of \( WD \) is given by the table built by Boswijk. For further detail see Boswijk H.P. (1994).
We began by estimating the general model,

**Export price equation**

\[
\Delta p_{x,t} = \theta + \zeta T + \sum_{j=0}^{k-1} \psi_j \Delta p_{x,t-j} + \sum_{j=0}^{n-1} e_j \Delta r_{t-j} + \\
\sum_{j=0}^{n-1} (1-\phi)^j \Delta c_{t-j} + \sum_{j=0}^{n-1} \mu_j \Delta p_{m,t-j} + \sum_{j=0}^{n-1} \varphi_j \Delta u_{c,t-j} + \\
+ a_1 p_{x,t-1} + a_2 g_{t-1} + a_3 c_{t-1} + a_4 p_{m,t-1} + a_5 u_{c,t-1} + z_t
\]

**Import price equation**

\[
\Delta p_{m,t} = \eta + \zeta T + \sum_{j=0}^{k-1} \omega_j \Delta p_{m,t-j} + \sum_{j=0}^{n-1} \tau_j \Delta r_{t-j} + \\
\sum_{j=0}^{n-1} (1-\phi)^j \Delta c_{t-j} + \sum_{j=0}^{n-1} \mu_j \Delta p_{m,t-j} + \sum_{j=0}^{n-1} \varphi_j \Delta u_{c,t-j} + \\
+ b_1 p_{m,t-1} + b_2 e_{t-1} + b_3 c_{t-1} + b_4 p_{x,t-1} + b_5 u_{c,t-1} + v_t
\]

to which a trend was added, as suggested by the properties of some of the model’s variables in the unit root tests. After excluding the non-significant regressors, the specification displayed in table 1 was obtained.

The analysis of the import and export price equations reveals some interesting aspects. As displayed in table 1, the long-run analysis shows that Portuguese exports hold a small market power in the presence of exchange rate movements, i.e., Portuguese exporters behave like international price-takers in aggregated terms. Conversely, foreign producers selling in Portugal do not allow for changes in their mark-up level due to fluctuations in the value of the escudo. Nevertheless, it should be noted that the market power of Portuguese agents is different from zero, since the prices practised abroad react to the pressures of total demand directed towards Portuguese goods.

Therefore, the long-run price strategy of Portuguese exporters consists in fixing prices denominated in foreign currency, so as to fully adjust the profit margin to the exchange rate movements (the coefficient of the export prices long-run elasticity vis-à-vis the exchange rate movements is around 1). This means that in the long-run, Portuguese producers hold little market power.

In contrast, the price strategy adopted by foreign producers exporting to Portugal consists in fixing prices in their own currency, so that changes in the escudo rate result in identical changes in the prices practised in the Portuguese market (i.e., the long-run pass-through averages 1). Consequently, these firms’ mark-ups remain unaltered when the currency fluctuates. Therefore, we are led to conclude these firms hold a high market power in Portugal.

The explanatory power of demand pressures, measured by the coefficient of the productive capacity utilisation, is significantly different from zero in the long-run, in both equations. As regards export prices, the additional demand pressures induce partial price increases (\(uc = 0.4\)), suggesting that Portuguese producers still tailor their long-run price policy to demand pressures.

The coefficient of \(uc\) in the import price equation indicates that in the long-run increases in total demand directed to foreign products imported by Portugal result into reductions in the Portuguese prices of imports.

The ECM also provides information on the speed of adjustment to the long-run equilibrium. This information is given by the coefficients associated with the import \([pm (-1)]\) and export price level \([px (-1)]\) one period lagged. The estimates suggest that import prices adjust almost 50 per cent in each quarter, in relation to the long-run deviation recorded in the previous quarter. Export

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(14) Coefficients were selected according to the \(t\) statistic. However, one is aware that residuals might be autocorrelated, and the parameters of the integrated variables may not follow an asymptotically normal distribution. Consequently, the \(t\) tests of the ECM equation may be biased, and hence should be interpreted with caution. Nevertheless, these statistics were used since they aid in identifying and specifying the ECM regression.

(15) This result can also be due to structural changes in the Portuguese economy, namely as regards the structure of output—making the interpretation of this coefficient difficult. This suggestion should, however, be subject to further investigation on this matter.

(16) Definitive conclusions cannot be drawn concerning the hypothesis of a price-to-market strategic behaviour, since no available data exists on the mechanism by which specific prices are determined in the domestic and foreign markets. This hypothesis could be tested only if it were possible, for instance, to check whether an escudo appreciation would make the escudo-denominated export prices lower than prices practised in the domestic market.

(17) Although the exchange rate pass-through coefficients regarding imports and exports exhibit identical values, their interpretation is the opposite—as established in the theoretical model.
prices react even faster, exhibiting a correction rate close to 70 per cent. We can conclude that the pass-through is very fast in both Portuguese imports and exports.

The econometric analysis also allows us to test whether changes in the exchange rate policy might have affected the pass-through dynamics in the period under review. For this purpose, the import and export price equations are estimated through the Recursive Least Squares Method. The analysis of the stability of the parameters (namely those of the error-correcting term and of the long-run pass-through coefficient) shows that

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**Table 1**

**ERROR – CORRECTION MECHANISM**

<table>
<thead>
<tr>
<th></th>
<th>Import price equation</th>
<th></th>
<th>Export price equation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficients t-statistic Prob.</td>
<td>Coefficient t-statistic Prob.</td>
<td></td>
</tr>
<tr>
<td>D(er)</td>
<td>0.297 (2.33) 0.028</td>
<td>D(p(-1))</td>
<td>0.280 (2.51) 0.018</td>
</tr>
<tr>
<td>D(pESC(-2))</td>
<td>0.962 (4.81) 0.000</td>
<td>px (-1)</td>
<td>-0.687 (-4.30) 0.000</td>
</tr>
<tr>
<td>pm (-1)</td>
<td>-0.486 (-7.55) 0.000</td>
<td>er (-1)</td>
<td>0.686 (4.31) 0.000</td>
</tr>
<tr>
<td>er (-1)</td>
<td>0.475 (6.67) 0.000</td>
<td>uc (-1)</td>
<td>0.277 (2.35) 0.026</td>
</tr>
<tr>
<td>uc* (-1)</td>
<td>-0.089 (-2.86) 0.008</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**long-run**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient Variance</th>
<th></th>
<th>Coefficient Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(er)</td>
<td>0.978 0.108</td>
<td>D(er)</td>
<td>0.998 0.483</td>
</tr>
<tr>
<td>pm (-1)</td>
<td>-0.184 0.006</td>
<td>pm (-1)</td>
<td>-0.184 0.006</td>
</tr>
<tr>
<td>Adj. R-sq.</td>
<td>0.83</td>
<td>Adj. R-sq.</td>
<td>0.52</td>
</tr>
<tr>
<td>SER(c)</td>
<td>0.005</td>
<td>SER(c)</td>
<td>0.014</td>
</tr>
<tr>
<td>DW(d)</td>
<td>2.79</td>
<td>DW(d)</td>
<td>2.12</td>
</tr>
<tr>
<td>BOSWIJK(e)</td>
<td>78.9 C.V. (1%) = 18.8</td>
<td>BOSWIJK(e)</td>
<td>30.0 C.V. (1%) = 18.8</td>
</tr>
<tr>
<td>LM(f)</td>
<td>1.61</td>
<td>LM(f)</td>
<td>2.54</td>
</tr>
<tr>
<td>ARCH(g)</td>
<td>0.46</td>
<td>ARCH(g)</td>
<td>0.31</td>
</tr>
<tr>
<td>RESET(h)</td>
<td>0.51</td>
<td>RESET(h)</td>
<td>0.94</td>
</tr>
</tbody>
</table>

(a) Long-run elasticities are calculated as the ratio of the coefficient of each variable in levels, one period lagged, on the symmetric of the coefficient of the endogenous variable one period lagged.

(b) Adj. R-sq. is the determination coefficient adjusted for the degrees of freedom.

(c) SER stands for the standard error of the regression.

(d) DW is the Durbin-Watson statistic for testing first order autocorrelation in residuals.

(e) Boswijk is the Wald test proposed by Boswijk, to test for the stationarity of the ECM equations. Cv is the respective critical value.

(f) LM is the Breusch-Goodfrey serial correlation test for four periods.

(g) ARCH stands for the Engle test, to find conditional and auto-regressive heteroskedascity of order 4.

(h) RESET is the probability associated to the Ramsey test for the omission of the variables.

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(18) The Portuguese exchange rate policy between 1985 and 1992 can be divided into three distinct stages. In the first sub-period from 1977 up to July 1990 a crawling-peg regime existed. This system consisted of the previous announcement of the monthly rate of effective depreciation of the escudo, and was supported by systematic interventions of the Banco de Portugal. The second period, between July 1990 and April 1992, featured a pre-determined but not announced band for the effective exchange rate of the escudo, which was managed taking into account the market behaviour. In April 1992, a new policy change was instituted, when the escudo adhered to the Exchange Rate Mechanism of the European Monetary System, in a 6 per cent band.

(19) See Appendix 2.
the changes in the exchange rates were not reflected in the speed of adjustment of prices. In fact, the expectations on the persistence of exchange rate movements remained unchanged. Furthermore, the size of the pass-through was not affected by the different exchange rate policies adopted.

The short-run dynamics component reflects the impact of competition on prices. In the short-run, foreign producers exporting to the Portuguese market follow almost totally the movements of the prices of domestic competitors, although with a six months lag (the short-run import price elasticity relative to changes in competitors’ price is close to 1). In contrast, Portuguese exporters adjust their prices fastly to changes in competitors’ prices (with only a three months lag), although the adjusted amount is quite low (about 0.3). In both cases this effect fades away in the long-run.

Finally, empirical evidence suggests that the impact of production costs on the prices of exported and imported goods is not significantly different from zero. This conclusion is common to the short-run and to the long-run analyses (insofar as unit labour costs are taken as a measure for total costs). This finding is not surprising for export prices, since Portuguese producers have little power in determining international prices. As regards imports, this finding is somewhat surprising. As a matter of fact, agents with high market power would be expected to transmit the changes in their production costs to the final prices of their products, so as to maintain their profit margins unchanged.

4. CONCLUSIONS

The results of this study suggest that between 1985 and 1992 the Portuguese economy behaved very much like a price-taker in foreign markets, although in aggregate terms it holds a non-zero market power.

In contrast, in the long-run, foreign producers exporting to Portugal fix prices in their own currency, so that the escudo prices closely follow the movements of the escudo exchange rate. The mark-up of these producers is thus maintained unchanged. Consequently, the long-run exchange rate pass-through to Portuguese imports is complete (the long-term elasticity of escudo-denominated import prices with respect to the exchange rate is very close to 1).

Prices of Portuguese exports are, however, fixed in the currency of the importing country, and producer's profit margins adjust fully to the changes in the value of the escudo (long-run elasticity close to 1). In the long-run, however, the pressures of overall demand also seem to influence the prices of Portuguese exports, thus suggesting that Portuguese exporters hold some power in the exports market.

Our results are consistent with a similar study on Portugal (20) indicating that in the long-run, escudo-denominated export prices vary in the same proportion of changes in the parity of the escudo.

In addition, the speed of adjustment of export and import prices to the respective equilibrium values is high, which suggests that a large part of exchange rate changes is expected to be permanent. In fact, export prices adjust about 70 per cent of the differential with respect to the equilibrium value in the first quarter, while import prices adjust by 50 per cent. We also show that different foreign exchange policies in Portugal in the period under analysis (namely a crawling-peg policy, a policy of exchange rate management in a non-announced band and finally the participation of the escudo in the Exchange Rate Mechanism of the European Monetary System) did not result in significantly distinct expectations regarding the persistence in time of the exchange rate movements.

Therefore, the results of this study provide interesting conclusions for economic policy. First of all, exchange rate changes are transmitted rapidly and in a sizeable proportion to domestic prices, by influencing both the prices of imports (which in six months adjust by 50 per cent of the long-run deviation) and the prices of exports (70 per cent adjustment of the deviation from long-run price in only one quarter). This finding is confirmed by the long-run analysis. Here the impact of exchange rate changes on domestic prices is total, confirming the hypothesis that the behaviour of the Portuguese economy is one of a small open economy.

Finally, this paper shows that the impact of changes in the exchange rate on the prices of ex-

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ports and imports is identical, when denominated in escudos. As a result, we can conclude that in the presence of exchange rate fluctuations the terms of trade remain unchanged.

REFERENCES

Appendix 1

Unit root test

To test the possibility of using the classical linear regression model (by means of the ordinary least squares method) the stationarity of our variables was tested. The graphical analysis suggests that unit roots may exist. However, in order to determine the level of integration of the series we used the ADF test, proposed by Dickey Fuller, using the sequential procedure suggested by Holden and Perman (21). To find the number of lagged terms necessary to eliminate the autocorrelation between residuals, we used the multiplier test, suggested by Breush and Goodfrey. For each variable the general formulation of the ADF was used:

$$D(y_t) = \alpha + \beta t + py_{t-1} + \sum_{i=1}^{m-p} \theta_i D(y_{t-i}) + \epsilon_t$$

Table 1 displays the main results.

The ADF test indicates that all variables are non-stationary in levels, and are integrated of order one - I(1).

### Table 1

**UNIT ROOT TEST**

<table>
<thead>
<tr>
<th>Series</th>
<th>$l(t)$</th>
<th>$t - \alpha$</th>
<th>$t - \beta$</th>
<th>$t - \rho$</th>
<th>$\Phi_1$</th>
<th>$\Phi_2$</th>
<th>$p$</th>
<th>$F^*$</th>
<th>BG</th>
<th>ADF</th>
</tr>
</thead>
<tbody>
<tr>
<td>pm</td>
<td>1</td>
<td>0.41</td>
<td>0.41</td>
<td>0.33</td>
<td>3.0</td>
<td>4.49</td>
<td>6</td>
<td>1.6</td>
<td>12</td>
<td>F=1.33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=0.68</td>
<td>P=0.68</td>
<td>P=0.68</td>
<td>P=0.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>px</td>
<td>1</td>
<td>0.19</td>
<td>0.85</td>
<td>0.11</td>
<td>4.6</td>
<td>3.5</td>
<td>0</td>
<td>-</td>
<td>12</td>
<td>F=0.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P=0.84</td>
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(a) Order of the auto-regressive process.
(b) Value of the t-statistic ($t$) and of the probability of not rejecting the null hypothesis ($p$), associated to parameter $\alpha$ (drift).
(c) Value of the t-statistic ($t$) and of the probability of not rejecting the null hypothesis ($p$), associated to parameter $\beta$ (linear trend).
(d) ADF test.
(e) $\Phi_1$ is statistic $F$ for hypothesis : $(\alpha, \beta, \rho) = (0, 0, 0)$.
(f) $\Phi_2$ is statistic $F$ for hypothesis : $(\alpha, \beta, \rho) = (0, 0, 0)$.
(g,h) $p$ is the order of the lagged endogenous variable ($D(y_t)$), with the corresponding t-Statistic and the associated probability.
(i,j) BG is the number of lags of the endogenous variable necessary to eliminate autocorrelation, according to the Lagrange multiplier test of Breush-Godfrey ($f$-statistic and its associated probability ($P$)).
Appendix 2

RECURSIVE ESTIMATION OF THE ERROR-CORRECTING MECHANISM

Between 1985 and 1992 two changes in the exchange rate regime were recorded. In July 1990 the previously announced crawling-peg system was substituted by a pre-determined but not announced band. In April 1992, the escudo entered the Exchange Rate Mechanism of the European Monetary System.

To test whether these policy changes affected the exchange rate pass-through coefficient (regarding both import and export prices) the equations for import and export prices were estimated by the recursive least squares method. The error-correcting term exhibits high stability over the course of the period under review, namely at the moments those policy changes took place. Hence, these results indicate that the speed of adjustment of prices was not significantly altered as a result of changes in the exchange rate regime. This is confirmed by the fact that the parameters used in constructing the long-term pass-through coefficients are also stable. Consequently, we conclude that the pattern of pass-through was not significantly affected by the changes in the exchange rate regimes occurred over the analysed period.

Charts for the tests of structural changes in parameters

Least squares

[Charts showing Import price equation and Export price equation with recursive estimation and ±2 standard deviation plots]