Pricing-to-Market for UK Exp

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SUMMERY

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This thesis investigates the pricing-to-market (PTM) behaviour of the UK export sector. Most earlier studies have focused on the UK export sector using highly aggregated data in cross-country comparisons. US studies show that US exporters practice very little pricing-to-market (PTM). Thus, it is interesting to know how PTM behaves in UK export sectors.

Unlike previous studies, this study econometrically tests for seasonal unit roots in the export prices prior to estimating PTM behaviour. Prior studies have seasonally adjusted the data automatically. This study's results show that monthly export prices contain very little seasonal unit roots implying that there is a loss of information in the data generating process of the series when estimating PTM using seasonally-adjusted data.

Prior studies have also ignored the econometric properties of the data despite the existence of ARCH effects in such data. The standard approach has been to estimate PTM models using Ordinary Least Square (OLS). For this reason, both, EGARCH and GJR-EGARCH (hereafter, GJR) estimation methods are used to estimate both a standard and an Error Correction model (ECM) of PTM.

The results indicate that PTM behaviour varies across UK sectors. The variables used in the PTM models are co-integrated and an ECM is a valid representation of pricing behaviour. The study also finds that the price adjustment is slower when the analysis is performed on real prices, i.e., data that are adjusted for inflation. The inflationary effects have been entirely ignored in prior studies. There is strong evidence of auto-regressive condition heteroscedasticity (ARCH) effects – meaning that the PTM parameter estimates of prior studies have been inefficiently estimated. Surprisingly, there is very little evidence of asymmetry. This suggests that exporters appear to PTM at a relatively constant rate. This finding might also explain the failure of prior studies to find evidence of asymmetric exposure in foreign exchange (FX) rates.

This study also provides a cross sectional analysis to explain the implications of the observed PTM of producers' marginal cost, market share and product differentiation. The cross-sectional regressions are estimated using OLS, Generalized Method of Moment (GMM) and Logit estimations. Overall, the results suggest that market share affects PTM positively. Exporters with smaller market share are more likely to operate PTM. Alternatively, product differentiation is negatively associated with PTM. So industries with highly differentiated products are less likely to adjust their prices. However, marginal costs seem not to be significantly associated with PTM. Exporters perform PTM to limit the FX rate effect pass-through to their foreign customers, but they also avoided exploiting PTM to the full, since to do so can substantially reduce their profits.

Keywords: Pricing-to-market; Seasonality; EGARCH; GJR; Error Correction Model; Ordinary Least Square; Generalized Method of Moment; Logistic estimation; Market share; Product differentiation; Marginal cost

To Mum and Dad for their endless love and encouragement

And to Brother for his support

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LIST OF ABBREVIATIONS

ADF	Augmented Dick Fuller
AIC	Akaike Information Criterion
AR	Auto-Regressive
ARCH	Auto-Regressive Conditional Heteroscedasticity
CAD	Canadian Dollar
CIRP	Covered Interest Rate Parity
CTL	Capital-To-Labour
DEM	Deutsche Mark
DHF	Dickey Hasza and Fuller
ECM	Error-Correction Model
ECT	Error-Correction Term
EGARCH	Exponential Generalised Autoregressive Conditional Heteroscedasticity
EMH	Efficient Markets Hypothesis
EP	Export Price
FERE	Foreign Exchange Rate Expectations
FGLS	Feasible General Least Square
FOB	Free On Board
FRF	French Franc
FX	Foreign Exchange
GJR	Glosten, Jagannathan and Runkle
GMM	Generalised Method of Moment
GARCH	Generalised Auto-Regressive Conditional Heteroscedasticity
HEGY	Hylleberg Engle, Granger and Yoo
IFE	International Fisher Effect
IGARCH	Integrated Generalised Auto-Regressive Conditional Heteroscedasticity
IID	Independently and Identically Distributed
IIT	Intra-Industry Trade
IMF	International Monetary Fund

IP	Import Price
IRP	Interest Rate Parity
JPY	Japanese Yen
LCPS	Local Currency Price Stability
LM	Lagrange Multiplier
LOP	Law of One Price
LR	Likelihood Ratio
MC	Marginal Cost
MR	Market Share
OLS	Ordinary Least Squares
ONS	Office for National Statistics
OCSB	Osborn, Chui, Smith and Birchenhall
PD	Product Differentiation
PPI	Producer Price Index
PPP	Purchasing Power Parity
PTM	Pricing-To-Market
SER	Standard Error of Regression
SITC	Standard Industry Trade Classification
TSO	Tariff and Statistical Office
UK	United Kingdom
UIRP	Uncovered Interest Rate Parity
US	United States
USD	US Dollar
VAR	Vector Auto-Regression

CHAPTER 1

INTRODUCTION TO THE THESIS

Since the collapse of the Bretton Woods system of fixed FX rates to more or less floating FX rates in March 1973, the potential impacts of FX rates on the value of firms has attracted substantial interest, amongst both research academics and practitioners. Moreover, the law of one price (LOP) and the purchasing power parity (PPP) predict that the FX rate change is equal to the inflation rate differential between two countries. However, some studies report substantial deviation from PPP in the short run (e.g., Marston 1997; Lai, 2003). In this case, firms will be exposed to FX rate changes which in turn will affect their international competitiveness, when their currency appreciates against other countries' currencies in which they export. In order to retain international competitiveness, firms tend to PTM as discussed in Krugment (1987), Knetter (1993), and Betts and Devereux (2000) so that the full FX rate effect does not fully pass through to importers (see, e.g., Mann, 1989; Knetter, 1989; Hung, 1992-1993; Pritamani, *et al.*, 2002). PTM can be defined as firms absorb some FX rate exposure into their profit margin and adjust their mark-up, so to keep importers' local currency price stable (see, e.g., Krugment, 1987). Alternatively, firms can also hedge the FX rate exposure by using derivatives, but this can be costly (see, e.g., Lewent and Kearney, 1990; Layard-Liesching, 1991). Additionally, there are risks to using derivatives such that the firm's value can decrease (see Joseph, 2000).[1]

[1] The case of Metallgesellschaft (see *Financial Times*, 16th November 1994) illustrates how the inappropriate use of futures and swap contracts can lead to substantial economic losses and potential bankruptcy. The firm made losses close to 1 billion US dollars.

This thesis focuses on the PTM behaviour of UK exporters, using UK export price indices. This is typically the approach used in prior studies of PTM. It focuses on UK data because prior studies show that PTM behaviour varies by country. For example, US exporters have a lower tendency to PTM (see, e.g., Knetter, 1993; Yang, 1998), presumably because of the dominance of the dollar in international trade and the relatively closed nature of the economy. There is very limited research effort directed at PTM for UK exporters. The research that does exist tends to be a sub-part of cross-country analysis based on high level aggregate data (see e.g., Feenstra, 1989; Webber, 2000). And although Kanas (1997) has studied the case of eight commodities for UK exporters using data at a reasonable level of aggregation in quarterly frequency, his sample size is relatively small.

Consequently, this thesis concentrates on the PTM behaviour of a larger set of UK export prices using data at a relatively low level of aggregation. The main results are based on an estimation method that accounts for the time-varying properties of the data. Specifically, both EGARCH and GJR estimation methods are used to test for PTM. This estimation approach has not previously been used for PTM. It is related to studies that test the asymmetric impacts of FX rate changes on export prices (see, e.g., Knetter, 1994; Mahdavi, 2002). However, this study concentrates on the asymmetry in the export prices themselves as opposed to the asymmetry in the FX rates. An important reason for adopting this approach is that export prices can contain asymmetry due to the response of exporters to FX rate changes and their desire to retain international competitiveness. The researcher assumes that exporters take the FX rate as given and alters export prices on observing or expecting a FX rate change.[2] Thus, pricing asymmetries and volatility clustering are estimated in a manner that enables the capture of the impacts of both

[2] The usual approach in those studies is partition of the FX rate a series into periods of appreciation and depreciation.

favourable and adverse shocks in export prices. Following Taylor's (2000) staggered price-setting model of FX rate pass-through, the prices of goods are set at different time points in relation to the perceived permanence of FX rate changes.[3] Similarly, in Kasa's (1992) theoretical model, a monopolist adjusts export prices more in response to permanent, than transitory FX rate changes. This study is, therefore, concerned with the variability and stability of export prices on observing changes in FX rates and price levels. If PTM stabilises prices in the buyer's local currency (Knetter, 1993), exporter prices will be unstable in domestic currency. Export prices will also be relatively unstable if exporters invoice goods in local currencies[4].

Thus, the contribution of the research includes:

i) The preliminary result indicates that the seasonally-unadjusted monthly data contains very little evidence of seasonal unit roots. This result allows the relationship to be modelled without the need to account for seasonal adjustments.

ii) An important result based on the EGARCH and GJR-GARCH models is that there is evidence of PTM in UK export sector prices. The elasticity of PTM varies across industries from 8-73%. Product differentiation and market share are vital factors in the PTM decision, while marginal costs are not.

iii) It is also found that export prices contain very strong ARCH effects implying that the studies that use the standard OLS method are likely to generate inefficient PTM estimates. Additionally, there is strong evidence of conditional volatility. It is worth

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[3] In the case of FX rate pass-through, Otani *et al* (2003, p. 71) find evidence of time-variation in the FX rate pass-through coefficients of Japanese imports whilst Baldwin (1988) finds instability in the FX rate pass-through equation of US import prices.

[4] Tavlas (1997) indicates that 38% of UK exports were invoiced in currencies other than the pound (sterling).

noting that the evidence on asymmetry is somewhat weak – only between 25% and 30% of the estimates are significant. If exporters PTM to reflect the relative value of importers' FX rates, export prices will be more stable, thereby resulting in weak pricing asymmetry.[5] The study's application of the Engle and Ng (1993) size-bias tests confirms that positive and negative shocks have similar impacts on export prices. This finding is important econometrically as it highlights the difficulties that some researchers have in capturing the PTM response of exporters following the asymmetry in FX rates (see e.g., Knetter, 1994).

iv) The study also finds a long-term relation between the PTM variables, thus allowing PTM to be modelled using an error-correction-model (ECM). This finding suggests that in the long run, an equilibrium relationship is established among the variables. This does not mean that PTM is inappropriate, since in the short run exporters can lose their competitiveness.

v) The above results are based on nominal prices. The effects of FX rate changes are mainly important on real export prices. An analysis based on real prices generally confirms the earlier findings of this study.

Finally, the remaining chapters of the thesis are as follows:

[5] The stabilising effects of PTM vary across countries and product category. For example, Gagnon and Knetter (1995) report that Japanese exporters of larger cars (2 litre plus) to the US, Canada, UK, Germany and Norway, off-set about 80% of the FX rate change through price adjustments. The price off-set by German exporters for 203 litre cars is 89% (for Japan) and 45% (for the UK). There is no evidence of PTM by US exporters, except for UK (35%) and Swedish (38%) imports. Other empirical studies report similar price behaviour for US and non-US exporters (see, Mann, 1986; Knetter, 1989).

Chapter 2 presents a critical discussion about existing theoretical and empirical work. This sets the foundation for the empirical work carried out in this research.

Chapter 3 presents the preliminary results for the data used in the analysis. This allows for the determination of the appropriate estimation method for the PTM models. For example, the tests for seasonal unit roots indicate that there is no need to account for seasonal variation in the data. This is contrary to the approach used in prior PTM studies, because it is not necessary to perform a seasonal adjustment or introduce seasonal dummies. Therefore, it avoids severe data distortion caused by seasonal adjustment (Gooijer and Franses, 1997).

Furthermore, in the light of the implications from the empirical results presented in Chapter 4, the model is modified into an ECM estimation in Chapter 5. Various tests are accomplished with the ECM, e.g., Johansen co-integration tests, co-integration restriction tests, impulse response test, and so on. Also, the inflation effect is taken into account in the PTM implementation.

After the time series analysis to discover the existence of PTM behaviour, the thesis proceeds to further research on the reason for the extent of PTM strategy, in Chapter 6. Here, OLS, GMM and Logit Model are employed in the cross-sectional analysis.

Chapter 7 summarises the results and provides some suggestions for future work. Some policy implications based on the findings are also provided in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter critically discusses some existing theories and empirical results that are relevant for the issues of FX rate and product price adjustments in international trade. The chapter also provides the background for the intended area of research and identify different perspectives and methods of analysis and the extent to which variation in empirical results can depend on those approaches. It is expected that new areas for the intended research will be identified in this critical review. The chapter is separated into five sections. Section 2.2 discusses the issues associated with parity relations. This is because the extent to which parity relations hold, has important economic and financial implications for managerial decisions regarding international product-pricing prior to corporate hedging decisions. Section 2.3 introduces economic exposure related to firms' competitiveness. Section 2.4 entails a discussion of the product-pricing strategies of firms and FX rate pass-through, and considers how they can have implications for the profitability of firms. Finally, section 2.5 provides conclusions and summarises the research area that will be explored in this thesis.

2.2 Economics of Pricing and Parity Relations

In international trade, FX rate changes can critically affect the profits obtained from the sale of international goods, both tangible, e.g., cars, and non-tangible, e.g., services[6]. Under the parity relationships, which rely on the assumption of no restriction on the flow of funds and minimal transaction cost, changes in FX rates will eliminate disparity in the monetary value of internationally-traded goods and services. However, empirically, the parity relations have been shown not to hold in the short run (see, e.g., Marston, 1997; Goldberg, 2000; Lai, 2003), which will in turn, result in FX rate exposure. More specifically, the failure of PPP to hold, leads to the situation where bi-lateral FX rates cannot being adjusted to equalise the target rate - the PPP rate across the countries. This results in the FX rate not passing through to the price of foreign goods or services and can lead to a lack international price competitiveness for certain countries, and consequently to a world trade imbalance. In order to retain price competitiveness and market share, firms have to adjust their price to foreign local markets - an issue considered in greater detail below. Risk management actions will also affect the extent to which parity conditions hold, thereby creating a cyclical effect in international trade. This section considers the four parity relationships that have been identified in international finance, and assesses the implications of those conditions on the PTM strategy of firms.

Two important questions arise in this connection, these being: Why do FX rates, interest rates and inflation rates fluctuate? What equilibrium conditions theoretically exist among them, if any? These economic variables are interrelated. The four main parity conditions are now described.

[6] The level of interest rate can also affect the level of investment both domestically and internationally (see, Ceglowski, 1989). Throughout this thesis, reference to the product price can also be taken to mean the prices of services.

2.2.1 Purchasing Power Parity

The PPP condition has its beginnings from LOP whereby the FX rate change can be found as the ratio of the prices of two similar goods in two countries. The PPP equation is given by:

$$\frac{E_t(S_{t+1})}{S_t} = \frac{(1+I_{t,F})}{(1+I_{t,D})} \tag{2.1}$$

where

S_t represents current spot rate at time t;
S_{t+1} represents expected spot rate at time $t+1$;
I_t represents inflation rate at time t;
E_t represents expectations parameter at time t;
$_D$ and $_F$ subscripts denote the domestic and foreign countries respectively[7].

PPP therefore involves the relationship between the bi-lateral FX rate and the ratio of the price of a basket of goods of two countries in terms of inflation. The PPP theory predicts that the observed FX rate change will be consistent with the relationship between the inflation rate differential (see, e.g., Melvin, 1992). Different countries have different inflation rates that lead to changes in domestic prices, which in turn will be adjusted through the future spot FX rate.

The PPP theory tends to apply mainly to traded goods under freely-tradable conditions; under the imperfect competition, PPP will not hold (see, e.g., MacDonald, 1988).

[7] Throughout, the subscripts $_D$, $_F$ and E_t are used to denote those parameters.

Under conditions of perfect competition in both domestic and international goods markets, home and foreign customers pay the same value of money for similarly-traded goods produced at home and abroad due to the FX rate change equating the inflation rate differential between those two countries (see Mann, 1986). If PPP holds, domestic and foreign investors are not exposed to a price difference for the same basket of goods in the two countries. However, since markets are not perfect and parity conditions do not hold, the prices of international goods will vary. Both the LOP and PPP focus on the relationship between goods of different countries. LOP emphasises that a basket of goods is sold in the same value of money in domestic and foreign countries, and FX rates are equal to the purchase power between those two countries (see, e.g. Goodwin *et al.*, 1990; Goodwin *et al.*, 1990). However, if the price of foreign goods changes because of inflation rate changes, theoretically, the domestic price for goods will also change through the FX rate. Under PPP, the FX rate must change to keep the domestic price stable.

However, PPP has been found not hold in the short-run (see, e.g., Cheng, 1999; Cuddington and Liang, 2000; Goldberg *et al.*, 1997, Serletis and Gogas, 2003 and Xu, 2003). Also, several empirical studies find deviations from PPP, their results appear to depend on both the estimation period and econometric method (see, Baum *et al.*, 2001; Francis *et al.*, 2002; Weber, 1997).[8] Moreover, Caporale *et al.*, (2001) and Engle and Rogers (2001), show that PPP does not hold in European countries.

When parity conditions do not hold, FX rates do not adjust to equalise the change of inflation rates between the relative two countries. Thus, the failure of PPP produces FX rate exposure. Conversely, in this circumstance, if exporters assume an attitude of "leave it" (see Rangan and

[8] Baum *et al.*, (2001) find deviations from PPP in an exponential smooth transition auto-regressive (ESTAR) model. Francis (2003) also rejects PPP conditions by using a two-country dynamic optimising model, while Weber (1997) finds the same result using a structure vector auto-regressive (SVAR) model.

Lawrence, 1993), the FX rate exposure will fully pass through to foreign customers' local currency price when PPP/LOP holds. Thus, firms with appreciating currencies will lose their price competitiveness, because their product will become more expensive after the FX rate alters. Consequently, the firm will also lose market share and its degree of profitability in comparison with other firms whose currencies are depreciating, assuming near-perfect substitutability of international goods. Nevertheless, as mentioned earlier, PPP does not hold in an imperfect competitive environment, and this imperfect condition provides international monopolistic firms with an opportunity to adjust their export prices. Consequently, exporters limit FX rate pass-though and keep their importers' local currency relatively stable, which is termed PTM (discussed in detail later).

Alternatively, firms could hedge FX rate exposure by using financial derivatives, when they deal with their foreign asset and liabilities after the trade has been completed. However, one implication of Modigliani and Miller's (1958) study is that firms' value cannot be increased or decreased by hedging, while Joseph (2000) states that firms' value can decrease by using derivatives. Further, Adler and Dumas (1984) conclude that hedge cannot be used to perfectly manage FX rate exposure and therefore protect the firm's value. Moreover, Pringle and Connolly (1993) announce that hedge cannot effectively measure the FX rate exposure in long term. Additionally, hedging, especially external hedging could be very costly (see, e.g., Lewent and Kearney, 1990; Layard-Liesching, 1991), so full currency hedging could cause an equal loss on the currency hedges.

2.2.2 Other Parity Conditions

Since the parity relation system involves the interaction of several components, so the failure of any parity relation will in turn affect the equilibrium for the other parity relations. Therefore, it is necessary to establish what interaction exists between PPP and the other parity relations.

2.2.2.1 Interest Rate Parity

While PPP is concerned with inflation rate differentials, interest rate parity (IRP) is concerned with the relationship between interest rate differentials and what that would mean for the next period's spot rate. There are two versions of the IRP condition: covered interest rate parity (CIRP) and uncovered interest rate parity (UIRP). The CIRP equation could be written as:

$$\frac{F_t}{S_t} = \frac{(1 + i_{t,F})}{(1 + i_{t,D})} \tag{2.2}$$

where

i represents interest rate at time t.

F_t represents forward rate at time t.

Under the CIRP, investors lock their exposure by using a certain forward FX rate which will apply at contract maturity. When CIRP holds, an investor will not benefit/lose from a favourable/unfavourable interest rate in any country, as in theory, the forward rate would adjust to the interest rate differential. The UIRP can be written as:

$$\frac{E_t(S_{t+1})}{S_t} = \frac{(1+i_{t,F})}{(1+i_{t,D})} \tag{2.3}$$

where

$E_t(S_{t+1})$ represents the one-period ahead expected spot rate. As $E_t(S_{t+1})$ is a random variable, it is likely the UIRP will not hold unless markets are perfect.

As for equation (2.3), the expected spot rate $E_t(S_{t+1})$ is unknown at t. Under UIRP, there is no need to hedge FX rate exposure, because when the interest rate of a country decreases (increases), its FX rate will appreciate (depreciate) relative to that of the other country.

Nevertheless, UIRP has been rejected in some empirical works (see, e.g., Marston, 1997; Goldberg, 2000; Baillie and Osterberg, 2000; Berk and Knot, 2001). More specifically, Anker (1999) and Francis *et al.*, (2002) suggest that the failure of UIRP to hold, is due to the existence of a time-varying risk premium. Deviations from UIRP are also found when different estimation methods are applied (see, e.g., Bordo and MacDonald., 2003; Drakos, 2003; Pesaran *et al.*, 2000)[9]. Furthermore, Kollmann (2002) and Faust and Rogers (2003) explain that monetary policy causes the rejection of UIRP.

Thus, the failure of UIRP to hold, causes the change of the bi-lateral FX rate so this does not equalise to the differential of the interest rate in the home and foreign countries. The influence on the FX rate also consequently affects the balance between the FX rate and the inflation rate across those two countries (PPP). In this case, firms can adjust their product price to account for

[9] For example, those studies employ a vector auto-regressive (VAR) framework, while co-integration captures the long-run relations among a set of variables. Evidence that a long run exists in this setting does not imply that in the short run, parity relations hold.

the impact of variation in interest and FX rate changes but there are limits as to how far this strategy can be applied (see the discussion in the next section for more detail).

2.2.2.2 International Fisher Effect

The International Fisher effect (IFE) seeks to address the relationship among the real interest rate, nominal interest rate and inflation rate. The IFE can be written as:

$$\frac{1+r_{t,F}}{1+r_{t,D}} = \frac{(1+\rho_{t,R,F})}{(1+\rho_{t,R,D})} \times \frac{(1+E_t(I_{t,F}))}{(1+E_t(I_{t,D}))} \tag{2.4}$$

where

r represents the nominal interest rate associated with each country;
$\rho_{t,R}$ represents the real interest rate in each country.

The IFE states that when money flows internationally, the international return would be adjusted for domestic inflationary expectations so as to equal local interest rates. Some empirical studies show that the IFE does not hold in the short run even under different data sets and estimation methods (see, e.g., Fahmy and Kandil, 2003; Valkanov, 2003; Koustas and Serletis, 1999; Chu *et al.*, 2003). In this case, the failure of the IFE to hold, causes the change of interest rates to be unequal to the real interest rate differential multiplied by the expected inflation rate differential between the two countries, and this in turn leads to FX rates exposure. That is, FX rates deviate from what is predicted by the LOP and PPP. Consequently, in order to maintain price competitiveness in the international market and avoid the FX rates risk, firms would need to keep the local currency price of goods stable by reducing their mark-up, via PTM, or the use of derivatives.

Comparing Eq. (2.1), (2.3) and (2.4), it can be recognised that PPP, UIRP and IFE are inter-related through the expected spot rate and the actual spot rate. Also, the difference in the inflation rates between two countries is equal to the differential of interest rates across the two countries, as well as the real interest rate differential multiplied by the expected inflation rate differential. If the level of interest rate can affect the level of investment (see, e.g., Ceglowski, 1989), the IFE condition has economic effects both on the return from international investments and the cash flows from the international trade, through the PPP effect.

2.2.2.3 Foreign Exchange Rate Expectations

Expectations about future FX rates are important determinants of the current values of cash flow. Under the foreign exchange rate expectation (FERE) theory, agents use all available information to set forward FX rates, so the forward rate is equal to the future expected spot rate. The forward rate expectations hypothesis can be depicted as:

$$F_t = E_t(S_{t+1}) \tag{2.5}$$

This means that if $F_t - E_t(S_{t+1}) = \varepsilon_t$ and ε_t is zero mean and is white noise, then agents would have used all available information in predicting the expected spot rate. Empirical tests of the expectations hypothesis are difficult as it assumes that agents know the model generating equilibrium returns and that they use all available information to determine the future price (see, Minford and Peel, 1983).

Since $E_t(S_{t+1})$ is not directly observable, researchers employ the FX rate forecasts of agents to assess the expectations hypothesis (see, Liu and Maddala, 1992). Alternatively, the unbiasedness hypothesis is set in terms of the forward rate, F_t and the realised spot rate, RS_{t+1}. Under the assumption that the forecast error ε_t is stationary, F_t is unbiased if $F_t - RS_{t+1} = \varepsilon_t$. That is, ε_t is a sequence of errors with an average value of zero. If ε_t =0.0, the future value is perfectly predictable such that F_t correctly predicts RS_{t+1}.

Some empirical studies (see, e.g., Torres, 2000; Nieuwland *et al.*, 1998; Benassy-Quere *et al.*, 2003) indicate that the expectations hypothesis does not hold due to the existence of a risk premium. In addition, Elliott and Ito (1999) indicate the rejection of forward market efficiency because of a forward premium. The FX rate expectations hypothesis has been rejected in several studies (see also, Campa *et al.*, 2002; Verschoor and Wolff, 2001; Tauchen, 2001). When the realised FX rate is different from the expected rate[10], firms will experience a FX rate loss/gain.

2.3 Economic Exposure

Following from the discussion about the parity relations, the issues associated with PTM and corporate exposure are now considered. The impact of FX rate movements on commodity prices

[10] Under the efficient market hypothesis (EMH), the forward premium (discount) equals the expected currency appreciation (depreciation). That is, $\Delta S_{t+k} = \Delta S^e_{t+k} + \varepsilon_{t+k}$, $\Delta S^e_{t+k} = E[\Delta S_{t+k} | I_t]$, where $\Delta S_{t+k} = S_{t+k} - S_t$, $\Delta S^e_{t+k} = S^e_{t+k} - S_t$, S represents the log of the spot rate while S^e represents the log of the expected spot rate, E is the mathematical expectations operations, I_t is the information on which the agents base their expectations and ε_{t+k} is a random forecast error (MacDonald and Torrance, 1990).

becomes more important and substantial for international competitiveness because of the globalisation of trade (see, e.g., Layard-Liesching, 1991). Economic exposure will result in a reduction or loss of future cash flows which would be different from the expected cash flow value. The reduction of expected cash flow can also be the outcome of (say) an appreciation of a firm's currency such that the firm's goods become less competitive in foreign markets. According to the PTM literature, firms adjust the mark-ups, in order to protect their competitiveness and keep the cash flow relatively stable (the detail of PTM will be discussed later).

FX rate exposure has been typically classified into economic exposure, transaction exposure[11], and translation exposure[12]. However, Pringle and Connolly (1993) argue that in reality, economic exposure is the only important currency exposure. More importantly, the core research objective of this study has been focused on PTM implementation, which is likely to be operated to diminish the economic exposure.

Economic exposure relates to expected cash flows. Unanticipated movement in FX rates will affect the expected future cash flow and, therefore, affect firm value. As such, economic exposure is also referred to as operating or cash flow exposure (see, e.g., Allayannis and Ofek, 2001; Booth and Rotenberg, 1990; Luehrman, 1990). Economic exposure also affects a firm's profit margins by altering the cash flows of its inputs and outputs (Pringle and Connolly, 1993). In this sense, all firms are exposed to FX rate risk, even domestic firms with no foreign assets and

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[11] Transaction exposure is usually associated with contractual commitments to sell a given number of goods at a pre-set price at a fixed time in a contract, but FX rates fluctuate in the period between when the contract is signed and the payment is made. Thus, there might be a loss in sellers' cash inflows when they convert from foreign currency into the home currency (see, e.g., Chow *et al.*, 1997).

[12] While economic exposure and transaction exposure happen in cash flow, translation exposure exists in the exchange of consolidated and subsidiary financial statements from foreign to home currency (see, e.g., Jorion, 1990 and Choi, 1986).

liabilities. Similarly, Hekman (1985) shows that FX rate movements affect the elasticity of foreign currency operating revenues, and then the elasticity of a firm's value.

Moreover, with respect to supply and demand conditions, firms' competitive position may suddenly alter due to FX rate changes, because firms whose currency experiences depreciation will become more competitive. Empirically, Pick (1990) shows that FX rate fluctuations are negatively relative to US agricultural exports. Pringle and Connolly (1993) state that according to whether a firm sells or acquires its products in a foreign currency, either directly or through a supply chain, economic exposure could be either direct or indirect. Also, some studies emphasise that economic exposure is long-term risk. FX rate movements alter the value of the firm through its long-term future cash flows (see, e.g., Chow *et. al.*, 1997). The explanation could be because relative PPP[13] does not hold in the short term, and economic exposure lasts in the long run (Pringle and Connolly, 1993).

Economic exposure has attracted a great deal of research attention. For example, Krugman (1987), and Froot and Klemperer (1989), develop models of FX rates pass-through that have implications for the degree of exposure facing a firm. Marston (2001) demonstrates that the industry structure is an important determinant of economic exposure. He indicates that the amount of competition in an industry can affect the extent of cash flow exposure. Furthermore, Booth and Rotenberg (1990) suggest that the measurement of economic exposure should relate to price, FX rate, and interest rates as well as the role of costs. The extent to which both FX rate and interest rate parity conditions hold, will affect the degree of economic exposure.

[13] PPP has been identified as absolute PPP and relative PPP, but the requirement of calculating absolute PPP is never satisfied in practice (Pringle and Connolly, 1993).

2.4 Price Adjustments and Exchange Rate Movements

As indicated earlier, the failure of parity relationships to hold leads to the FX rate fluctuation, which will in turn, contribute to FX rate pass-through. The extent of FX rate pass-through can have implications for the volume of sales, marginal cost, price, and so on. The empirical literature has typically focused on the FX rate-price effect (see, e.g., Knetter, 1989; Mann, 1986). Of course, the risk management strategy of a firm can also have impacts on the firm's level of international trade. However, risk management that takes the form of the use of derivatives and internal hedging techniques often comes about following the denomination of financial amounts of foreign currencies. PTM will apply prior to risk management strategy. This section therefore, discusses how PTM implementation limits the FX rate pass-through.

2.4.1 Foreign Exchange Rate Pass-Through

Menon (1995, p. 367) defines the FX rate pass-through as:

> "The degree to which exchange rate changes are reflected in the destination currency prices of traded goods."

More specifically, the pass-through relationship is defined as the percentage change in importers' local currency prices (prior to exporting), following a change in the nominal FX rate. It refers to the relationship between local currency import price and FX rate. Assuming that there is fluctuation in FX rates, this leads to the change of the foreign price for a basket of goods.

Furthermore, Mann (1986) states that the fundamental principle for the analysis of the FX rate pass-through is LOP. Under the condition of perfect competition[14], the FX rate is equal to the importers' local currency price of similar goods traded in the domestic and international market. In this sense, when PPP holds, the FX rate effect will fully pass through to the importers' local currency prices, since perfect market competition exist. This phenomenon is also named complete FX rate pass-through (see, e.g., Hung, 1992-1993). However, in reality, market competition is imperfect, so problems will occur when firms do not adjust their export prices to reflect changes in FX rates. Particularly, if the FX rate movement results in an appreciation of the home currency, the product price becomes less competitive in the foreign market, and hence its export volume is predicted to drop. As a consequence, the firm's profits are likely to fall. Since complete pass-through would produce a trade imbalance in the international market and lead to firms' bankruptcy, firms need to operate PTM to limit the pass-through effects.

It is worth noting that many studies show that the FX rate pass-through to importers' local currency prices works on a one-to-one basis in imperfect competition, and this is more likely to happen for monopolist firms, with significant (foreign) market segments and market power, because they are extremely competitive and their market share is comparably stable in the international market. For example, building on Dixit's (1989) study, the dollar FX rate pass-through coefficient for importers' local currency prices is found to be equal to one in US export sectors. Similarly, Mann (1986) concluded that many US exporters appear to have been relatively insensitive to FX rate changes and do not adjust mark-ups in response to FX rate fluctuation. Furthermore, there is some evidence (see, e.g., Rangan and Lawrence, 1993; Hung *et al*, 1993; McCarthy, 1999) to show that changes in FX rates have little effect on the US export firms. Those firms tend to keep the product price unchanged, when FX rates fluctuate. This finding

[14] Perfect competition means zero profits or no profit in excess of "normal economic" profits (Mann, 1986).

might reflect the competitive nature of US goods in international markets. Thus, on the importers' side, complete pass-through has normally been found in small open countries (see, e.g., Pritamani *et al.*, 2002). Specifically, exporters do not PTM for Hong Kong, so customers in Hong Kong have to take the cost increased by the FX rate pass-through (see, Parsley, 2003). Nevertheless, some researchers suggest that US manufacturers should pay attention to the price adjustment in conjunction with the FX rate fluctuation in their international trade. For example, Pritamani *et al.*, (2002) illustrate that US multinational firms can pass through the dollar FX rate effect to their importer's local currency prices, and then maintain their profit margin, but this may cause them to lose some foreign sales and market share. Somewhat surprisingly, Rangan and Lawrence (1993) imply that recent research has been interested in why firms might not fully pass through the FX rate changes into prices if they have market power. They interviewed senior executives responsible for pricing in three major US exporting firms, obtaining results showing that PTM behaviour was more popular than the complete pass-through behaviour. Thus, there is a distinct difference between the econometric findings and the results of interview surveys. The reasons could be inefficient and biased estimates caused by employing unsuitable data sets and estimations (the limitations of previous data sets and methods used in PTM will be discussed later). For example, most of the cross-country studies are based on highly aggregated data of export and import prices (see, e.g., Betts and Devereux, 2000; Yang, 1998). Furthermore, UK data is usually included in such studies at that level of aggregation. One of the aims of this thesis is to examine the PTM strategies of UK exporters using a lower level of aggregation for exports.

The pass-through literature identifies various degrees of PTM behaviour that introduce zero and incomplete pass-though (see, e.g., Knetter, 1993). In contrast to complete pass-through, zero pass-through allows the domestic-currency export prices of exports to fall (or rise) to the same extent that the home currency has appreciated (or depreciated). This could be caused by local-currency price stability strategy (LCPS) (see, Knetter, 1993). In this manner, firms try to reduce their domestic-currency export prices in order to keep the same foreign country's local-currency price for their foreign customers when the foreign export prices are converted via the flexible FX rate, so that they can retain their market share. However, Hung (1992-1993) argues that even if a firm keeps the same amount of foreign currency profit under zero pass-through, the profit will be less when translated into the home currencies. Thus, the firm's profit is still likely to decline. Similarly, Pritamani *et al.*, (2002) agree that firms could preserve their market share by stabilising importers' local currency price, but this leads to a loss in profit. This is because firms have to reduce the mark-ups to keep the importers' prices constant, but the mark-ups are always very limited. Empirically, zero pass-through has been found on German exports (see, Knetter, 1989), but this is not a common finding in previous studies, possibly because the mark-ups do not allow exporters to reduce the price to offset the FX rate fluctuation in full. More importantly, Deveruex and Engle (2002) argue that PTM can be one of the reasons that PPP does not hold, because PTM limits FX rate pass-through and causes bi-lateral FX rate cannot equal to the PPP rate across the two countries. Therefore, LCPS (the highest level of PTM) would make the FX rate exposure more serious in the macro-economy. By contrast, the incomplete pass-through phenomenon has dominated in international trade.

Moreover, Hung (1992-1993) states that there is a type of pass-through between complete and zero pass-through, which is incomplete pass-through. Incomplete pass-through can balance the effects between price/volume and translation. He also points out that compared with zero pass-through, a given appreciation of the exporters' home currency gives less export profits because a higher price to importers causes a loss in the volume of sales. However, more export profits are produced through a currency translation effect, since the increase in the export price in response to a home currency appreciation, creates larger export profits. Furthermore, Pritamani *et al.*, (2001) and Knetter (1989) illustrate that the reasons for incomplete pass-through are based on market segmentation, which can be created by transaction costs, tariffs and other barriers. Under market conditions, and assuming segmented markets, exporters may choose to change the profit margin to increase its profit when FX rate fluctuations are associated with large changes in demand from their importers, and so on. For example, Japanese exporters have been found to reduce their profit margin by about 4% to US importers (Klitgaard, 1999). As a consequence, incomplete pass-through leads to the FX rate effect partially passing through to importers' local currency prices. Building on Tange (1997), there are two cases that result in a decrease of domestic-currency export prices and lead to incomplete pass-through. In one case, because of the home currency's appreciation, imported material charges are less and the production costs decrease, so export firms may reduce domestic-currency export prices. In the other case, multinational firms reduce their mark-up to discriminate the product prices in both domestic and foreign markets. The latter is called PTM (Krugman, 1987). (The details of PTM will be presented later).

Thus, incomplete pass-through has been emphasised in international trade and many researchers have found this phenomenon in their empirical studies. Of course, incomplete pass-through can be the outcome of PTM. For example, Hooper and Kohlhagen (1978) analyse the impact of FX rate volatility on bi-lateral and multilateral trade flows among the US, Germany, and several other industrial countries. Their results show that, except for the US, an FX rate appreciation is associated with a decline in trade price and subsequent stability in the trade volume. Furthermore, according to Gron and Swenson (1996), incomplete FX rate pass-through is found in the US automobile market from Japanese exporters. Finally, Hung *et al.* (1993) show that, compared with previous studies, the impact of FX rate changes on prices is becoming smaller. This is because firms adjust their export prices, so as to avoid their foreign market price being affected by FX rate changes. More specifically, their results exhibit significant distance between the USA, Japan, and Germany in their export-pricing behaviour. For example, Japanese and German exporters tend to keep their foreign market prices little affected by FX rate changes, so the FX rate effect incompletely passes through to the importers' local currency prices. In contrast, US exporters are insensitive to the FX rate fluctuation, so the FX rate effect completely passes through to the importer's cost.

In summary, the degree of pass-through varies and depends on the proportional effect of the FX rate change on importers' local currency prices, which is determined by the implementation of the PTM. There is also a country effect such that US exporters PTM much less than European exporters. If the proportional relationship between local currency import prices and FX rates holds, pass-through will be complete and PPP is more likely to hold. Under complete pass-through, firms do not change their domestic-currency export prices, and even their home currency becomes stronger against their importers' currency, so the FX rate changes fully pass through to the importers' local currency. This would benefit those firms if they were able to retain their international competitiveness and market power. Otherwise, complete pass-through can cause them to lose market share, profit, and then face bankruptcy, particularly if near product substitutes can be found by importers. Conversely, zero pass-through reveals that FX rate changes have little effect on importers' local currency prices, because firms eliminate the FX rate effect by adjusting their domestic-currency export price in the same percentage as the changes in the FX rate, which arises from local currency price stability strategy.

2.4.2 Pricing-to-Market

As already indicated, FX rate pass-through is the relationship between local currency import prices and FX rates. Moreover, in the international financial market, pass-through relationships are phenomena, which arise from firms' price adjustment strategies. More importantly, incomplete pass-through has been regarded as the most optimal phenomenon in which firms' profitability can be protected, which is the consequence of PTM strategy. However, a number of questions arise concerning PTM, for example, how well-understood is PTM? How does movement in FX rates transfer to PTM? How do firms use PTM strategy to adjust their prices and ensure the value of firms? Obviously, the answers to these questions are very beneficial for firms' management decisions, especially in relation to price adjustment. This section, therefore, provides an insight into the PTM strategy.

2.4.2.1 Definition of Pricing-to-Market

PTM means that when the FX rate changes, exporters' mark-ups undergo a destination-specific adjustment in response to the fluctuation (see, Krugman, 1987). Moreover, according to Rangan and Lawrence (1993, p. 343), PTM refers to

> "The behaviour of exporters, who, in an attempt to maintain their foreign currency prices to an optimal level, absorb at least some portion of changes in the foreign exchange rate in their profit margins."

Under PTM strategy, in general, exporters will obtain more profit margins on their foreign sales when their home currency appreciates. This is because they take into account their knowledge of local market conditions and their competitors' prices, and on the basis of this information, discriminate their foreign market prices from their home currency prices. More specifically, PTM theory emphasises that, when sellers' currencies have appreciated against their buyers, sellers reduce mark-ups to buyers, thereby stabilising importers' local currency prices at an optimal level related to a constant mark-up policy. The PTM model is associated with fluctuations in the mark-up of price over marginal cost of exporters. Particularly, some studies[15] indicate that PTM applies to the assumption in which the market is segmented and there is imperfect competition. In this circumstance, firms are monopolistically competitive and have the ability to set different prices in different market segments. However, PTM is also found in currency depreciation (see, e.g., Marston, 1990). When exporters' currency depreciated, they increase mark-up via PTM and keep the foreign local currency price stable.

However, PTM departs from the LOP or PPP theory. If there are unanticipated shocks to the FX rate, deviations from LOP and PPP occur for firms that utilise PTM strategy (see, for example, Betts and Devereux, 2000; Devereux, 2000; Duarte, 2003; Obstfeld and Rogoff, 2000). Since firms set different domestic-currency export prices in different foreign markets, so their prices discriminate across foreign destinations, as well as between domestic and foreign markets.

It should be noted that PTM is inversely related to the FX rate pass-through. When firms do not adopt a PTM strategy, the FX rate changes will fully pass through over time to the price

[15] See, for example, Adolfson, 2001; Gron and Swenson, 1996; Gil-Pareja, 2003; Sopraseuth, 2003; Feenstra *et al.*, 1996; Irandoust, 1999; Duarte, 2003; Bergin, 2003; Hamid, 1995.

expressed by their importers' currency. Alternatively, if firms achieve complete PTM in the form of LCPS, then FX rate changes have little effect on import price, which in turn reflect zero FX rate pass-through. Additionally, this is considering that the more firms use PTM strategy, the lower the FX rate effect passes through to their importers' local currency prices.

More importantly, many researchers do appreciate PTM implementation. For example, Koutmos and Martin (2003) announce that PTM can help exporters to keep foreign market share and retain a stable cash flow. Also, PTM can solve the trade imbalance problem caused by FX rate changes (see, Tang, 1997 and Irandoust, 1999), since the PTM functions to keep sales volume and market share. Thus, PTM plays an important role in protecting firms' profitability and their market value. Furthermore, under a flexible FX rate regime, PTM enhances consumption (see, e.g., Carre and Collard; 2003 and Duarte, 2003), investment (see, e.g., Sopraseuth, 2003), income (Carre and Collard, 2003), and protects home welfare (see, e.g., Obstfeld and Rogoff, 2000; Aizenman, 2004; Betts and Devereux, 2000).

2.4.2.2 Influences on Firms' Pricing-to-Market Strategy

In the following section, the elements that affect PTM decisions in both macro-economic and micro-economic environments are discussed. Broadly, the micro-economic components could be market share, market power, firm-specific characteristics, product's mark-up, its cost, and/or price elasticity of demand. Alternatively, in macro-economy, the extent of PTM behaviour can also be determined by inflation/FX rate volatility. This situation is clarified as follows:

Market Share

In international trade, market share could be considered as the ratio of the amount of exporters' sales to the total sales at the particular destination market. According to Feenstra *et al.* (1996), when the exporters have a very large share of the total destination market share, the FX rate pass-through is predicted to be high. Alternatively, this implies that the degree of PTM tends to be lower for exporters who have a very large share of the total destination market share. When the market share is very high, the monopolist firms face little competition in the international market, and hence have less incentive to adjust their price when the FX rates fluctuate. Thus, PTM behaviour is negatively associated with exporters' market share. Lawrence's (1983) results indicate that PTM is not so popular for US exporters, and they pass through the FX rate changes to the importers' local currency prices or they do not adjust their price when the US dollar appreciates. Thus, US exporters tend to sell their products at a higher price, so they can gain more profits (Yang, 1998).

However, some (see, e.g., Falk and Falk, 2000; Bowe and Saltvedt, 2004) argue that PTM is expected to be zero, when exporters have little market share or dominate the market in the international market. This is because the small exporters do not have any ability to adjust prices, while the monopolists are extremely competitive and it is not necessary for them to change their export prices even though the FX rate changes. Moreover, PTM is also expected to be less in developing countries, where firms have less market share, and subsequently less market power to adjust prices (see, Aizenamn, 2004). Nevertheless, it is worth noting that Athukorala and Menon (1995) found that PTM is a common feature for Swedish machinery exporters, and they emphasised that no matter how small a market share/country is, as long as it has a range of specialised products, it can still be a price maker in the world market. However, Athukorala and Menon (1995) used quarterly data and their sample size was very small, both of which features must affect the reliability of their results.

Some studies report on a non-linear relationship between PTM implementation and market share, despite such studies having adopted a standard OLS estimation approach. In fact, this is common in all the empirical work in the area. Yang (1998), for example, investigates the PTM behaviour based on a cross-sectional analysis. His results show that at small to intermediate market shares, the theoretical relationship between PTM and market share is potentially non-linear because of PTM's sensitivity to assumptions concerning the character of consumer demand and firm interactions. Similarly, Feenstra *et al.,* (1996) examined the FX rate pass-through relative to market share in the world automobile trade. Their findings demonstrate that French exporters have the lowest FX rate pass-through among the investigated countries[16], Swedish exporters have about 30% more than French exporters, and German and US exporters have pass-through about 60% more than French exporters. Feenstra *et al.* (1996) indicate that PTM is highest when the exporters' market share in the destination market is around 40%, and lowest when the market share approaches 100% for the automobile trade. The relationship is significantly non-linear during the period. It is worth noting that, it would in turn have important implications for the choice of the method used for estimation. That is, the non-linear relationship established from those empirical works implies that linear estimation methods would not be appropriate for drawing statistical inferences since the parameters of the model would have been inefficiently estimated. This study shows later that the data used for estimating PTM contains strong ARCH and asymmetry effects, which can affect the parameter estimates if not allowed for.

[16] The investigated countries include France, Germany, US, Norway and Swedish.

Thus, the reliability of such prior studies is questionable because of the likely unreliability of standard OLS to account for those effects. For example, original market share could enhance PTM strategy, especially when exporters face some international major importers, e.g., exporters to the US always want to provide a lower price to the competitive market, thus, the original market share should motivate them to PTM and gain more market share in the US market. Baqueiro, *et al.,* (2002) argue that when the international market is very competitive, all firms try to chase a larger market share, so they have to avoid passing on the FX rate exposure to their customers through increased prices. If exporters adjust their prices for international goods in the light of FX rate changes, there is no reason to believe they capture the variation in FX rate changes in a linear manner. This suggests that the export price adjustment can be asymmetric depending on the degree of risk aversion. Furthermore, Knetter (1993) compares PTM behaviour internationally, revealing similar PTM behaviour among British, German and Japanese exporters, showing from 36-48% of the effect of exporters' FX rate changes on importers' local currency prices being offset by exporters' mark-up adjustment. This implies that all these exporters try to provide competitive price in the international market no matter what their existing proportion of market share. In addition, many empirical studies[17] demonstrate that the market structure is a crucial determinant of the variations of FX rate pass-through. Hence, any analysis that only considers market share and ignores the actual competitive market structure, is arbitrary.

Finally, in international market, if exporters are competitive, they can also use various currencies to invoice their importers, as a strategy to facilitate price discrimination effectively (see, e.g., Gil-Pareja, 2003). Furthermore, Bowe and Saltvedt (2004) suggest that invoicing decisions are based on several considerations, including the exporters' market position, the size and dependency of

[17] There is quite a long list for such studies (see, e.g., Froot and Klemperer, 1989; Kadiyali, 1997; Hung, 1992-1993; Rangan and Lawrence, 1993; Mann, 1986; Bowe and Saltvedt, 2004; Pritamani *et. al.*, 2002; McCarthy, 1999)

the importers, and the currency of the importing country. In international business, there are three main strategies for invoicing: domestic currency invoicing, foreign currency invoicing, and vehicle currency invoicing. More specifically, they indicate from their survey that exporters with power will invoice in the exporting currency. This invoicing strategy locks exporters' FX rate exposure, when the currencies move in an inappropriate direction. On the contrary, the importers' local currency will vary depending on the fluctuation of the FX rate. However, when the third country competition is strong, the competitor's currency will be invoiced as a vehicle currency (see, Bowe and Saltvedt, 2004). For example, the US dollar is commonly used in the international trade market. In this case, exporters engage in both price comparison and competition within the specific market environment. Obviously, among the above three invoicing strategies, exporting currency invoicing is more likely to have the probability and necessary for PTM, because importers' local currency prices are exposed to the FX rate and the exporters have the ability to price discriminate across markets.

Market Power

With regard to exporters, the greater their share in the international market, the more market power they are likely to have, in contrast with the case for importers. Indeed, if one country's importers have a higher demand schedule relative to the importers of other foreign countries, they are likely to have more market power and, therefore, the degree of PTM from exporters to this country will be higher. Under imperfect competition, the goods market would be segmented, which would make some importers have more pronounced market power than the others. Empirically, importers' market power has been found to be significantly related to FX rate pass-through. For example, US importers have an incentive to put pressure on their exporters to adjust the export prices to an optimal level, thus affecting the extent of pass-through (see, e.g., Wei and Parsley, 1995; Engle and Rogers, 1998). From the case study of US vanilla bean imports conducted by Rakotoarisoa and Shapouri (2001), it is found that in order to gain a part of the market share in the US, foreign exporters have to exercise PTM and compete on price as the FX rate changes. Moreover, a recent study by Marazzi and Sheets (2006) indicates that the FX rate pass-through to US import prices has been found declining further from 0.5 to 0.2 over the last decade. Conversely, US importers can take advantage of the FX rate movement, adjust import prices downward, and then absorb some profit margin from the FX rate changes.

On the contrary, when importers have little market power, they do not have the ability to discriminate in relation to the prices provided by exporters in reaction to FX rate movement. This seems more likely to happen in developing countries. From the findings by Parsley (2003), foreign exporters do not undertake PTM in Hong Kong, probably because Hong Kong is a small market and has no market power. Hence, the price in Hong Kong is very flexible. Hung *et al.*, (1993) demonstrate that the smaller and more open countries have greater coefficients of FX rate pass-through. Campa and Minguez (2006) also found that the degree of FX rate pass-though depends on the openness of countries. Furthermore, Falk and Falk (2000) investigate the PTM strategy of German exports to a group of countries, showing that Germany exporters reduced their mark-ups significantly to the US, Japan, Italy and Spain when the FX rate fluctuated. However, PTM is not in evidence in some other countries, e.g., the UK, Greece, Sweden, Canada, Australia, because they have lower import demand.

However, Rangan and Lawrence (1993) argue that market power can be associated not only with market structure, but also with superior technology. Obviously, superior technology[18] implies higher competition, which induces imperfect competition and then affects the PTM decision. According to Bergin (2003), when the availability of foreign technology is higher than that at home, it will tend to lower the relative foreign price level. This is because foreign-manufactured goods are more efficient and, thus, highly desirable and competitive. In order to gain some market share in the foreign country, exporters have to sell goods cheaper than at home. Thus, differentiated national relative price levels, and PPP do not hold, and an environment for PTM is created. This therefore reveals that the higher the technology in the importers' country, the higher level of PTM will be performed by exporters.

Firm-Specific Characteristics

Some empirical studies indicate that firm-specific characteristics, such as economies of scale and profit orientation, are important in PTM behaviour (see, e.g., Irandoust, 1998). Firstly, economies of scale of firms may motivate PTM behaviour. For example, in order to reduce costs created by economies of scale, even the source countries' currency appreciates since exporters tend to keep the cost low for importers rather than pass on to them the cost caused by FX rate movements. Thus, exporters will reduce the export prices and partially stabilise the importers' local currency prices. In the same manner, differences in profit orientation between firms and countries can also affect the PTM behaviour (see, e.g., Irandoust, 1999), because different firms are based on different source country-specific characteristics. When they are enterprising, different firms have various kinds of ownership and control structure. Moreover, with regard to the relationship

[18] Empirically, a cross-industry study demonstrates that FX rate pass-though is higher in high –technology industry (Landon and Smith, 2006).

between industry-specific factors and FX rate pass-through effects, Feinberg (1996) finds a limiting effect of US market concentration on FX rate pass-through into both domestic and import prices. Also, imported intermediates (e.g., wage cost) play an important role in the decision to pass through the FX rate effect into domestic prices.

Furthermore, according to Rangan and Lawrence (1993), the variability of FX rate pass-through also depends on the managerial behaviour ('take it or leave it'). When managers are inward-looking, they do not care about foreign sales, and are thus not motivated to discriminate their price from that of other foreign competitors in order to gain more market share. This behaviour thus produces high FX rate pass-through.

Notably, the PTM behaviour of Japanese export firms has been considered in previous studies. Marston[19] (1990) and Baba (1997) investigate PTM in Japanese firms and point out that the PTM elasticity is significantly greater than zero. Furthermore, Irandoust (1998) examined the degree of pass-through of FX rate fluctuations to the consumer price paid in Sweden, his results revealing that PTM behaviour was more pronounced in Japanese export pricing than in that for British, Italian, and German exports. Tange's (1997) findings also show that the degree of PTM in Japan is higher than that in Germany. Therefore, the significant PTM behaviour reveals that Japanese exporters are intended to gain more market share, so they operate PTM by reducing the mark-up.

Hence, when firms make the PTM decision, they always need to do this based on their own situation. Different firms have diverse targets and specific characters, and consequently different strategies are required.

[19] Marston's investigation was from 1979 to 1987, which included a depreciation of the Yen in real return in the early 1980s followed by a sharp appreciation.

Mark-up

In PTM theory, by reducing mark-up, exporters adjust the domestic-currency export price and therefore, partially stabilise local currency prices for foreign customers. This implies that positive stationary mark-up gives the possibility of operating a PTM strategy. Without mark-up, firms would not have the ability to price discriminate across foreign markets. In fact, Campa and Goldberg (1995) demonstrate that FX rate pass-though is lower in the case of industries with higher mark-up, because they have more ability to adjust the prices. According to Bowe and Saltvedt (2004), a positive mark-up could arise under two different scenarios. Firstly, in a perfectly competitive market, prices are supposed to equal the marginal cost. However, when the wholesale producer prices represent marginal costs badly, firms can get some mark-up from the deviation. Secondly, in an imperfect competitive market, more powerful firms have the ability to set prices regarding different marginal costs. Profit-maximising firms can set different prices to separate markets under first-order condition, in which marginal revenue equals marginal cost (see, e.g., Rakotoarisoa and Shapouri, 2001; Irandoust, 1998; Parsley, 2003; Betts and Devereux, 2000; Tange, 1997).

Building on Irandoust's (1999) study, when traded goods mark-up is determined by the price elasticity of demand in the destination market, firm should fix prices at a mark-up over the marginal cost. In other words, the curvatures of the demand functions of exports and of the marginal cost curve, determine the mark-up, and then affect the PTM behaviour. Under the circumstance that both demand elasticity for exports and marginal costs are constant, exporters are competitive and PTM will not be applied. If neither the export demand elasticity nor the marginal cost is constant, PTM is regarded as a strategy for firms. Finally, when the demand for exports is infinitely elastic, like the perfectly competitive environment, the individual exporter is a price-taker and has to fully absorb FX rate changes. Thus, the price strategy should be complete PTM (or LCPS), and no pass-through will take place.

Marginal Cost/Cost

As mentioned earlier, exporters operate PTM by reducing mark-up that should be fixed over marginal cost. In mark-up pricing, the mark-up ratio should be equal to the price divided by marginal cost, and thus, when the exporters' currency appreciates, the marginal cost of their products should be reduced (see, e.g., Baba, 1997). This is because their raw materials cost less when they are imported from foreign countries. As a consequence, when the return to scale (e.g., mark-up) is constant, exporters with currency appreciation should have more space to reduce their mark-up and keep their foreign costumers' local currency price relatively stable, because the marginal cost is decreased (see, An, 2006). Notably, in international trade, the marginal cost is also crucial in the PTM decision and many studies have involved marginal cost in their PTM models (see, e.g., Parsley, 2003; Marston, 1990). More particularly, Yang (1998) indicates that when the demand is constant, exporters with flexible marginal cost are more likely to control the FX rate effects pass-through to importers' local currency prices, and try to keep their sales in the destination market stable. If production changes lead to large variations in marginal cost, then the variable marginal cost induces various mark-ups, which allows exporters to have more capability to operate PTM. Therefore, the variations of marginal cost have a positive relationship with PTM strategy.

However, marginal cost can also be affected by productivity. Bergin (2003) has investigated PTM behaviour and relative price levels, finding that higher productivity raises foreign prices relative to those in the home country, and then diminishes the extent of PTM. He explains this occurs because firms have to use labour more intensively to achieve the higher level of production. This implies that firms also need to pay workers more wages, and in consequence, the unit cost of the production is expected to be increased, which results in a narrow mark-up and a reduction in the PTM. For instance, a Japanese fashion firm might sell clothes to the UK, and find a particular line becomes very popular, meaning the UK importers place more orders, thereby requiring higher productivity and, hence, higher costs for the Japanese manufacturer. In such a case, the Japanese firm would intend to add the extra cost to the price for the UK market instead of the home market, because other Japanese firms might target other foreign countries' markets rather than the UK. Thus, the extra cost is not necessarily occasioned to the other Japanese firms. In order to preserve their competition in home country, manufacturers will not pass on the cost to domestic consumers. However, since the extra cost is added to the export prices, the mark-up is more limited. Thus, higher productivity enhances relative price level and firms would have less incentive to apply PTM.

Nevertheless, Gron and Swenson[20] (1996) argue that flexible production help firms to avoid increasing their costs, and this then reduces the FX rate pass-through. If multinational firms have the ability to manufacture products in multiple locations, it gives them more flexibility to adjust to changes in cost and FX rate fluctuations. Thus, even if a firm's currency appreciates, the firm can pass through a small portion of the charges in production into prices. Therefore, higher flexibility in production can reduce the level of FX rate pass-through in prices.

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[20] They focus on the US automobile market and the pricing of US and Japanese firms in particular.

Moreover, the degree of PTM is also determined by the financing costs and transportation cost of pre-buy goods (see, Aizenman, 2004). Some manufacturers buy input materials ahead of time, because pre-buying allows them to find the cheapest means of transportation, so the transportation cost for pre-buy is normally lower than that for last-minute delivery. Nevertheless, when firms pre-buy input on credit, they need to consider the interest rate. Higher interest rate causes higher pre-buying transportation costs, and therefore leads to higher financing costs (see, Aizenman, 2004). These latter costs limit exporters' ability to reduce the mark-up, and therefore decrease the implementation of PTM strategy. Thus, financing cost and transportation cost have a very complicated relationship with PTM strategy. When manufacturers pre-buy inputs, they have to consider the time gap, interest rate, transportation cost and so on. When exporters achieve lower costs, there is more room for them to adjust the mark-up and then adopt the PTM strategy.

Demand/Elasticity of Demand

If the elasticity of demand is very high, a higher price would lead to lower demand. The elasticity of demand has a significant impact on the PTM decision (see, e.g., Kongsted, 1998; Bergin and Feenstra, 2001; Feenstra *et al.*, 1996; Irandoust, 1998). Also, Floden, *et al.*, (2006) indicate that FX rate pass-through is associated with the price elasticity of demand negatively. For instance, if the elasticity of demand increases as the price rises, it will lead to a loss in the sales/trading volume when the prices increase. In order to maintain the demand and keep the market share, exporters have to refrain from passing through the FX rate effect to their importers' local currency prices, and this action thereby increases the implementation of PTM behaviour. Additionally, Kadiyali (1997) studies the price adjustment by Fuji Film of Japan in the US photographic print film industry and demonstrates that demand, cost and market structure sway the FX rate pass-through to prices. Also, Corsetti and Dedola (2005) indicate that profit maximising firms optimally adjust mark-ups concerning the demand fluctuation, so it affects the FX rate pass-through. Nevertheless, Yang (1998) states that higher demand leads to a higher cost of production for exporters, so they tend to keep higher import price for foreign customers and the degree of PTM is expected to be lower. However, this statement ignores the economies of scale that could be attained by increases in output.

Generally speaking, weak substitutability and high production differentiation can limit the elasticity of demand. Some investigations state that the closer the substitutability between domestic and foreign products, the higher the level of PTM (see, e.g., Feinberg, 1996; Feenstra *et al.*, 1996; Hamid, 1995). A higher degree of substitutability between products implies a higher elasticity of demand, in which demand is more sensitive to a change in relative price. However, compared with the home market, the demand abroad is more sensitive to the FX rate fluctuation. Thus, there is a greater change in the prices set for the foreign market in response to movements in the value of currency, than there is for the home market. When the FX rates change, producers therefore become more concerned with their foreign market and try to partially stabilise the local currency prices for their customers. Thus, with a higher degree of substitutability, firms are more likely to utilise PTM, and thus diminish the effect of the FX rate pass-through to prices. Similarly, Pritamani *et al.,* (2002) stress that product substitutability is an essential determinant of firms' ability to pass through FX rate changes to product prices. More specifically, lower product substitutability means the product with special characteristics can be distinguished from other common goods, thereby enabling the manufacturers to keep the same export price despite an appreciation in their home currency. Thus, product substitutability is negatively associated with the FX rate pass-through. Moreover, Mann (1986) states that booms and recession in demand could affect a firm's pricing strategy, and in turn influences the degree of FX rate pass-through. When a product is in high demand, even if its price has increased to importers because of FX rate appreciation, customers are still likely to purchase it if the degree of substitutability for this product is weak. Thus, this product is less sensitive to the FX rate fluctuations. Somewhat surprisingly, Feinberg (1996) finds some weak evidence to show that higher substitutability produces high FX rate pass-through, demonstrating that substitutability is negatively related to PTM. That said, Feinberg (1996) only used 10 years annual data in a simple OLS regression, so the result could be biased by this limitation.

In contrast to product substitutability, product differentiation provides each firm with an advantage when competing in the same market and gives them some monopolistic power to adjust their prices in reaction to FX rate changes. If a product is differentiated, it is always the case that exporters keep the export price unchanged from the domestic price in the export country, and when the FX rate changes, the importers' local currency prices depart from the domestic prices in the destination country. More specifically, the PTM is less in the more differentiated product, sales of highly differentiated products are less susceptible to price changes, and the FX rate effect is more likely to be added to importers' local currency prices as a cost shock (Yang, 1998). This provides product differentiation exporters with more market power, which in turn makes PTM through reducing the mark-up, unnecessary. Thus, the more product differentiation of firms, the less extent of PTM, and the more FX rates effect pass through to importers' local currency prices.

Empirically, Marston (1990) found that PTM elasticity varied widely across products in his study on Japanese exports to the US. He pointed out that compared with other consumer goods (e.g., colour TVs, tape recorders, cameras, mircrowave ovens), small tracks carry smaller and insignificant PTM elasticity. This could be because the diversity of small tracks is not as great as TVs and recorders, so Japanese manufacturers can use this advantage to gain more profit when their currency becomes stronger. Moreover, Gagnon and Knetter (1991) explain that the differences in automobile price adjustments reflect varying degrees of competition in different segments of the auto market, showing that Japanese auto exporters tend to be in smaller engine-size categories and face more competition than US and German exports. They concluded that Japanese auto exporters are estimated to offset approximately 70% of the effect of FX rate changes on buyers' prices through mark-up adjustment. The comparable number for German auto exports varies by engine size: for small autos, about 40% of the effect of FX rate changes is offset by destination-specific mark-up changes, whereas for large autos the adjustment in minimal. Furthermore, Falk and Falk (2000) indicate that PTM is more prevalent in exports of chemicals and fertilisers than in machinery product. Nevertheless, Adolfson (2001) investigates PTM behaviour in automobile and kraft paper from Swedish exports to Germany, UK and France. This was weak evidence to distinguish the PTM implementation between automobile and kraft paper. In contrast to the research on other traditional methods in PTM, Adolfson (2001) has considered the dynamic effect and employed an ECM and disaggregate data to assess PTM elasticity. However, he used lower frequency quarterly data and his sample size is very small. Thus, the results for those two industries could be biased or play only a minor role when considered in the wider picture of the international economy.

Inflation /FX rate volatility

Devereux, *et al.*, (2004) express that FX rate pass-through has positive relationship with the volatility of money growth. More specifically, Baqueiro, *et al.,* (2002) illustrate that the extent of FX rate pass-through is associated with the inflation environment. Their empirical results show that higher inflation leads to higher FX rate pass-through. Conversely, high pass-though would lower inflation pressures (Coricelli, *et al.*, 2006). Additionally, the degree of FX rate volatility has been shown to affect the FX rate pass-through. Some researchers (see, e.g., Bowe and Saltvedt, 2004; Wei and Parsley, 1995) indicate that FX rate pass-through is inversely related to FX rate volatility. This is because greater FX rate movement may make importers more wary of changing prices and more willing to adjust profit margins, thus reducing pass-through (Mann, 1986). Particularly, some major importers, for example in the US, have the power to exert pressure on exporters' pricing decisions.

Indeed, Kadiyali (1997) indicates that in the short run, price and advertising costs' pass-through effects are a function of demand, costs and market structure. In the long run, FX rate changes determine the market price and cost technologies. Froot and Klemperer (1989) show in their theoretical model, that the firm's price strategy depends on whether the FX rate change is perceived to be permanent or temporary. While a temporary currency appreciation can lead to either an increase or decrease in foreign prices, a perception that the FX rate appreciation is permanent leads foreign firms to price more aggressively in the host country, so as to gain market share. In this case, estimation methods such as EGARCH models that capture both the degree of volatility and permanence of elements of the time series will be more appropriate.

2.4.2.3 Empirical Methodologies of Prior Studies

From the discussion, it can be seen that a further investigatioı contribution to international finance and economy. Moreover, previous empirical studies presented in section 2.4.2.2, expose Therefore, the following section will critically discuss prev methodologies.

Firstly, most previous studies have employed high level aggrega Devereux (1996) and Betts and Devereux (2000) employed CPI a rate pass-through effects. Also, Yang (1998) used 2-, 3- and exporter price indices. As discussed, PTM is operated in individu data is expected to give more accurate feedback on PTM implem data is not available for every country but it would appear that t data, the closer one could get to a micro-level understanding of P use the bi-lateral FX rate (see, e.g., Tange, 1997), but the inv normally exports its products to more than one foreign country, ar with the bi-lateral FX rate can be biased if the export industı Although a multilateral FX rate would appear to be more appropr not contain much variability, thereby providing weak evidence of

Some researchers also test pricing adjustment in imports and exports using quarterly (see, e.g., Feenstra, 1989; Kanas, 1997; Kadiyali, 1997; Webber, 2000) and annual (see, e.g., Feinberg, 1996, Knetter, 1994) data. The usage of low frequency data will result in the loss of information in the data generating process, so it will affect the sensitivity of prices to FX rate movement. Also, higher frequency data tend to provide more observations when compared to low frequency data for a certain period that may only be available to provide that data. Only a few studies use monthly data (see, Kasa, 1992) but those studies are also accompanied by highly aggregated export price data.

Also, the seasonality in the data can affect the parameter estimates if this is not accounted for. Prior empirical studies (see, e.g., Korhonen and Wachtel, 2006, Klitgaard, 1999 and Weber, 1997) have typically de-seasonalised time series data without econometrically testing whether this transformation is appropriate. Furthermore, automatically de-seasonalising that data results in a loss of information (see, e.g., Osborn, 1988; Franses and Dijk, 2005) which can subsequently lead to unreliable results. The proper approach is to first test for seasonal unit roots and if present in the data, these need to be accounted for. Alternatively, if seasonal unit roots are not present, then to de-seasonalise the data will result in a loss of information. This is the approach adopted in this study. Notice that this study is the first to utilise such an approach to test for PTM

All the prior empirical studies on PTM employ standard OLS estimation methods, and do not take into account the data asymmetry and volatility clustering. Joseph (2003a) shows that monthly data contains strong ARCH effects.[21] When data contain strong volatility and

[21] This runs contrary to Baillie's and Bollerslev's (1989, p. 303) view that the ARCH effects are "...minimal on monthly data". Data on export and import prices are not available at higher frequencies.

asymmetry, standard OLS methods generate inefficient and inconsistent parameter estimates, thereby affecting the reliability of the inferences that can be made. These statistical properties can affect the parameter estimates and give rise to dissimilarities of the empirical results on PTM.[22] ARCH effects also cause the standard OLS method to over-estimate (under-estimate) parameter estimates following positive (negative) shocks relative to GARCH-type models.[23] PTM estimates based on GARCH-type models allow us to discard the restrictive assumptions of constant conditional variance, linearity and time invariance that underlie the standard OLS method.

For example, even when Knetter (1994) explored the asymmetric effect of PTM behaviour, he only used a simple static regression. However, the evidence on asymmetric export price adjustments suggests that the relationship depicted in PTM models is essentially non-linear and time-varying.[24] In Kasa's (1992) theoretical model, the monopolist adjusts the export prices more in response to permanent FX rate changes than transitory ones. Taylor's (2000) staggered price-setting model of FX rate pass-through also allows for the prices of goods to be set at different time points in relation to the perceived permanence of FX rate changes. Under both theoretical models, the prices of international goods will be volatile and time-varying. The volatility and time-varying properties export prices and FX rates cannot be captured by the standard approach of using OLS estimation methods to model PTM.[25] Depending on the magnitude and direction of the FX rate shock, exporters may systematically mis-price exports

[22] Menon (1995) notes that the differences in the choice of data and methodology can give rise to significant differences in the FX rate pass-through estimates. He surveys 43 studies on pass-through and finds that 27 of them employed OLS. Only a small minority adjusted the residuals for problems of residual auto-correlation and heteroscedasticity (see e.g., Froot and Klemperer, 1989; and Citrin, 1989). A GARCH approach seeks to model the heteroscedasticity in the series rather than *minimise* it in the data.

[23] This finding is based on the abnormal returns (see, e.g., Corhay and Rad, 1996).

[24] In the case of FX rate pass-through, Otani *et al.,* (2003, p. 71) find evidence of time-variation in the FX rate pass-through coefficients of Japanese imports, whilst Baldwin, (1988) finds instability in the FX rate pass-through equation of US import prices.

[25] There is ample evidence to show that FX rates are time-varying, particularly at high frequency (see, e.g., Mcfarland *et al.*, 1982).

following a FX rate shock - a feature empirically shown to be associated with the sensitivity of stock returns to FX rate changes (see Bartov and Bodnar, 1994). Moreover, following the literature on the asymmetric impacts of good and bad news (see Bollerslev *et al,* 1992), exporters are likely to react more strongly to negative news of their home currency appreciation (bad news) than to good news of their home currency depreciation. This under/over-reaction can result in larger adjustments to export prices under FX rate appreciation than under FX rate depreciation, even when there are other constraints in the form of market share and distribution technologies. The reason is that in the short term, exporters are likely to be more concerned about the magnitude and direction of FX rate changes compared with long-run considerations associated with market share, for example.[26] However, the literature suggests that the particular reaction of an exporting firm will depend on whether the firm wishes to pursue a market share or profit maximisation strategy (see. e.g., Froot and Klemperer, 1989; Knetter, 1994). Similarly, the use of derivatives such as currency options (see, e.g., Joseph, 2000) to hedge exports also generates asymmetric cash flow pay-offs. These factors will in turn, bring about a non-linear and possibly asymmetric relationship between export prices and FX rates.

Moreover, it is well known that most financial and economic series are non-stationary and OLS regression will produce inconsistent estimates of these series. Engle and Granger (1987) introduce a concept of co-integration. When a set of time series are co-integrated, there is a long-term relationship among them, and those series can then be modelled using an ECM framework. This approach enables us to obtain both consistent estimates of the series and to assess the short-term and long-term dynamics of the relation. In fact, many studies in FX rate exposure (see, e.g., Joseph and Solomon, 1997; Bowe and Saltvedt, 2004) demonstrate that ECM performs much more efficiently than simple OLS and provides consistent results. Nevertheless, Sedgley and

[26] The PTM literature (see. e.g., Froot and Klemperer, 1989; Knetter, 1994) suggests that the reaction to FX rate changes depends on whether exporters wish to pursue market share or profit maximisation strategy.

Smith (1994) employed a standard OLS ECM to assess the FX rate pass-through in the UK, but the diagnostic test shows that the residuals are serially-correlated. Cuthbertson (1986) also used an ECM in his study concerning UK export prices behaviour, but he did not empirically test whether the series are co-integrated via Johansen test.

Furthermore, most researchers assume that the relationship between export price and FX rate changes is contemporaneous. This is unlikely to hold unless exporters have perfect foresight. Thus, most prior studies ignored the lag effects in PTM models by using a static model (see, Yang, 1998; Kentter, 1993; Gil-Pareja, 2003; Rangan and Lawrence, 1993). However, Kikuchi and Sumner (2002, p. 279) indicate

> "... that pass-through is incomplete only in the shortest of short-runs ..."

so, lags of the variables also capture the price stickiness and pricing based on expectations. Only a limited number of studies implement PTM with lags but this is only in respect of the FX rate change (see e.g., Tang, 1997). So the PTM model is not truly dynamic. Moreover, the lagged sensitivity of the difference between export and import prices can arise due to competition and FX rate pressure, so it can capture the substitution effect between domestically and internationally-traded goods which can be affected by the changes in FX rates. This is actually a very important element in PTM, since Bodnar *et al.,* (2002) show that the degree of substitutability between imports and exports whilst keeping exporters' market share objectives constant, can lead to weaker FX rate pass-through. However, prior studies have not included this variable, so they may not truly capture all the impacts on PTM. The researcher accounts for those estimation issues in the model used in this study, but estimates two PTM models, one of which is an ECM. Both models are estimated using EGARCH and GJR methods as this approach is likely to capture the properties of the data generating process. An important advantage of both the EGARCH and GJR models is that they are constructed to have long memory. That is, the models allow all lags to have an influence on the estimation by including past values of the conditional variance itself, as well as the past values of square errors.

Thus, this study estimates a model of PTM for UK monthly export prices, and utilises both EGARCH and GJR estimation methods to capture the volatility and time-varying effects of shocks on estimates of PTM. This approach allows the researcher to simultaneously model the PTM parameters and capture both volatility and asymmetry in conditional properties of the parameter estimates. The strategy does not allow for direct testing for asymmetric pricing as in prior studies of PTM[27] (see, e.g., Knetter, 1994; and Mahdavi, 2002). However, pricing asymmetries and volatility clustering are estimated in a manner that enables the capture of the impacts of both favourable and adverse shocks on the variables in the model. In this way, some of the mixed evidence on asymmetric exposure of export prices to FX rate changes can be uncovered.

2.5 Hypothesis

Based on the literature review, I formulate below four main hypothesis. They will be empirically tested in this thesis as follows:

$H_{o,1}$: UK exporters do not PTM and there is no evidence that PTM varies according to export sector.

[27] The usual approach in those studies is to partition the FX rate series into periods of appreciation and depreciation.

$H_{o,2}$: There is no asymmetry and ARCH effects in export prices and exporters PTM at a constant rate.

$H_{o,3}$: PTM is not impacted upon by the inflation level. That is, the use of real prices does not affect the inferences based on nominal price.

$H_{o,4}$: The PTM coefficients are not related to factors such as market share, product differentiation and marginal cost.

2.6 Conclusion

Under perfect competition the LOP and PPP hold. So FX rates will change in response to differences in the prices of international goods. Depending on macro-economic and micro-economic factors, FX rate pass-through takes the forms of complete pass-through, zero pass-through and incomplete pass-through. Both FX rates pass-through and PTM measure, for the most part, similar things: the relation between the FX rate and import prices or export prices. While PTM is a pricing strategy performed by firms, pass-through is incomplete and is a phenomenon of PTM strategy. The degree of PTM leads to different levels of FX rate pass-through, the extent of which goes inversely along with the degree of PTM. The higher level of PTM, the less FX rate effect passes through to importers' local currency prices.

However, PTM behaviour exists in a segmented market, which is imperfect competition, so the degree of PTM is essentially based on firms' competitiveness in the international market. In a complex economic environment, PTM can become diverse in different countries and in different industries. With a study of PTM across countries, the relevant macro-economic factors including inflation and FX rate volatility. As for the micro-economic consideration, higher PTM with the industry that have less market share, lower market power, more sufficient mark-up, larger variations of marginal cost, lower elasticity of demand and also depend on firm-specific characteristics. From some previous studies, it can be observed that PTM varies across countries and also across industries.

To conclude, the failure of parity relationship to hold in the short-run leads to important empirical issues regarding the pricing strategies of firms. This literature review indicates that incomplete FX rate pass-through produced by PTM is a dominant finding in empirical studies. PTM plays an important role in keeping the international trade balance, protecting firms' profitability and their market value, enhancing consumption, investment and so on. However, the literature review shows that there are econometric problems associated with the estimation approach of prior PTM studies, most of which have employed standard OLS estimation methods even if monthly data contains strong ARCH and asymmetry effects. Furthermore, prior studies have typically employed de-seasonalised data, and none has tested whether it is necessary to treat the data in this way. This can result in a loss of information in the data generating process.

This study will employ two models of PTM, both of which account for the DGP of the time series. The analysis is at a lower level of aggregation of export prices for UK data. This level of aggregation is likely to reveal more interesting results on PTM which can be specific to particular export sectors. As indicated earlier, firm-level data is not available and no prior study has used such data. The analysis will employ monthly data because of the advantages of higher frequency data. This is the highest frequency of data that is available. The research methodology and empirical results are presented in the remaining chapters.

CHAPTER 3

MODELLING THE INNOVATION IN EXCHANGE RATE EXPOSURE

3.1 Introduction

Ideally, a proper model is one that is able to generate unbiased parameter estimates. The literature review in Chapter 2 shows that the OLS is the standard estimation method used in previous PTM studies. However, the OLS estimation method might not generate consistent and reliable estimates of the parameters because of the time-varying properties of the data. Consequently, it is necessary to develop a different econometrics approach to model PTM that is consistent with the data generating process of the time series. In this chapter, the assumptions of OLS when incorporated with the properties of time series data will first be discussed in section 3.2. Secondly, the methodology and data sets of this study will be introduced in sections 3.3 and 3.4 respectively. Finally, section 3.5 presents the preliminary analysis for the data sets. Thus, this chapter provides an opportunity to understand the statistical properties of the univariate series prior to undertaking formal multivariate statistical tests. The aim is to help identify a suitable econometric model for exposure to, and to understand the issues associated with, pass-through.

3.2 Ordinary Least Squares Regression

It is well known that regression analysis is used to describe and evaluate the relationship between a set of variables. More specifically, regression analysis is used to study the movements in dependent variables by reference to movements in one or more other explanatory variables. However, the accuracy of estimators determines the "goodness of fit" for the regression. (see, e.g., Brooks, 2002)

Theoretically, under some assumptions[28], the OLS estimators are unbiased when the sum of squared residuals is minimised (see, e.g., Wooldridge, 2003 and Maddala, 2001). However, in the case of time series data when non-stationarity cannot be satisfied, OLS regression assumptions have been shown to be inconsistently estimated (see, e.g., Brooks, 2002). The reasons for this problem are discussed as follows:

Firstly, the zero conditional mean of the residuals requires that the explanatory variables be strictly exogenous (Wooldridge, 2003). There is a strong sense in which the average value of residuals is unrelated to the independent variables in all time periods. Nevertheless, this assumption will fail if the regression residuals are correlated with the explanatory variables. For instance, they could be omitted variables and measurement error in some of the regression. Unfortunately, in reality, it is near impossible to avoid these mis-specifications. It is worth noting that the failure of this assumption will lead to biased OLS estimators.

[28] Five assumptions of the OLS regression analysis are: linearity in parameters, random sampling, zero conditional mean, sample variation in the independent variable and homoscedasticity. The former four assumptions determine unbiasedness of the OLS estimators, while the last one manages the constant variances of the OLS estimators (Wooldridge, 2003).

Secondly, the validity of the OLS standard error estimations requires that there is no serial correlation in the standard error (Wooldridge, 2003). In practice, it is common to find a positive correlation between neighbouring errors, particularly in static and finite distributed lag models (see, Wooldridge, 2003). This causes the OLS residuals to be inconsistently estimated. In order to test whether there is serial correlation existing in the regression residuals, an F-modified or Serial Auto-correlation Lagrange Multiplier (LM) statistic can be applied. If the null hypothesis cannot be rejected, then it may be necessary to use a Feasible General Least Square[29] (FGLS) procedure, such as Cochrance-Orcutt or Paris-Winsten, to correct AR(1) serial correlation (see, Woodridge, 2003).

Finally, one of the OLS assumptions is homoscedasticity, which requires that data must be stationary and its variance be not time-varying. If the series are heteroscedastic, then the OLS estimators are still unbiased but not efficient (see, e.g., Brooks, 2002; Maddala, 2001). However, time series data has long memory in most cases, so heteroscedasticity can be obtained, even if there is no serial correlation. More importantly, before testing for heteroscedasticity, it is necessary to make sure that errors are not serially correlated, since any serial correlation will cause the test to be invalidated. However, in recent years, dynamic forms of heteroscedasticity have become popular in the study of financial markets by using the econometric method. The ARCH model is the leading example. In general, statistical tests that seek to assess the failure of OLS assumptions are important. Failure to test for these assumptions can lead to incorrect statistical inferences.

[29] The FGLS estimates are different from the OLS estimates: the FGLS estimates are obtained from OLS on quasi-differenced variables.

3.3 Methodology

The standard model for estimating the sensitivity of export prices to the FX rate and producer prices index changes is to write an equation of the form shown in Eq. (3.1) as in Yang[30] (1998), thus[31, 32]

$$\Delta EP_{i,t} = \alpha_{0,i} + \beta_i \Delta X_t + \lambda_i \Delta PPI_{i,t} + \varepsilon_{i,t} \qquad (3.1)$$

where

i represents 1, ..., N and t represents 1, ..., T index the industries and time, respectively;
$EP_{i,t}$ represents the export price index for industry, i;
X_t represents the nominal exchange rate;
$PPI_{i,t}$ represents the UK producer price index for industry, i;
Δ represents the difference operator; and
$\varepsilon_{i,t}$ represents the error terms which is assumed to be white noise and normally distributed.

In Eq. (3.1), the coefficient of ΔX, β is the degree of PTM, measured as the elasticity of export price with respect to FX rates. The statistical interpretation of β is straightforward and is predicted to be negative and between -1 and 0, since an appreciation of Sterling should lead to a decrease in the export price if exporters execute PTM. A value of zero implies that the export prices from the UK to foreign countries are insensitive to fluctuation in the value of the exporters' currency against that of the buyers. Therefore, changes in the currency values would be fully passed through to the buyers. Negative values of β indicate that mark-up adjustment is

[30] Yang (1998) also takes into account the effect of the multi-lateral trade-weighted producer price index, but this variable is not available in the UK.
[31] In reality, this is a more complicated version of the model. Hung (1992-1993) shows a simpler version of the model where changes in exports are regressed on changes in exchange rates.
[32] Originally, I introduced interest rate into the model, but the coefficients of this variable were not significant.

associated with PTM. For example, a value of -0.4 denotes that in response to a 10% appreciation (depreciation) of his currency, the exporter would reduce (increase) his mark-up by 4%. Assuming constant costs, the price paid in units of the buyers' currency would rise (fall) by only 6% rather than 10%. On the contrary, a positive value of β corresponds to the case in which industry-specific changes in export prices amplify the effect of FX rates changes on the price in units of the buyers' currency. This could happen in the case of some extremely competitive monopolists.

The producer price index, PPI, is employed to control the costs of the UK exporters' products. The coefficient, λ , for Δ PPI is predicted to be positive because a higher cost in UK manufacturing should cause firms to charge higher prices, including export prices. The reverse is also true.

3.4 Data Sets

The data sets comprise of monthly observations of the Bank of England trade-weighted FX rate index, disaggregated export prices index (EP), and import prices index (IP), and producer price index (PPI). All the data sets were taken from DataStream, except for some of the PPIs obtained from the UK Office for National Statistics (ONS). The data sets are seasonally-unadjusted and start from January 1986 for the most part to March 2005.[33] The univariate series are seasonally-unadjusted as this ensures that the data contains all the available information for estimation purposes. Seasonality is tested for at monthly frequency to confirm the model specification at a subsequent stage.

[33] The data set constraints are due to the availability of PPIs observations that do not go as far back to January 1986 for the Office for National Statistics.

The FX rate is the Bank of England nominal traded weighted Sterling index. Although the use of a trade-weighted FX rate index may not capture sufficient variation in export prices[34], a nominal rates and a trade-weighted index are used for good reasons. The level of aggregation of export prices does not allow us to distinguish between the different currencies used for exports, but this does not have to be considered as problematic since Joseph and Hewins (1991) show that UK firms adopt a portfolio approach to currency management, of which exported goods will be a part. The use of an index also potentially helps in avoiding possible problems of multi-colinearity when several bivariate currencies are used in the model.[35] Also, exporters do not observe instantaneous inflation in export prices and theoretically, what they are likely to observe is the impact of FX rate changes on export prices.

EPs were collected for 50 UK industries, but only 48 industries are over the same time period, and half of those have shown no changes in their values. Therefore, the EPs, which contain no more than 18 months of consecutive zero observations in their first difference level, can be suitably selected for this research project. The selection of EPs is also limited by the availability of matched PPIs. Finally, 28 EPs that satisfied the limitation were identified and selected for use in the study.

---

[34] This is an argument that has been put forward in the literature on exposure associated with stock returns (see, e.g., Allayannis and Ofek, 2001; Bartov and Bodnar, 1994; Choi, 1986; Choi *et al.*, 1992; Jorion, 1990) but there is no clear consensus.

[35] Evidence from empirical studies of stock price sensitivity indicates that the use of an FX rate index as opposed to firm-specific bi-lateral rates does not affect the degree of stock price sensitivity obtained (see Bartram, 2004; Fraser and Pantzalis 2004). To further validate the choice of the FX rate index, correlation tests are made of changes in the sterling FX rate index against changes in the Deutsche mark (DEM), Euro, Japanese yen (JPY), US dollar (USD), Canadian dollar (CAD), and French franc (FRF). The FX rate changes for the DEM and FRF are up to January 1999 whilst for the Euro, the price changes are after January 1999. The correlation coefficients are significantly non-zero and remarkably close to 1. This indicates that the sterling FX rate index follows closely the same evolution of bivariate FX rate changes.

For the PPI series, aggregate data was used in some cases since it is very difficult to obtain one-to-one matched time series on a consistent basis for each industrial sector. This has been a common problem identified in many previous studies, such as Coutts and Norman (2002) and Cuthbertson (1986) in their research concerning the UK, and Yang (1995) and Yang (1998) in his two studies of the USA. In this study, the EPs are on a Balance of Payment basis and compiled by ONS. The data is originally from the Tariff and Statistical Office (TSO) of HM Custom & Excise. However, the information supplied by the TSO is on a different basis to that required for the Balance of Payment statistics. Accordingly, in order to conform to the International Monetary Fund (IMF) definitions, the ONS has made various adjustments, e.g., the valuation of export (dispatches) is on a Free On Board (FOB) basis. The ONS grouped them by using two classifications published by United Nations - Standard International Trade Classifications (SITC) (Rev.3) and the Classification by Broad Economic Categories. As for SICT, the purpose is for compiling international trade statistics on all merchandise entering international trade, and to promote international comparability of international trade statistics. This classification has also been used in some previous empirical studies (see, e.g., Athukorala and Menon, 1995).

The indices - FX rate, EPs and PPIs – were selected because the time series span the longest period and contain more industrial sectors. More importantly, in terms of the methodology, EPs are collected and accessed in a similar way to PPIs. Both measure prices in the home market. Ideally, we should be able to use the individual PPIs to match each EPs. However, as discussed above, in the UK, due to the various classification systems and the limited time period, it is not possible to do that in current years. Furthermore, due to the problem of discontinued data, the study uses 28 either higher level or relevant PPIs to fit the EPs series, because even though they are more aggregated, they can cover the whole duration and are highly related to the EPs series. Those series are seasonally unadjusted because this ensures that the raw data contains all available original information. However, seasonality is tested for statistically, prior to estimation. All the series are transformed into natural logarithms, in an effort to stabilize the variance of the univariate series. This transformation is often employed in empirical work (see, e.g., Sedgley and Smith, 1994).

3.5 Preliminary Investigation of Data

This section provides some preliminary analysis about the data.

3.5.1 Plots of Univariate Series

Fig. 3.1 shows the plots of the level data (in natural logarithms) in the time series from 1986M1 to 2005M3. This is illustrated for a small set of the series. The plots suggest that the time series are non-stationary and that most of them have significant upward or downward trends. It is also worth noting that there appears to be a structural break around 1987M10 which perhaps relates to the stock market crash for that year. However, the non-stationary behaviour of the univariate series with structural breaks can imply that the level series are trend stationary. Although no test is conducted for structural breaks, a dummy variable is used for the 1987M10.

Figure 3.1 Plots of Levels (in logs) of the univariate series

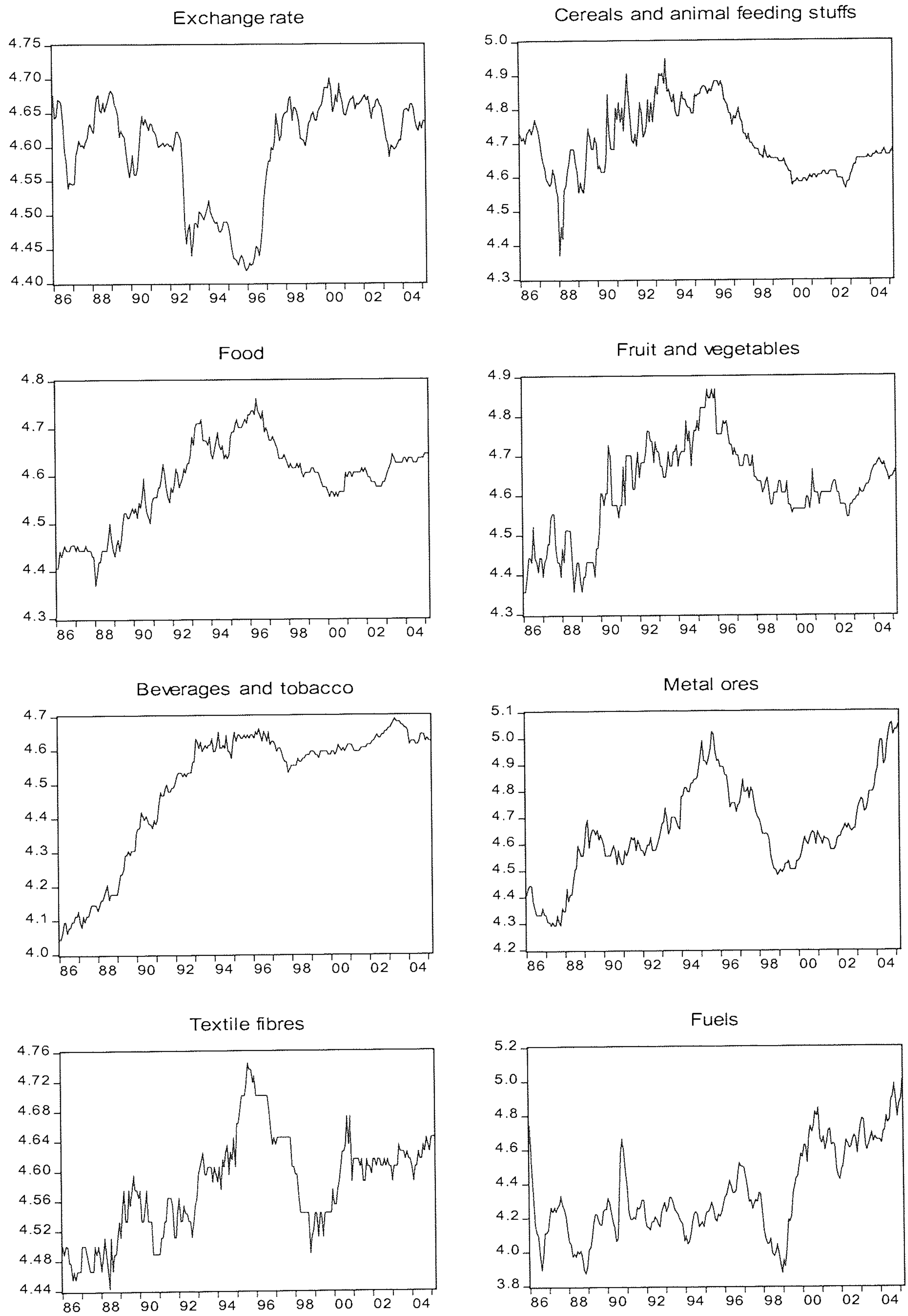


Fig. 3.1 Cont'd

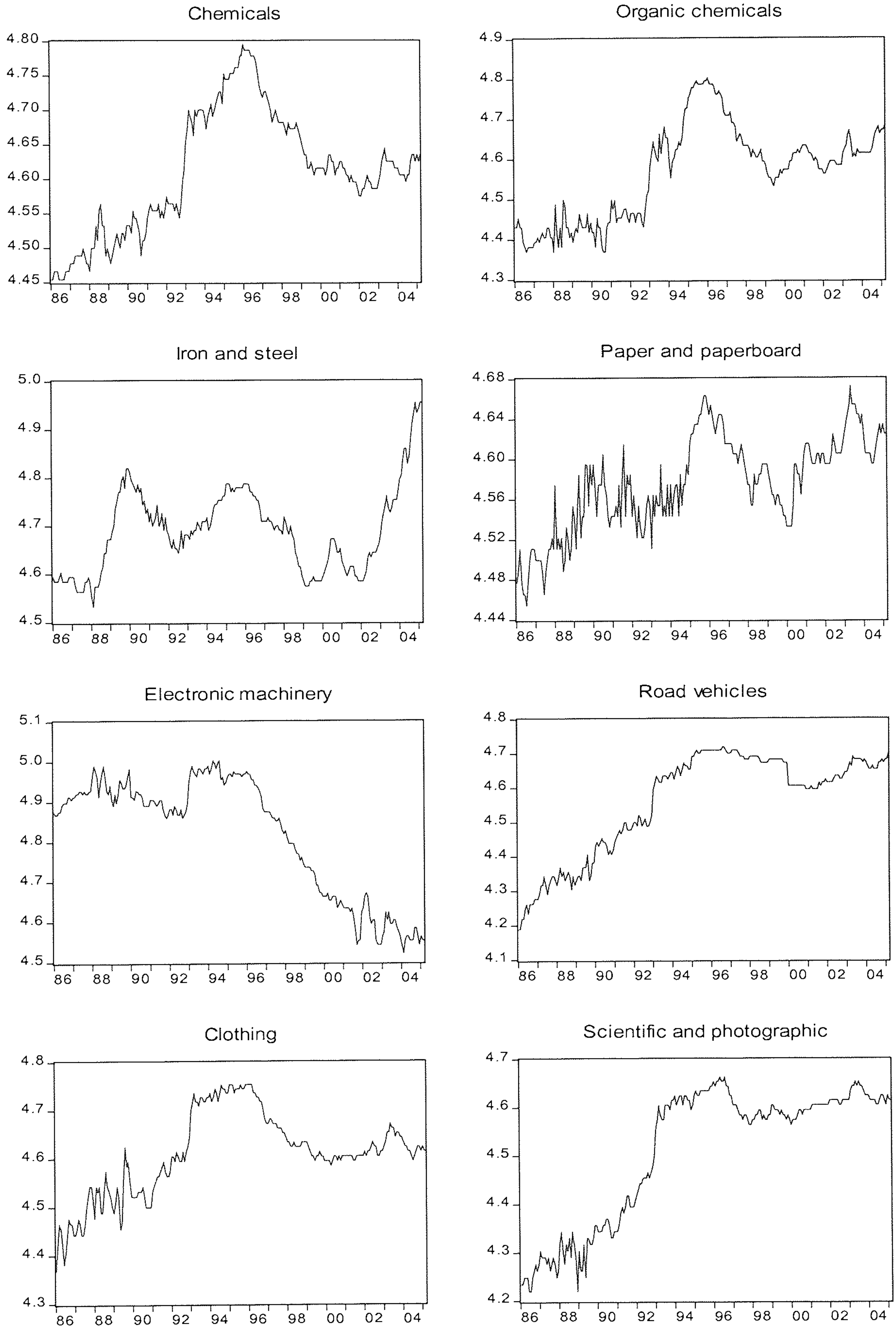
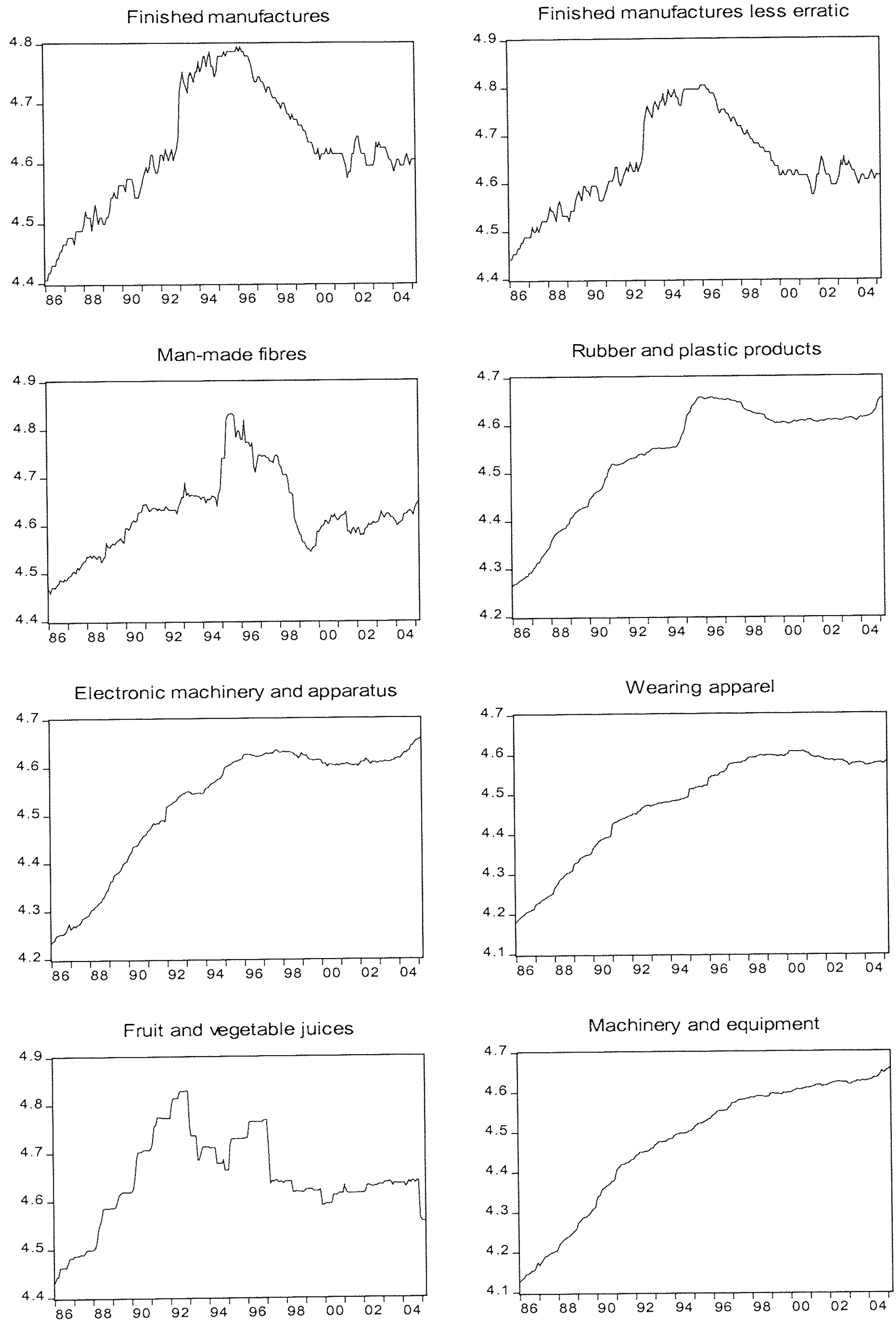

Chemicals
Organic chemicals
Iron and steel
Paper and paperboard
Electronic machinery
Road vehicles
Clothing
Scientific and photographic

Fig. 3.1 Cont'd


Finished manufactures
4.8
4.7
4.6
4.5
4.4
86 88 90 92 94 96 98 00 02 04
Finished manufactures less erratic
4.9
4.8
4.7
4.6
4.5
4.4
86 88 90 92 94 96 98 00 02 04
Man-made fibres
4.9
4.8
4.7
4.6
4.5
4.4
86 88 90 92 94 96 98 00 02 04
Rubber and plastic products
4.7
4.6
4.5
4.4
4.3
4.2
86 88 90 92 94 96 98 00 02 04
Electronic machinery and apparatus
4.7
4.6
4.5
4.4
4.3
4.2
86 88 90 92 94 96 98 00 02 04
Wearing apparel
4.7
4.6
4.5
4.4
4.3
4.2
4.1
86 88 90 92 94 96 98 00 02 04
Fruit and vegetable juices
4.9
4.8
4.7
4.6
4.5
4.4
86 88 90 92 94 96 98 00 02 04
Machinery and equipment
4.7
4.6
4.5
4.4
4.3
4.2
4.1
86 88 90 92 94 96 98 00 02 04

Furthermore, plots of the first (log) differences of the level series are shown in Fig 3.2. This is illustrated for a small set of the series. The univariate series appears to be stationary over the period and there is still some evidence of a structural break at 1987M10. There is no clear evidence of seasonality but this is explicitly tested separately. Below, some descriptive statistics for the difference series and their relevance for OLS estimation, are considered.

Figure 3.2 Plots of changes (in differences) of the univariate series

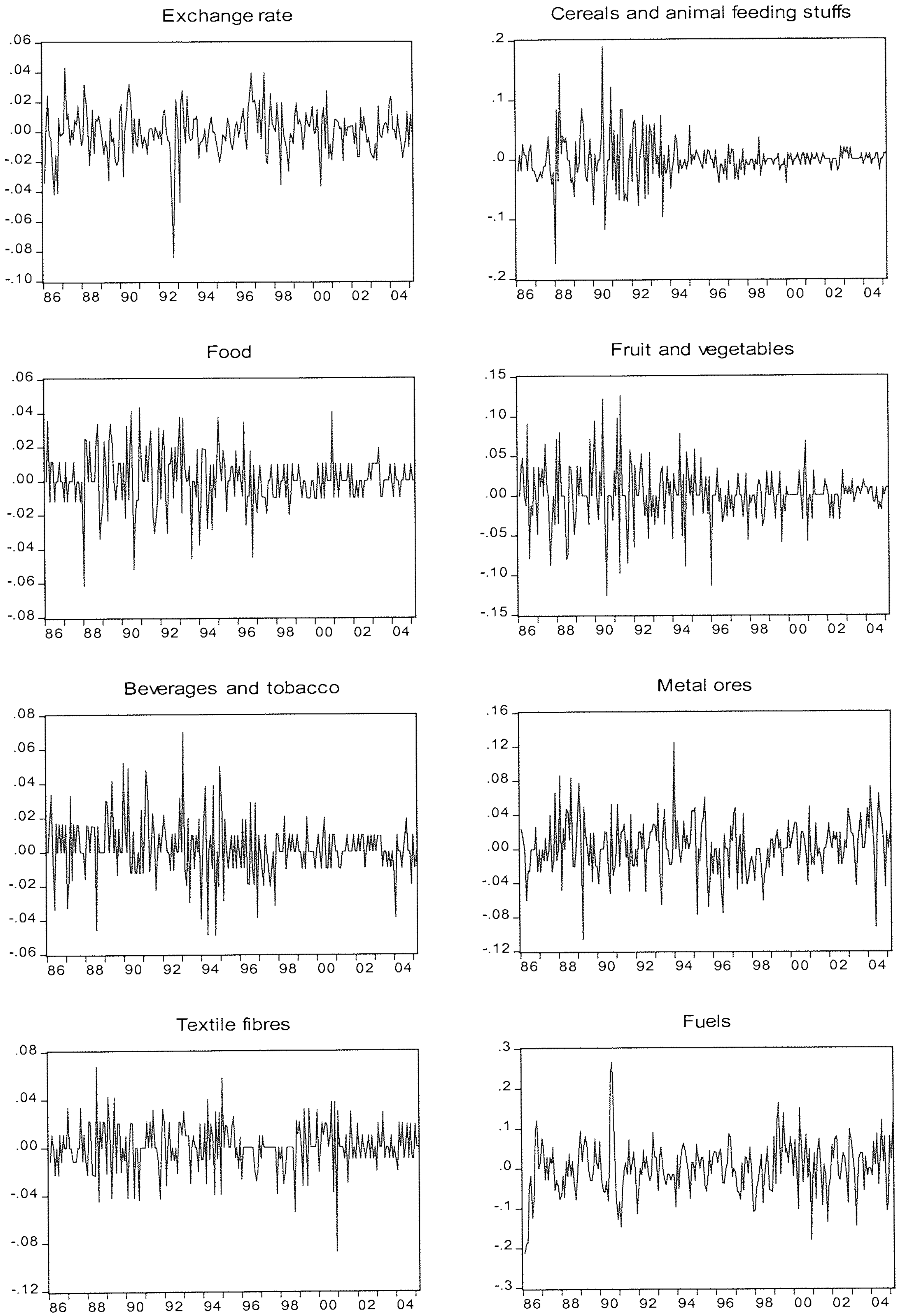


Fig. 3.2 Cont'd

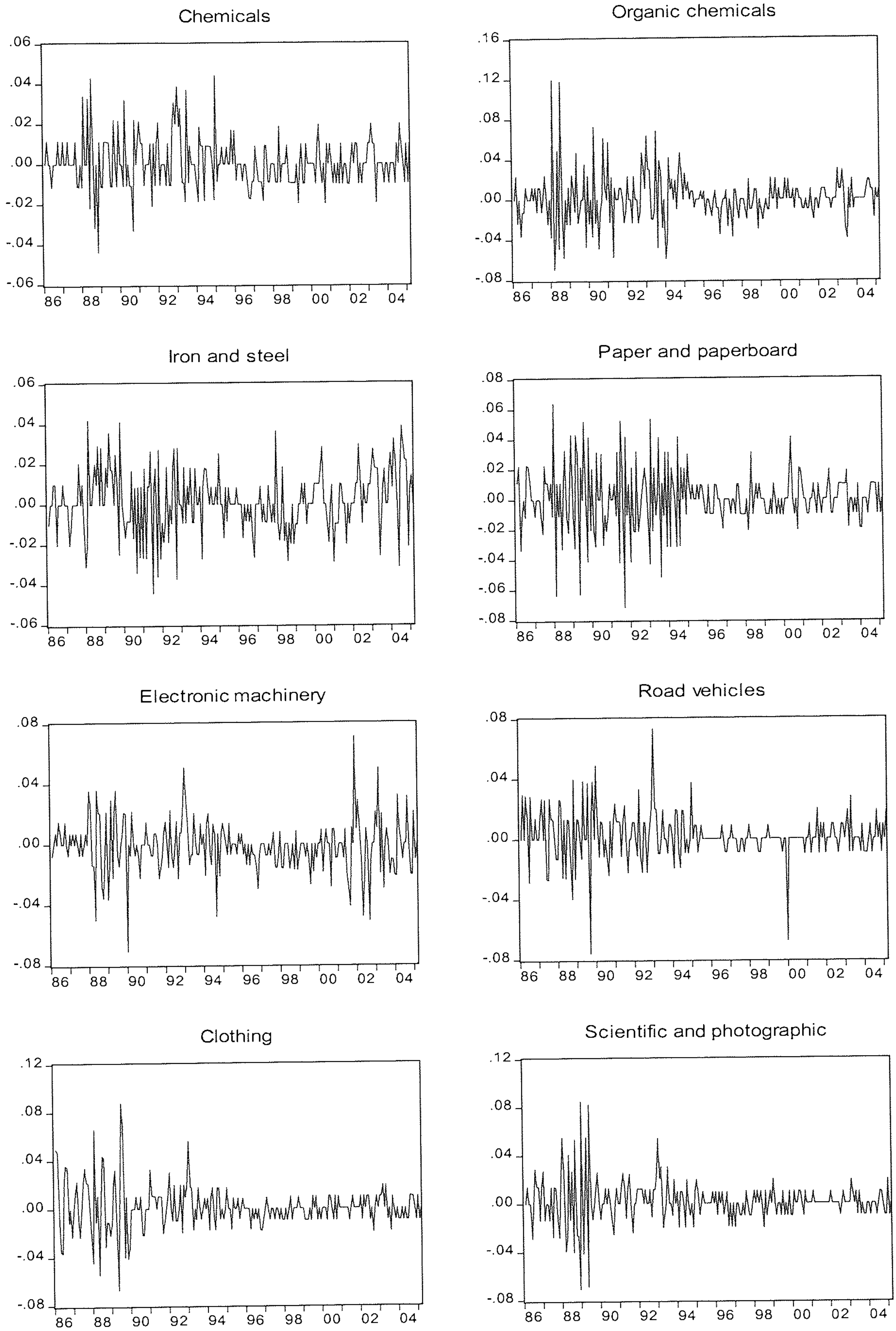
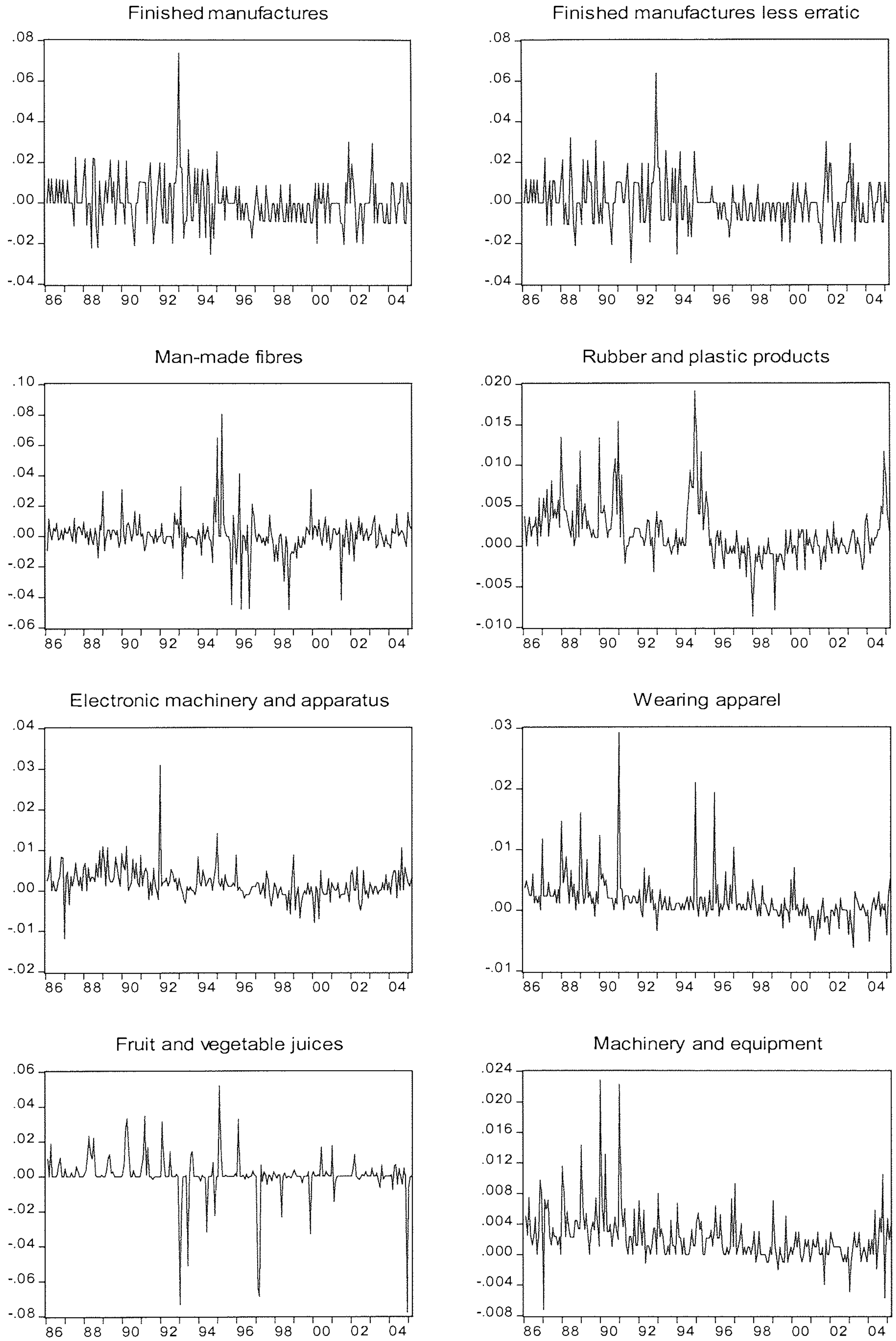

Chemicals
.06
.04
.02
.00
-.02
-.04
-.06
86 88 90 92 94 96 98 00 02 04
Organic chemicals
.16
.12
.08
.04
.00
-.04
-.08
86 88 90 92 94 96 98 00 02 04
Iron and steel
.06
.04
.02
.00
-.02
-.04
-.06
86 88 90 92 94 96 98 00 02 04
Paper and paperboard
.08
.06
.04
.02
.00
-.02
-.04
-.06
-.08
86 88 90 92 94 96 98 00 02 04
Electronic machinery
.08
.04
.00
-.04
-.08
86 88 90 92 94 96 98 00 02 04
Road vehicles
.08
.04
.00
-.04
-.08
86 88 90 92 94 96 98 00 02 04
Clothing
.12
.08
.04
.00
-.04
-.08
86 88 90 92 94 96 98 00 02 04
Scientific and photographic
.12
.08
.04
.00
-.04
-.08
86 88 90 92 94 96 98 00 02 04

Fig. 3.2 Cont'd


Finished manufactures
.08
.06
.04
.02
.00
-.02
-.04
86 88 90 92 94 96 98 00 02 04
Finished manufactures less erratic
.08
.06
.04
.02
.00
-.02
-.04
86 88 90 92 94 96 98 00 02 04
Man-made fibres
.10
.08
.06
.04
.02
.00
-.02
-.04
-.06
86 88 90 92 94 96 98 00 02 04
Rubber and plastic products
.020
.015
.010
.005
.000
-.005
-.010
86 88 90 92 94 96 98 00 02 04
Electronic machinery and apparatus
.04
.03
.02
.01
.00
-.01
-.02
86 88 90 92 94 96 98 00 02 04
Wearing apparel
.03
.02
.01
.00
-.01
86 88 90 92 94 96 98 00 02 04
Fruit and vegetable juices
.06
.04
.02
.00
-.02
-.04
-.06
-.08
86 88 90 92 94 96 98 00 02 04
Machinery and equipment
.024
.020
.016
.012
.008
.004
.000
-.004
-.008
86 88 90 92 94 96 98 00 02 04

3.5.2 Descriptive Statistics

The descriptive statistics for the changes in the univariate series are shown in Table 3.1. The mean of the univariate series is non-zero in 20 out of 57 (35%) cases, which include 2 out of 28 EPs and 18 out of 28 PPIs. Thus, the mean price changes are typically zero. Both skewness and kurtosis are statistically significant (p-value ≤ 0.10) and they can reject the null in 70% and 98% respectively. Indeed, the table suggests that the empirical distributions exhibit fat-tails and are leptokurtic. This implies that that prices changes cluster during certain periods. Thus the Jarque-Bera (J-B) test rejects normality (p-value <0.05) for 98% (56 out of 57) of the series. As a consequence, the assumption that the price changes are normally distributed cannot be maintained. The results suggest that linear estimation methods will generate inconsistent parameter estimates and that perhaps both GJR-GARCH and EGARCH models will better be able to capture the skewness and kurtosis in the series.

Table 3.1 - Descriptive Statistics for Changes in the Level of the Series

	N	Mean	S.D.	Skewness	Kurtosis	J-B
UK sterling trade-weighted rate	230	0.0003	0.0159	-0.7615[a]	4.0340[a]	178.1825[a]
Food and live animals						
Cereals and animal feeding stuffs	230	-0.0002	0.0366	0.5306[a]	6.4516[a]	409.6816[a]
Food	230	0.0010	0.0161	-0.2000	1.5434[a]	24.3605[a]
Fruit and vegetables	230	0.0013	0.0354	-0.0471	2.4083[a]	55.6694[a]
Meat	230	0.0016	0.0411	-0.1395	1.1637[a]	13.7226[a]
Beverages and tobacco						
Beverages and tobacco	230	0.0025[b]	0.0170	0.2161	2.0397[a]	41.6609[a]
Basic Materials						
Metal Ores	230	0.0028	0.0319	-0.0134	1.3150[a]	16.5777[a]
Textile fibres	230	0.0006	0.0203	-0.3161[c]	1.6687[a]	30.5151[a]
Fuels						
Fuels	230	0.0011	0.0662	0.0467	1.8650[a]	33.4167[a]
Chemicals						
Chemicals	230	0.0008	0.0126	0.4820[a]	1.6410[a]	34.7106[a]
Organic chemicals	230	0.0011	0.0242	0.9766[a]	4.9442[a]	270.8179[a]
Inorganic chemicals	230	-0.0025	0.0428	-2.0578[a]	17.793[a]	3196.5212[a]
Plastics	230	0.0003	0.0151	-0.0155	1.0947[a]	11.4941[a]
Material Manufactures						
Iron and steel	230	0.0016	0.0156	-0.0848	0.1895	0.6197
Paper and paperboard	230	0.0006	0.0200	-0.1211	1.6904[a]	27.9459[a]
Material manufactures	230	0.0008	0.0210	-0.2267	2.5082[a]	62.2591[a]
Mineral manufactures less precious stones	230	0.0012	0.0226	0.3515[b]	1.8576[a]	37.8051[a]
Miscellaneous metal manufactures	230	0.0016	0.0155	-0.0008	2.4536[a]	57.6939[a]
Non-ferrous metals	230	0.0002	0.0226	-0.5782[a]	11.7979[a]	1346.7322[a]
Textiles	230	0.0001	0.0128	0.2909[c]	1.3155[a]	19.8287[a]
Machinery & transport equipment						
Electronic machinery	230	-0.0014	0.0173	-0.0019	2.7807[a]	74.1010[a]
Machinery and transport equipment	230	0.0008	0.0117	0.7739[a]	2.0721[a]	64.1055[a]
Machinery	230	0.0002	0.0138	0.7979[a]	2.9032[a]	105.1757[a]
Road vehicles	230	0.0022[b]	0.0157	-0.2421	5.5988[a]	302.6464[a]
Miscellaneous						
Clothing	230	0.0011	0.0182	0.7412[a]	4.4970[a]	214.8620[a]
Clothing and footwear	230	0.0011	0.0172	0.8117[a]	5.6939[a]	335.9456[a]
Scientific and photographic	230	0.0017	0.0177	0.5421[a]	5.9456[a]	350.0406[a]
Others						
Finished manufactures	230	0.0009	0.0117	1.2136[a]	6.0111[a]	402.7278[a]
Finished manufactures less erratic*	230	0.0007	0.0117	0.9456[a]	3.3892[a]	144.3522[a]

Table 3.1 Cont'd

	N	Mean	S.D	Skewness	Kurtosis	J-B
Producer Prices indices						
Meat and poultry meat product	230	0.0021[a]	0.0076	0.3650[b]	3.4962[a]	122.2474[a]
Man-made fibres	230	0.0008	0.0131	0.7496[a]	10.8668[a]	1153.2037[a]
Fabricated metal products, exc. machinery and equipment	230	0.0022[a]	0.0039	1.7917[a]	5.4851[a]	411.3845[a]
Other basic organic chemicals#	230	0.0015	0.0254	-0.6650[a]	10.7298[a]	1120.2747[a]
Rubber and plastic products	230	0.0017[a]	0.0036	1.4893[a]	4.4663[a]	276.1926[a]
Manufactured products excluding food, beverages, tobacco and petroleum	230	0.0014[a]	0.0029	0.6014[a]	3.4491[a]	127.8743[a]
Paper and paperboard	230	0.0008	0.0086	-0.1567	9.0285[a]	782.1084[a]
Manufacture of basic precious and non-ferrous metal, aluminum product	230	0.0004	0.0136	0.3821[b]	1.1185[a]	17.5862[a]
Electronic machinery and apparatus	230	0.0018[a]	0.0040	1.8131[a]	12.3605[a]	1590.1825[a]
Wearing apparel	230	0.0017[a]	0.0038	3.1480[a]	16.4943[a]	2987.1338[a]
Footwear	230	0.0017[a]	0.0040	1.4964[a]	6.0208[a]	433.2295[a]
Chemicals, chemical products and manmade fibres	230	0.0015[a]	0.0052	-0.3635[b]	4.6039[a]	208.1878[a]
Fruit and vegetable juices#	230	0.0005	0.0133	-2.6205[a]	16.3524[a]	2825.8140[a]
Processed and preserved fruit and vegetables	230	0.0019[a]	0.0066	-0.1199	9.1373[a]	800.6726[a]
Motor vehicles	230	0.0022[a]	0.0060	0.8699[a]	7.9986[a]	642.1204[a]
Machinery and equipment	230	0.0023[a]	0.0034	2.2985[a]	10.8378[a]	1328.1569[a]
Transport equipment	230	0.0023[a]	0.0039	1.7270[a]	7.0904[a]	596.1283[a]
Food product less beverages	170	0.0013[a]	0.0037	0.6586[a]	0.9842[b]	19.1515[a]
Prepared animal feed for farm animals	170	0.0006	0.0105	-0.5298[a]	3.0860[a]	75.4083[a]
Beverages	170	0.0023[a]	0.0072	0.8713[a]	5.1484[a]	209.2577[a]
Motor spirit	170	0.0039[b]	0.0198	0.6488[a]	2.8850[a]	70.8821[a]
Fuel oil	170	0.0037	0.0489	-0.4818[b]	0.9926[a]	13.5557[a]
Gas oil and derivatives	170	0.0043[b]	0.0254	-0.1656	3.1597[a]	71.4953[a]
Textiles fabrics	170	0.0005	0.0057	0.0587	2.6486[a]	49.7892[a]
Non metallic mineral products	170	0.0020[a]	0.0042	1.3057[a]	1.8432[a]	72.3680[a]
Base metals	170	0.0016[b]	0.0089	0.6965[a]	4.6894[a]	169.5111[a]
Photographic chemical materials	170	0.0011	0.0203	-0.2172	8.3686[a]	497.4063[a]
Basic pharmaceutical products	170	0.0003	0.0082	-1.1353[a]	7.9163[a]	480.4133[a]

Note: [a], [b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-percernt level, respectively. The J-B denotes the Jarque-Bera that is the test statistic for testing weather the series is normality distributed. The J-B statistic is distributed as χ^2 with 2 degrees of freedom. Most of the data begin from 1986M1, and some PPIs begin from 1991M1. All the series end at 2005M3. *The erratic items here including precious stones, silver, aircraft and ships. #The outliers in these two series have been adjusted by replacing the outliers with the average values of the previous one and next one observation.

3.5.3 Unit Root Tests for Stationarity

3.5.3.1 Augmented Dickey-Fuller Unit Root Tests

Under the standard OLS model, it is essential that the series have stationarity in order to ensure estimation consistency (see, Maddala, 2001). If there is a unit root existing in the data, then the series is non-stationary in levels. In this situation, it would be helpful to difference the series or undertake some other transformation to ensure stationarity. The augmented Dickey-Fuller (ADF) statistic is a popular test for stationarity[36]. Tests for stationarity are consistent with tests for a unit root. Intuitively, under the null hypothesis of a unit root, the series can contain a stochastic trend, and hence its variance and auto-covariances are time-varying. Tests of stationarity are important as the standard *t*- and *F*-tests are inappropriate when applied to non-stationary series.

For series x_t (in log levels), the ADF test involves running the following regression:

$$\Delta x_t = \mu_0 + \mu_1 T + \mu_2 x_{t-1} + \sum_{i=1}^{p} \xi_i \Delta x_{t-i} + \varepsilon_t \qquad (3.2)$$

Where

μ_0 is constant;

$\Delta x_t = x_t - x_{t-1}$ represents the first-order time difference of the series;

T is the time trend;

p [37]is the lag order which can be increased to ensure the error term;

ε_t is white noise.

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[36] The ADF test is more powerful that the simple Dickey Fuller test, since the ADF allows us to account for auto-correlation in the regression residuals which can affect the power of the test.

[37] In order to achieve comparability of the analytical result, we use lags of up to 13 for every time series consistently.

We induce the time trend term to ensure that μ_2 is independent of the constant term μ_0, since the presence of structural breaks will lower the power of ADF statistics. To determine the existence of unit root, the ADF test statistics τ_μ is used in the absence of a time trend and separately, τ_τ when both a constant and a time trend are included. τ_μ and τ_τ are determined by the t-ratio of the coefficient of x_{t-1} in each case. In order to choose the optimal lag length, Eq.(3.2) was initially run with p from 1 to 13 lags. From the output, we select the value of τ_μ and τ_τ that minimised the Akaike Information Criterion (AIC)[38] in the sequence of vector auto-regressive (VAR). The null hypothesis for the test statistics is that the time series is non-stationary, i.e., the time series contains a unit root. If the absolute values of (each of) τ_μ and τ_τ exceed the critical criteria, the hypothesis that the time series contains a unit root can be rejected. The critical values can be obtained from MacKinnon (1991).

Since the AIC does not ensure that the residuals are white noise (Joseph, 2001), a test was also made for white noise using the modified Serial Auto-correlation Lagrange Multiplier (LM) statistic at the lag structure suggested by the AIC. If however, the null hypothesis that the residuals are white noise at the chosen lag could not be accepted (p-value < 0.10), the order of the lag for the unit root test was increased by one (to a maximum of 13) or decreased by one (to a minimum of 1) and the residuals were again tested for whiteness until this was obtained. These procedures were also followed when testing for a unit root on the first difference of the series which is of the form:

$$\Delta^2 x_t = \mu_0 + \mu_1 T + \mu_2 x_{t-1} + \sum_{i=1}^{p} \xi_i \Delta^2 x_{t-i} + \varepsilon_t \qquad (3.3)$$

where

[38] AIC is a more general criterion that can be applied to any model that can be estimated by the method of maximum likelihood (See, e.g., Maddala, 2001).

Δ^2 is the second difference of the level series.

The unit root tests were applied to all the univariate series, and the results are presented in Table 3.2. For the level series without a trend, i.e., τ_μ the null hypothesis of a unit root was rejected in 19% of all cases (*p*-value< 0.10). Similarly, the null hypothesis for τ_τ was rejected in only 11% (6 out of 57) of the cases. The null hypotheses for both τ_μ and τ_τ were rejected in most cases (80%) in their first difference level (*p*-value<0.10). Even though there are several individual PPIs that cannot reject the ADF test statistically, the overall results strongly suggested that the level series contain a unit root and that the first differences of the level series are stationary. In general, the first differences of the series are stationary. This means that the standard *t*- and *F*-statistics can be applied to the differenced series for statistical inference.

Table 3.2 - Results for ADF Tests in the Univariate Series

	Log level series				First difference series			
	m	$\hat{\tau}_{\mu}$	m	$\hat{\tau}_{\tau}$	m	$\hat{\tau}_{\mu}$	m	$\hat{\tau}_{\tau}$
UK sterling trade-weighted rate	3	-2.3561	3	-2.7082	2	-7.8042[a]	2	-7.7866[a]
Food and live animals								
Cereals and animal feeding stuffs	13	-1.9066	13	-1.9657	12	-3.6873[a]	12	-3.679[b]
Food	0	-2.1483	0	-1.9935	0	-16.5332[a]	0	-16.562[a]
Fruit and vegetables	13	-2.049	13	-1.9042	12	-3.7613[a]	12	-3.829[b]
Meat	13	-3.0096[b]	13	-2.9937	13	-3.9424[a]	13	-3.9076[b]
Beverages and tobacco								
Beverages and tobacco	11	-2.4749	11	-1.4055	10	-3.2231[a]	10	-3.8332[b]
Basic Materials								
Metal Ores	6	-1.4553	6	-1.8343	5	-5.0433[a]	5	-5.0253[a]
Textile fibres	1	-1.8216	1	-2.1256	0	-20.8921[a]	0	-20.8484[a]
Fuels								
Fuels	4	-1.2413	1	-3.9556[b]	3	-8.3053[a]	3	-8.3477[a]
Chemicals								
Chemicals	2	-1.7259	2	-1.3792	1	-9.6659[a]	1	-9.7247[a]
Organic chemicals	5	-1.4793	5	-1.6502	4	-6.8296[a]	4	-6.8218[a]
Inorganic chemicals	6	-2.2769	6	-1.7502	5	-8.1635[a]	5	-8.3129[a]
Plastics	1	-1.3746	1	-2.2089	0	-18.3003[a]	0	-18.3636[a]
Material Manufactures								
Iron and steel	2	-0.3859	2	-0.6215	1	-9.0327[a]	1	-9.0841[a]
Paper and paperboard	2	-2.1023	2	-2.8153	1	-14.7415[a]	1	-14.7125[a]
Material manufactures	1	-2.2754	1	-1.9648	0	-23.3841[a]	1	-13.9012[a]
Mineral manufactures less precious stones	6	-2.0256	6	-1.1327	5	-7.2627[a]	5	-7.5115[a]
Miscellaneous metal manufactures	1	-1.6950	1	-1.5671	0	-20.4683[a]	0	-20.4742[a]
Non-ferrous metals	0	-2.4916	0	-2.5321	0	-16.5684[a]	0	-16.5474[a]
Textiles	0	-1.7472	0	-1.4964	0	-16.6983[a]	0	-16.8089[a]
Machinery and transport equipment								
Electronic machinery	3	0.2209	3	-2.0046	2	-10.1351[a]	2	-10.2927[a]
Machinery and transport equipment	1	-2.2491	1	-1.6863	0	-13.1639[a]	0	-13.4776[a]
Machinery	1	-1.5176	2	-1.671	1	-11.0145[a]	1	-11.266[a]
Road vehicles	12	-1.9167	12	-1.4366	11	-3.55[a]	11	-3.7471[b]
Miscellaneous								
Clothing	12	-2.1096	12	-1.7734	11	-3.2379[a]	11	-3.4385[b]
Clothing and footwear	12	-2.0244	12	-1.7336	11	-3.1903[b]	13	-3.7916[b]
Scientific and photographic	1	-1.8867	1	-1.2121	0	-19.9514[a]	0	-20.0551[a]
Others								
Finished manufactures	0	-2.2978	0	-1.4132	0	-14.0562[a]	0	-14.3685[a]
Finished manufactures less erratic	1	-2.1557	0	-1.4508	0	-13.6284[a]	0	-13.8749[a]

Table 3.2 Cont'd

	Log level series				First difference series			
	m	$\hat{\tau}_{\mu}$	m	$\hat{\tau}_{\tau}$	m	$\hat{\tau}_{\mu}$	m	$\hat{\tau}_{\tau}$
Producer Prices indices								
Meat and poultry meat prod.	1	-2.9895[b]	1	-0.9562	0	-12.7133[a]	0	-13.2391[a]
Man-made fibres	6	-2.1865	6	-2.0387	5	-5.1137[a]	5	-5.1646[a]
Fabricated metal products, exc. machinery and equipment	12	-0.6343	12	-3.037	11	-0.9675	11	-0.3364
Basic organic chemicals	10	-1.8191	10	-2.2444	9	-5.0339[a]	9	-5.0324[a]
Rubber and plastic products	3	-2.7494[c]	3	-2.0647	2	-4.1615[a]	2	-4.581[a]
Manufactured products exc. food, beverages, tobacco and petroleum	13	-2.2964	12	-3.1944[c]	11	-1.6523	12	-1.7457
Paper & paperboard	4	-2.4394	4	-2.6388	3	-3.812[a]	3	-3.8586[b]
Manufacture of basic precious and non-ferrous metal, aluminum prod.	4	-3.5367[a]	4	-3.5326[b]	12	-4.2724[a]	12	-4.2574[a]
Electronic machinery and apparatus	13	-2.576[c]	13	-2.5435	12	-1.6875	12	-2.0522
wearing apparel	12	-2.6243[c]	12	-1.672	11	-1.5642	11	-2.5254
Footwear	6	-3.8248[a]	11	-1.6658	11	-2.4752	10	-4.3394[a]
Chemicals, chemical prod. and manmade fibres	4	-3.0005[b]	4	-2.8995	3	-6.4252[a]	3	-6.6127[a]
Fruit and vegetable juices	1	-2.1857	1	-1.9248	0	-11.7613[a]	0	-12.0087[a]
Processed and preserved fruit and vegetables	0	-2.3819	0	-0.4961	1	-9.0838[a]	1	-9.3754[a]
Motor vehicles	12	-2.6445[c]	2	-1.558	11	-2.1835	11	-2.9375
Machinery and equipment	12	-2.5246	12	-2.8821	11	-1.3132	11	-1.6498
Transport equipment	12	-2.6308[c]	12	-2.0788	11	-1.7019	11	-2.258
Food prod. less beverages	6	-3.4587[a]	6	-2.9721	10	-2.6773[c]	5	-5.8495[a]
Prepared animal feed for farm animals	2	-2.377	2	-2.4774	1	-5.9758[a]	1	-5.9656[a]
Beverages	12	-1.9956	11	-3.763[b]	12	-3.6943[a]	11	-3.6182[b]
Motor spirit	2	-1.2539	2	-2.2324	1	-10.5046[a]	1	-10.5028[a]
Fuel oil	2	-0.2972	2	-3.0007	1	-10.2706[a]	1	-10.2982[a]
Gas oil and derivatives	3[#]	-0.5517	3[#]	-2.4114	2	-8.0532[a]	2	-8.0273[a]
Textiles fabrics	8	-2.2815	8	-2.3505	6	-2.7713[c]	6	-2.7958
Non metallic mineral prod.	12	-0.4379	13	-3.7502[b]	11	-2.1816	11	-2.1734
Base metals	10	-1.9341	10	-2.0847	8	-3.2847[b]	8	-3.3008[c]
Photographic chemical materials	2	-1.6346	2	-3.2918[c]	1	-12.592[a]	1	-12.5535[a]
Basic pharmaceutical products	10	-2.0049	10	-2.4158	4	-4.8502[a]	4	-4.8952[a]

Note: [a, b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-percemt level, respectively. $\hat{\tau}_{\mu}$ is the ADF statistic with a constant while $\hat{\tau}_{\tau}$ is the ADF statistic with both a constant and a trend. The critical values for $\hat{\tau}_{\mu}$ and $\hat{\tau}_{\tau}$ were obtained from MacKinnon (1991). [#]The number of lag is adjusted for these series, since the optimal lags chosen by AIC can reject the null hypothesis of serial correlation LM test in either 2 or 4 lags.

3.5.3.2 OCSB Seasonal Unit Root Tests

The ADF test indicates that there is no unit root at zero frequency. However, this is not sufficient to decide that conventional first difference transformation is suitable for the series since the series can contain a seasonal unit root which is not detected by the ADF test. The reason why we use seasonally unadjusted data is because raw data always contains original information (see, e.g., Lee and Siklos, 1997). Additionally, several empirical works (see, e.g., Gooijer and Franses, 1997) show that many seasonal adjustment methods can severely distort time series data, because business cycles and non-linearities are affected by seasonal adjustment. If the raw data contains seasonal unit roots then this needs to be captured for estimation.

To test for seasonal unit root the test of Osborne *et al.* (1988) is applied. Several studies have tested for seasonal unit root (see, e.g., Osborne, 1990; Franses and Dijk, 2005; Matas-Mir and Osborn; 2004, Proietti, 2000) in monthly data[39]. The evidence regarding seasonal unit roots tends to be mixed. There are several seasonal unit root tests are available including those of Dickey, Hasza and Fuller (DHF), Hylleberg Engle, Granger and Yoo (HEGY), and Osborn, Chui, Smith and Birchenhall (OCSB), of which the OCSB and the HEGY are the most popular. However, some empirical work has shown the OCSB test to be more preferable in terms of size and power, while the HEGY might have a high probability of incorrectly concluding that the process is seasonally-integrated (see, e.g., Castro and Osborn, 2005; Rodrigues and Osborn, 1999). The OCSB test is therefore employed in this study.

For series x_t (in log levels), the OCSB test has the form:

[39] There are also some other studies interested in quarterly time series, for example, Hylleberg (1995), Taylor (2005) and Burridge and Taylor (2004).

$$\Delta_1\Delta_{12}x_t = \tau_1\Delta_{12}x_{t-1} + \tau_2\Delta_1 x_{t-12} + \sum_{k=1}^{12}\delta_k D_{kt} + \sum_{i=1}^{p}\xi_i\Delta_1\Delta_{12}x_{t-i} + \varepsilon_t \qquad (3.4)$$

where

$\Delta_1\Delta_{12}x_t = x_t - x_{t-1} - x_{t-12} + x_{t-13}$ is the first-order time difference of the series with a seasonal difference at 12;
D_{kt} is a dummy variable taking the value one in month k and zero otherwise,
p is the order of augmentation needed to ensure that the disturbance ε_t is *iid* (0, σ^2).

In the case of the study's monthly data, the application of first and annual differences to time series x_t results in $\Delta_1\Delta_{12}x_t$. If x_t is non-stationary, but $\Delta_1\Delta_{12}x_t$ is a stationary invertible process, we can refer to x_t as being *I*(1, 1) (Osborn *et al.*, 1988). Under the *I*(1, 1) null hypothesis, $\tau_1 = \tau_2 = 0$ and we test this hypothesis using an *F*-type statistic, as discussed by Hasza and Fuller (1982) and OCSB. One alternative to the *I*(1, 1) null hypothesis is that stationarity is induced by removing deterministic seasonal means using seasonal dummy variables after taking first differences. This alternative hypothesis is represented in Eq. (3.4) by τ_1=0 with τ_2<0 and is denoted as *I*(1, 0). A second alternative is that the time series requires annual differencing, but not conventional first differencing. This becomes the *I*(0, 1) alternative hypothesis, captured in Eq. (3.4) by τ_2=0 with τ_1<0. OCSB suggest the use of separate *t*-type statistics for τ_1=0 and τ_2=0 to distinguish these two possibilities.

Similar to the ADF test, when we estimate the OCSB model, it is essential to specify a leg length in order to account for the serial auto-correlation properties of the data. In this sense, the researcher considers lag orders p = 0, 1,..., 12, testing down from lag 12 to lag 0 and picking up the one with the largest *t*-statistic in absolute terms. The selected models are subjected to conventional diagnostic checks for serial auto-correlation based on the modified LM test. If all of the 12 lags cannot pass the LM test at the 10% level, two more lags will be added to order 14. If p = 14 is not enough to account for serial correlation, an additional set of models will be needed which specify some intermediate ξ_i to be zero by introducing a seasonal lag of 12 in conjunction with an intra-year lag order from 0 to 10, so there is a total of 24 models examined. In some cases, we extend the lag order 12 to 14 in conjunction with an intra-year lag order from 0 to 10, meaning that 48 models are examined in order to ensure the white noise process.

Table 3.3 shows the results for the OCSB tests. Firstly, the joint $F_{1,2}$ statistics indicate that the $I(1, 1)$ null hypothesis is rejected at the 1% level of significance for all the 57 series considered. That means the data do not have both a unit root and seasonal unit root, but the $I(1, 1)$ results cannot yet reveal whether the series contains a unit root or seasonal unit roots. As to the choice between the $I(1, 0)$ and $I(0, 1)$ alternatives, the results are almost equally determinative. More specifically, in terms of the $I(1, 0)$, there are only 9 out of 57 cases (16%) that reject that τ_1=0 at the 10% level, compared with the $I(0, 1)$ that τ_2=0 is rejected in all the cases at the 1% level. This result implies that there is no seasonal effect existing in the series and confirms the ADF test that the data contains a unit root.

The table also shows that the conventional R^2 is obtained from a regression of the first difference series against twelve monthly dummy variables. Higher values of this measure can arise in the presence of seasonal unit roots. For example, the highest and lowest values of R^2 are 0.4889 and 0.0153 for the sectors of Non-metallic mineral products, and Paper and paperboard respectively. This means that Non-metallic mineral products are more likely to exhibit seasonal unit roots than Paper and paperboard.

Table 3.3 - Results for OCSB Tests in the Univariate Series

	Seas. R^2	Lags	τ_1	τ_2	$F_{1,2}$
UK sterling trade-weighted rate	0.0464	1-13	0.1976	-11.2125[a]	63.0494[a]
Food and live animals					
Cereals and animal feeding stuffs	0.0855	1-3	1.8145[c]	-11.3569[a]	65.2575[a]
Food	0.0834	1-5	-0.7931	-12.5489[a]	80.7653[a]
Fruit and vegetables	0.1042	1	0.6751	-16.0311[a]	128.511[a]
Meat	0.2615	1,12-13	-0.4790	-10.3309[a]	53.3976[a]
Beverages and tobacco					
Beverages and tobacco	0.0311	1	2.2123[b]	-16.1206[a]	130.115[a]
Basic Materials					
Metal Ores	0.0611	1	-1.4296	-23.4352[a]	92.1339[a]
Textile fibres	0.0306	1-14	0.9094	-9.4317[a]	44.6224[a]
Fuels					
Fuels	0.0640	1-10	0.9488	-13.6224[a]	106.2069[a]
Chemicals					
Chemicals	0.0637	1-6	-1.6281	-13.8084[a]	97.6628[a]
Organic chemicals	0.0595	1-12	0.8679	-9.8690[a]	48.9489[a]
Inorganic chemicals	0.0760	1-5	0.6283	-12.4792[a]	79.0104[a]
Plastics	0.0244	1-7	-1.8472[c]	-14.6201[a]	108.3904[a]
Material Manufactures					
Iron and steel	0.0628	1-7	-0.6528	-12.3120[a]	75.8004[a]
Paper and paperboard	0.0379	1,12	1.0348	-9.6247[a]	46.3794[a]
Material manufactures	0.0176	1-10,12-14	-0.0509	-1.1034[a]	64.6583[a]
Mineral manufactures less precious stones	0.0472	1-14	0.6505	-9.0652[a]	41.4593[a]
Miscellaneous metal manufactures	0.1312	1,12-13	-0.7410	-7.9600[a]	31.7340[a]
Non-ferrous metals	0.0312	1-7	-1.4414	-14.0591[a]	99.3569[a]
Textiles	0.0726	1-6	-2.6753[a]	-14.4211[a]	105.4244[a]
Machinery and transport equipment					
Electronic machinery	0.0751	1-4	-1.2381	-13.8581[a]	96.1114[a]
Machinery and transport equipment	0.1020	1-12	-0.9413	-8.0038[a]	32.0479[a]
Machinery	0.1102	0	-0.9541	-14.7066[a]	108.2322[a]
Road vehicles	0.0983	1-10	-1.8501[c]	-11.1700[a]	66.4835[a]
Miscellaneous					
Clothing	0.1241	1	-0.6946	-11.0410[a]	61.1419[a]
Clothing and footwear	0.1361	1	0.3571	-11.0404[a]	61.4254[a]
Scientific and photographic	0.0615	1-8	1.8438[c]	-13.7826[a]	95.5461[a]
Others					
Finished manufactures	0.1364	1-4	-1.6891[c]	-12.6784[a]	80.37404[a]
Finished manufactures less erratic	0.1179	1-6	-1.1613	-13.1704[a]	87.9664[a]

Table 3.3-Cont'd

	Seas. R^2	Lags	τ_1	τ_2	$F_{1,2}$
Producer Prices indices					
Meat and poultry meat prod.	0.0788	0	-0.0279	-13.7631[a]	95.0236[a]
Man-made fibres	0.0516	1-6	-0.7105	-14.5489[a]	107.9889[a]
Fabricated metal products, exc. machinery and equipment	0.1698	1-2,12-14	-0.7350	-6.9328[a]	24,0515[a]
Basic organic chemicals	0.0411	1-13	-0.6732	-10.0197[a]	54.4026[a]
Rubber and plastic products	0.0743	1-2,12-13	-0.2120	-6.3673[a]	20.2729[a]
Manufactured products exc. food, beverages, tobacco and petroleum	0.1628	1-2,12-13	-0.1719	-7.1594[a]	25.6658[a]
Paper and paperboard	0.0153	1-14	0.0216	-9.7645[a]	47.7111[a]
Manufacture of basic precious and non-ferrous metal, aluminum prod.	0.0233	1-3	-1.5004	-13.5793[a]	92.2090[a]
Electronic machinery and apparatus	0.1186	1-13	0.6075	-7.3398[a]	27.5343[a]
wearing apparel	0.1869	1-12	-0.5934	-6.6361[a]	22.0275[a]
Footwear	0.1064	1-13	-1.3033	-7.5471[a]	28.5098[a]
Chemicals, chemical prod. And manmade fibres	0.1043	1-2,12-13	-0.6414	-9.0850[a]	41.6550[a]
Fruit and vegetable juices	0.0430	1-13	1.6882[c]	-9.5340[a]	45.4524[a]
Processed and preserved fruit and vegetables	0.0566	1-7	2.1993[b]	-12.1001[a]	77.4526[a]
Motor vehicles	0.1380	12	0.1690	-8.1506[a]	33.2871[a]
Machinery and equipment	0.1867	0	0.6008	-9.4446[a]	45.4201[a]
Transport equipment	0.2413	12	0.0472	-6.7033[a]	22.5559[a]
Food prod. less beverages	0.2668	1-13	-0.1630	-7.5782[a]	28.7156[a]
Prepared animal feed for farm animals	0.1970	1-8	0.8461	-12.2101[a]	75.2173[a]
Beverages	0.2018	1-3	1.4303	-10.2936[a]	54.3661[a]
Motor spirit	0.1624	1-6	-1.0001	-11.1206[a]	61.8840[a]
Fuel oil	0.0345	1-14	-0.5438	-7.4590[a]	27.8232[a]
Gas oil and derivatives	0.0964	1-13	-0.4992	-10.0173[a]	50.1765[a]
Textiles fabrics	0.0733	1-5	-0.5029	-10.3115[a]	53.1640[a]
Non metallic mineral prod.	0.4889	1-8	0.9567	-10.2834[a]	53.3313[a]
Base metals	0.0488	1-2	-2.7214	-9.5638[a]	48.3572[a]
Photographic chemical materials	0.1262	1-4,12	0.1209	-9.0470[a]	40.9242[a]
Basic pharmaceutical products	0.0518	1-6	0.5558	-10.6536[a]	60.1671[a]

Seasonality R^2 values obtained for regressions of the first difference series against twelve monthly dummy variables. The higher value of Seas. R^2 indicates stronger seasonal patterns. [a], [b] and [c] indicate that the test statistic is significant at a 1-, 5- or 10-percernt level, respectively. τ_1 is the OCSB seasonal unit root statistic for fist differences while τ_2 is the OCSB seasonal unit root statistic for annual differences. The critical values for τ_1 and τ_2 obtained from Rodrigues and Osborn (1997). $F_{1,2}$ statistic is the joint hypothesis critical value for $\tau_1 = \tau_2 = 0$.

However, the magnitude of the larger R^2 would not appear to suggest a seasonal unit root as this is not supported by the τ_2. Finally, the results from the ADF test and the OCSB seasonal unit root test are consistent and indicate that the series contains a unit root without seasonal effects. Hence, the remainder of the analysis the data is transformed by taking the log first differences. By not using seasonally-adjusted data, the models are estimated without a loss of information. Prior studies seasonally adjust the data without first testing that this procedure is necessary (see, e.g., Korhonen and Wachtel, 2006, Klitgaard, 1999 and Weber, 1997).

3.5.4 BDS Tests for Linearity

Besides stationarity, linearity is an important feature of time series data, the reason being that linear models rely on the linearity of the data to ensure estimation efficiency. Several empirical studies have examined the linearity of financial data (see, e.g. Panagiotidis and Pelloni, 2001; Wei, 1998) using a large number of statistical tests including those of McLeod and Li (1983), Engle LM (1982) and Brock *et al.* (1987) BDS.

To test whether the residuals are independently and identically distributed *(iid)* in the univariate series, the BDS test, which is considered to be the most powerful test of the *iid* condition (see, e.g., Brock *et al.*, 1991) was applied. The test is usually applied to the standardised residuals of a model as by implication, failure to reject the null implies that the *iid* condition is satisfied.

3.5.4.1 AR (*p*)-EGARCH (1, 1) Pre-whitening Process

To test for *iid* in the series, an AR (*p*) EGARCH process is used to pre-whiten the series. This approach is adopted since the EGARCH model also allows for the capture of volatility clustering and asymmetry of the data. If exporters mis-price their exports in response to FX rate and PPIs changes, then there is likely to be asymmetry in EPs.

The optimal lag for the AR (*p*)-EGARCH (1, 1) model was determined by the AIC using an initial lag structure of p=1 to p=13. A dummy variable was also used to capture the apparent structural break in 1987M10[40]. The specification of the model resulted into the following mean equation

$$r_{i,t} = \mu_{0,i} + \sum_{j=1}^{p} \upsilon_i r_{t-j} + \varepsilon_{i,t} \tag{3.4}$$

where

$$\varepsilon_{i,t} \left| \Omega_{t-1} \right. \sim t(0, \sigma^2_{i,t}).$$

Moreover, a conditional variance equation is as follows:

$$\ln(\sigma^2_{i,t}) = \omega_i + \theta_i \ln(\sigma^2_{i,t-1}) + \varphi_i \frac{\varepsilon_{i,t-1}}{\sqrt{\sigma^2_{i,t-1}}} + \kappa_i \left[\frac{\left|\varepsilon_{i,t-1}\right|}{\sqrt{\sigma^2_{i,t-1}}} - \sqrt{\frac{2}{\pi}} \right] + \delta_i D_{i,t} \tag{3.5}$$

[40] I introduce the dummy variable only into the variance equation, because there are some studies (e.g. Doornik and Ooms, 2003) that show that the inclusion of dummy variables as regressors can lead to multimodality in the GARCH model.

where

$r_{i,t}$ and r_{t-j} are respectively left-hand side and exogenous variables;
$D_{i,t}$ is any zero/one dummy variable for structure breaks in the variance of series;
$\varepsilon_{i,t}$ depicts the error term;
$\sigma^2_{i,t}$ is the conditional variance of $\varepsilon_{i,t}$ and Ω_{t-1} is the information set at t-1.

The coefficients in Eq. (3.5) are estimates of the conditional parameter vectors. $t(0, \sigma^2_{i,t})$ depicts some distribution with a mean of zero and a variance of $\sigma^2_{i,t}$. The conditional distribution of the errors can be assumed to follow the Student t-distribution, this is because the results in Table 3.1 show that the data is not normally-distributed. More importantly, the conditional t distribution is shown to perform better than the conditional normal distribution (see, Joseph, 2003). In the EGARCH model, there is no need to artificially impose non-negativity constraints on the model parameters, since the $\ln(\sigma^2_{i,t})$ is modelled, and even if the parameters are negative, $\sigma^2_{i,t}$ will be positive. Furthermore, asymmetries are allowed for under the EGARCH formulation, since if the relationship between volatility and return is negative, φ_i, will be negative. When φ_i is negative, it implies that negative innovation generates larger volatility than a positive shock. According to Nelson (1991), the leverage effect is the negative correlation between volatility and past value (return) of the series. However, there are many recent studies (see, e.g., Lee, 2006; Chen and Liow, 2006) that find that the impact from positive innovation on the conditional variance is larger than that from negative shock, when φ_i is positive. Moreover, the coefficient κ_i manages the effect of last period's shock on the volatility. Furthermore, the coefficient θ_i measures the relationship between the past variance and current variance. When the sum of κ_i and θ_i is close to one, it represents high level of volatility persistence. That is, shock in volatility does not vanish quickly over time.

Again, since the AIC does not ensure that the errors are white noise, the ARCH-LM test is used to confirm that there is no ARCH effect in the residuals. Although ARCH itself does not invalidate standard OLS inference, ignoring ARCH effects may result in loss of efficiency.

The results of the variance equation are shown in Appendix 1. The mean, coefficient ω, are typically negative and significant in 37 out of 57 (65%) cases. The current news component κ_i is statistically significant in no more than half of the cases (13 out of 28 EPs and 11 out of 28 PPIs), indicating that the EGARCH model captures the effect of last period's shock. In addition, the coefficients of θ_i are significant and close to unity in 12 out of 28 EPs and only 6 out of 28 PPIs, so this result indicates that the shocks to the conditional variance will be highly persistent in minor cases. Furthermore, the impact is asymmetric if $\varphi_i \neq 0$, and the leverage is present if $\varphi_i < 0$. That is, negative shock causes volatility to rise by more than a positive shock of the same magnitude. However, the reverse is true, when $\varphi_i > 0$. In general, positive and negative innovation from the series in the study do not seem to have asymmetric impact on their own volatilities as the coefficient φ_i is significant in only 6 out 28 EPs and 7 out of 28 PPIs. In the EPs, there are 5 cases carrying positive signs for φ_i significantly, while φ_i should be negative in stock returns. This is because higher stock price (good news) is agreeable, but higher EPs means less competitive. Specifically, a positive shock means that EPs are increased and then less competitive, this bad news gives a signal to the manufacturer that they need to adjust their EPs, in order to gain more market share. Alternatively, a negative shock means that EPs are decreased are more competitive, then less intense to use PTM to change their EPs. Also, the limited profit margin would not allow them to reduce the price lower than the cost. Therefore, compared with negative shocks, positive shocks have larger impact on the EPs' volatility.

Additionally, the FX rate index is an essential element in the model used in the study, but it does not show high persistent volatility and does not have leverage effects on volatility. It might not be true that leverage effects exist in all financial and economics data. For example, when So (2001) investigated the asymmetries in the US dollar interest rate, he found there to be no difference between negative and positive innovations for the interest rate.

It is worth noting that the *t*-distribution statistics are significant in more than half the cases, thereby implying that the conditional *t*-distribution does not provide an adequate fit in those instances. Also, the dummy variable is significant in 65% of the cases. More importantly, from Appendix 1, there is some strong evidence to show that serial correlation still exists in most case. For example, information in lag 1, 4, 10 and 13 can still affect the dependent variable in the EPs for the Fuels industry.

3.5.4.2 BDS Tests for Standardised Residuals of AR (*p*)-EGARCH (1, 1)

There is some strong evidence of outliers in the residuals as shown in Appendix 1. Therefore, the EGARCH models have not been able to remove all the excess kurtosis and skewness. To test this possibility, the BDS test was performed on the standardised residuals of the EGARCH model, and the results appear in Appendix 2. The results show that there is only one out of 57 cases that can be proved as non-linear in different dimensions, and that is Footwear PPIs. Beside, for the standard deviation l=0.25, the test reveals no evidence of non-linearity dependence for only three series: Finished manufactures less erratic EPs, Meat and poultry meat products PPIs, and Motor vehicles PPIs. Furthermore, in the case of l=0.5 and l=0.75, there are about half – 50% and 55% of the cases that can accept the null hypothesis of the BDS test that the data is *iid*. Overall, there is some tendency for the EGARCH model to neglect some of the non-linearity in the univariate series. The *iid* condition is not always satisfied. Even so, this result means that the EGARCH will still ensure better estimation efficiency than the standard OLS model. The tendency for GARCH-type models to neglect some of the non-linearity in the data has been noted by Joseph (2003b), amongst others.

3.6 Conclusion

This chapter presented an overview of the data that will be used for the main analysis in the thesis. Since we are using time series data, we need to be clear about the data generating process. The chapter indicates that the plots of the level series are non-stationary and first differencing renders them stationary. Although the original series are non-seasonally adjusted, the OCSB test indicates that the overall seasonal unit roots are not present and the ADF supports stationarity in the first difference of univariate analysis of the series. By using seasonally-unadjusted data, more information will be employed than if the data were seasonally adjusted. Prior studies seasonally adjust the data without testing that this procedure is necessary (see, e.g., Korhonen and Wachtel, 2006, Klitgaard, 1999 and Weber, 1997). The descriptive statistics indicate that the differenced series are non-normally distributed. Using an EGARCH model to pre-whiten the univariate series, the BDS also rejects the null that the residuals are *iid*. Even so, this result suggests that a GARCH-type model is likely to generate more efficient parameter estimates than a standard OLS model. So the PTM will be estimated using a GARCH-type model that captures asymmetry and volatility clustering in the data.

CHAPTER 4

Empirical Results for the EGARCH and GJR Estimates

4.1 Introduction

In the last chapter, the background was presented for the development of the exposure model, in which the associated variables were identified. The preliminary analysis indicated that the asymmetry and ARCH effects in the data support a GARCH-type estimation approach. Consequently, this chapter provides the results for both the EGARCH and GJR estimation methods.

Section 4.2 presents the results for the standard model. These are estimated using EGARCH and GJR methods. The results for the dynamic model are illustrated in section 4.3. Those two sections also report the BDS statistics to examine the non-linearity in the residuals from the EGARCH and GJR models. Using both the EGARCH and GJR to estimate the exposure models, allows for an assessment of which model provides a better fit in the evaluation of PTM. Finally, section 4.4 concludes that the GJR model with lags is able to capture more properties for the data, and the BDS test indicates that the GARCH-type model cannot capture the non-linear dependence.

4.2 Standard Model

The standard model is estimated using EPs, FX rates and PPIs. This is specified as

$$\Delta EP_{i,t} = \alpha_{0,i} + \beta_i \Delta X_t + \lambda_i \Delta PPI_{i,t} + \varepsilon_{i,t} \tag{4.1}$$

The parameters are as described in Chapter 3. Eq. (4.1) is similar to Yang's (1998) model. However, it is estimated using GARCH-type estimation methods – not OLS as is done in previous studies. This is because of the need to capture the time-varying properties and asymmetry in the data that can affect the parameters of the model. Of course, Eq. (4.1) contains no lags and this structure may not be representative of the behaviour of agents. Asymmetric GARCH-type models perform better than the standard GARCH models, in capturing the asymmetry in the data (see Engle and Ng, 1993; Shamiri and Hassan, 2005). Thus, both the EGARCH and GJR estimation approaches are used.

Eq. (4.1) is estimated in first differences since both the ADF and OCSB tests show that the time series are stationary in the first differences. It needs to be emphasised that the level variables are not seasonally adjusted since the OCSB tests indicate that they contain no seasonal unit roots. This avoids the loss of information that arises when seasonally-adjusted data are used.

Both the EGARCH and GJR models are estimated using a zero/one dummy variable which corresponds to the period of the stock market crash of October, 1987. The variable seems important for estimation. Again, it is assumed that the conditional errors in the GARCH-type estimates follow a conditional *t* distribution. The BDS statistic is employed to validate whether the associated conditional errors satisfy the *iid* condition under both the EGARCH and GJR.

4.2.1 Mean Equations for Standard Model

Before discussing the mean estimates in detail, it is useful to assess their diagnostic tests for model adequacy. As can be seen from Table 4.1 and 4.2, the GJR estimation is more superior than the EGARCH. In terms of the *t*-distribution, the GJR fits the data better than the EGARCH model (14 industries vs. 12 industries). Furthermore, the GJR estimation has higher $\overline{R^2}$ and lower AIC, which indicate that the GJR model is better than the EGARCH in terms of the information captured by it.

4.2.1.1 EGARCH Estimates

The mean equation estimates under the EGARCH model are shown in Panel A of Table 4.1. The parameters for the conditional variance are presented (see Panel B) in a separate section. The results indicate that the FX rate coefficients are negative and significant in 23 of 28 cases. This means that the EPs of international goods are negatively impacted by FX rate changes. The finding suggests that exporters operate PTM, and this is consistent with previous empirical work (see e.g., Knetter, 1989; Athukorala and Menon, 1995). The negative coefficients for FX rate changes suggest that when sterling appreciates, this causes a decrease in the price of exports. This decrease can be as large as the amount that sterling appreciates based on the coefficient estimates in Panel A. For the Organic chemicals industry, the coefficient for the FX rate changes is -0.4356 (*p*-value=0.01). It is worth noting that, all the industries in the Chemicals sector reveal a significant and high degree of PTM, a finding that has also been supported by previous studies (see, e.g., Falk and Falk, 2000).

Similarly, the table shows that 18 of the 28 EPs are influenced by PPIs. The positive coefficients for PPI suggest that EPs increase in line with producers' costs. However, this is the first study to investigate the impact of PPIs on EPs, and hence, there are no previous results that can be compared.

Overall, the findings exactly match the prediction that EPs are negatively related with FX rate changes, but positively related with PPIs.

Table 4.1 Estimates of the EGARCH Regression Coefficients under the *t*-density

	Food and live animals				Beverages and Tobacco	Basic materials		Fuels	Chemicals	
Panel A										
	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres	Fuels	Chemicals	Organic chemicals
α	0.0005	0.0000	0.0018	0.0031	0.0015	0.0014	0.0013	-0.0030	-0.0009	-0.0001
	(0.0011)	(0.0008)	(0.0022)	(0.0030)	(0.0011)	(0.0024)	(0.0011)	(0.0034)	(0.0007)	(0.0007)
ΔX_t	-0.2246[a]	-0.2343[a]	0.1857	-0.0786	-0.4343[a]	-0.1903	-0.1513[b]	-0.1941	-0.3109[a]	-0.4356[a]
	(0.0704)	(0.0593)	(0.1227)	(0.1645)	(0.0480)	(0.1354)	(0.0703)	(0.2488)	(0.0350)	(0.0480)
ΔPPi_t	0.2628[b]	1.1945[a]	0.0914	0.1024	0.1317	0.6584	0.3684[a]	1.4702[a]	0.4717[a]	1.0285[a]
	(0.1040)	(0.2627)	(0.1624)	(0.3506)	(0.1351)	(0.5170)	(0.0580)	(0.1333)	(0.1174)	(0.1380)
$\overline{R^2}$	-0.0368	0.0671	-0.0325	-0.0348	0.0882	-0.0249	0.0431	0.2759	0.0852	0.0695
AIC	-5.1607	-5.9947	-3.8672	-3.5710	-5.6608	-4.0401	-5.1093	-3.2346	-6.1702	-5.3371
Panel B										
ω	-0.0299	-0.4171	-6.7784[a]	-1.1820	-8.4523[a]	-7.0508	-0.2120[a]	-1.4308	-8.8636[a]	-0.3656[a]
	(0.0795)	(0.3375)	(1.9866)	(0.9469)	(1.0726)	(11.8739)	(0.0103)	(1.0648)	(0.9772)	(0.1360)
κ	-0.0330	0.3628[b]	0.2929[b]	0.2034	0.7575[a]	-0.0151	-0.1053[a]	0.2352	0.6484[a]	0.2412[a]
	(0.0510)	(0.1801)	(0.1193)	(0.1267)	(0.1695)	(0.1997)	(0.0039)	(0.1701)	(0.1406)	(0.0837)
φ	0.0462	0.0949	-0.0295	0.1787[b]	0.0807	0.0267	0.0681	-0.1198	-0.2319[a]	0.0251
	(0.0466)	(0.1040)	(0.0847)	(0.0836)	(0.1260)	(0.1301)	(0.0473)	(0.1009)	(0.0850)	(0.0765)
θ	0.9957[a]	0.9878[a]	0.0381	0.8418[a]	0.0894	-0.0247	0.9643[a]	0.7968[a]	0.0842	0.9787[a]
	(0.0052)	(0.0326)	(0.2893)	(0.1371)	(0.1300)	(1.7242)	(0.0012)	(0.1643)	(0.1103)	(0.0128)
$D_{t,1987}$ *			-0.2082	-0.4085		-1.1053	2.3473[a]		-0.0913	3.0502[a]
			(11.5700)	(1.2126)		(251.8380)	(0.3729)		(9.8086)	(0.8308)
t-dist	19.4247	83.6905	17.0246	26.1500	18.5011	6.0373[b]	7.2787[b]	6.0827[c]	17.8842	4.5301[b]
	(31.4408)	(496.8092)	(12.8013)	(58.0420)	(18.3399)	(2.8075)	(3.5968)	(3.4096)	(12.3112)	(1.8252)

Table 4.1 Cont'd

	Chemicals		Material Manufactures							Machinery and transport equipment
	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery
Panel A										
α	-0.0005	-0.0005	0.0012	0.0003	-0.0007	-0.0005	0.0012	0.0002	-0.0002	-0.0018[c]
	(0.0009)	(0.0007)	(0.0009)	(0.0011)	(0.0012)	(0.0013)	(0.0008)	(0.0010)	(0.0001)	(0.0009)
ΔX_t	-0.4111[a]	-0.3004[a]	-0.2538[a]	-0.2847[a]	-0.3229[a]	-0.2341[a]	-0.2716[a]	-0.3125[a]	-0.0810[a]	-0.1181[b]
	(0.0565)	(0.0458)	(0.0515)	(0.0624)	(0.0550)	(0.0766)	(0.0479)	(0.0576)	(0.0076)	(0.0567)
ΔPPi_t	0.3089[b]	0.7252[a]	0.5707[a]	0.1253	1.2960[a]	0.1488	1.0475[a]	0.3435[a]	0.0029	0.5133[b]
	(0.1251)	(0.2271)	(0.1037)	(0.1128)	(0.2900)	(0.2417)	(0.2808)	(0.0647)	(0.0188)	(0.2410)
$\overline{R^2}$	-0.0531	0.0153	0.0597	0.0284	0.0679	0.0032	-0.0436	0.0616	-0.0002	-0.0187
AIC	-4.7322	-5.8215	-5.7804	-5.2794	-5.2640	-5.2721	-5.7976	-5.2276	-9.6317	-5.4287
Panel B										
ω	-0.2633[a]	-0.2894	-0.2578	-7.6826[a]	-7.4906[a]	-8.1345[a]	-0.7307[b]	-11.9709[a]	-0.4982	-7.7309[a]
	(0.0912)	(0.1872)	(0.1909)	(0.7923)	(0.7162)	(1.0368)	(0.3059)	(1.7162)	(0.3420)	(2.5295)
κ	0.1739[b]	0.1787[b]	0.0575	0.8041[a]	0.7612[a]	0.7408[a]	0.2999[a]	0.0936	0.2838[a]	0.4990[b]
	(0.0830)	(0.0838)	(0.0668)	(0.1911)	(0.1774)	(0.1365)	(0.1120)	(0.1698)	(0.0982)	(0.2268)
φ	-0.1190	0.1075	0.1524[b]	-0.0008	0.1399	-0.3242[a]	0.2116[b]	-0.3101[b]	-0.0134	0.0803
	(0.0780)	(0.0819)	(0.0647)	(0.1178)	(0.0963)	(0.1082)	(0.1071)	(0.1247)	(0.0777)	(0.1430)
θ	0.9846[a]	0.9826[a]	0.9753[a]	0.1426	0.1614[c]	0.0823	0.9433[a]	-0.4977[b]	0.9783[a]	0.0841
	(0.0084)	(0.0179)	(0.0195)	(0.0966)	(0.0898)	(0.1332)	(0.0318)	(0.2120)	(0.0240)	(0.3163)
$D_{t,1987}$*	3.3979[a]	1.2024[c]		-2.9043	-0.4048		2.1011[b]	-0.1127		-3.4384
	(0.7455)	(0.7151)		(2.1751)	(10.2102)		(0.9167)	(2.0600)		(154.8001)
t-dist	4.1556[a]	6.0665[a]	9.5011[c]	15.8811	16.9672	18.6820	12.5439	3.7956[a]	16.6048	3.4006[a]
	(1.1815)	(1.5977)	(5.6955)	(9.8240)	(13.1317)	(13.3455)	(14.4965)	(1.2202)	(26.0078)	(0.9249)

Table 4.1 Cont'd

	Machinery and transport equipment			Miscellaneous			Others	
	Machinery and transport equipment	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
Panel A								
α	-0.0018^{b}	-0.0013	0.0000	-0.0002	0.0000	0.0007^{a}	-0.0012^{b}	-0.0011^{b}
	(0.0008)	(0.0008)	(0.0004)	(0.0003)	(0.0004)	(0.0002)	(0.0006)	(0.0005)
ΔX_t	-0.1264^{a}	-0.1472^{a}	-0.0002	-0.3526^{a}	-0.3548^{a}	-0.2479^{a}	-0.1819^{a}	-0.1912^{a}
	(0.0415)	(0.0478)	(0.0161)	(0.0316)	(0.0411)	(0.0427)	(0.0354)	(0.0303)
ΔPPi_t	0.6828^{a}	0.5129^{b}	0.0041	0.3833^{a}	0.1567	0.0052	1.0228^{a}	0.9226^{a}
	(0.1563)	(0.2189)	(0.0244)	(0.1191)	(0.1596)	(0.0325)	(0.2058)	(0.1710)
$\overline{R^2}$	0.0306	-0.0144	-0.0563	-0.0383	-0.0617	0.0087	0.0387	0.0298
AIC	-6.1794	-5.8504	-6.1458	-6.0381	-6.0657	-6.4821	-6.2993	-6.3202
Panel B								
ω	-8.6910^{a}	-7.6004	-0.1395^{b}	-0.1288^{a}	-0.0742^{a}	-0.0770^{a}	-0.6502	-0.8497^{b}
	(2.5723)	(4.8773)	(0.0710)	(0.0002)	(0.0072)	(0.0028)	(0.4234)	(0.3932)
κ	0.1159	0.2291	0.2361^{b}	-0.1074^{a}	-0.0753^{a}	-0.0926^{a}	0.2251^{b}	0.3238^{a}
	(0.1940)	(0.2115)	(0.1198)	(0.0004)	(0.0038)	(0.0003)	(0.1132)	(0.1097)
φ	0.0871	0.0287	0.3437^{b}	0.1296^{a}	0.0547	0.0695^{a}	0.0627	0.1608
	(0.1315)	(0.1430)	(0.1427)	(0.0006)	(0.0359)	(0.0219)	(0.0988)	(0.1065)
θ	0.0373	0.1216	0.9967^{a}	0.9795^{a}	0.9882^{a}	0.9859^{a}	0.9483^{a}	0.9317^{a}
	(0.2847)	(0.5748)	(0.0099)	(0.0000)	(0.0009)	(0.0008)	(0.0426)	(0.0402)
$D_{t,1987}$*	-11.6096^{a}	-3.5357	2.2935^{a}	2.1635^{a}	1.7922^{a}		0.4366	-3.1663^{a}
	(3.4891)	(78.3922)	(0.8600)	(0.0053)	(0.3065)		(0.7172)	(1.2072)
t-dist	4.6551^{b}	3.3524^{a}	2.0908^{a}	7.2611^{b}	6.0459^{b}	13.2793	6.8348^{b}	4.1284^{a}
	(1.8316)	(0.9871)	(0.0722)	(3.0801)	(2.5214)	(12.1973)	(2.7469)	(1.3888)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-percernt level, respectively.* Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for some industries. $\overline{R^2}$, AIC and *t*-dist denote the adjusted R squared, Akaike Information Criterion and *t*-distribution, respectively.

4.2.1.2 GJR Estimates

The study also estimates a GJR since Engle and Ng (1993) argue that the variability of the conditional variance implied by the EGARCH is too high, and they suggest that GJR is the best parameter model to capture the asymmetry of the volatility response to news. Panel A in Table 4.2 shows the results to be generally consistent with those of the EGARCH model. There are 25 (20) significant cases (out of 28) of FX rate (PPIs) coefficients. The table, therefore, shows that EPs are strongly affected by FX rates and PPIs, confirming the earlier results from the study. To illustrate, the FX rate coefficient for the Beverages and tobacco industry of -0.4866 (which is slightly higher in the EGARCH, i.e., -0.4343), means that the EPs decrease by almost a half, following increases in FX rates. As indicated, the FX rate coefficients are not significant in three cases. For example, the Fruit and vegetables, and Meat are insignificant suggesting a full pass-through effect. It is worth noting that the Fruit and vegetables, and Meat industries are located in the Food and live animal sector. They are daily consumables and their price elasticity of demand is much smaller than other products e.g. Chemicals.

However, overall, there is very strong evidence of PTM, which demonstrates that UK exporters are intended to operate PTM to maintain their international price competitiveness and market share.

Table 4.2 Estimates of the GJR Regression Coefficients under the *t*-density

	Food and live animals				Beverages and Tobacco	Basic materials		Fuels	Chemicals	
	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres	Fuels	Chemicals	Organic chemicals
Panel A										
α	0.0002	0.0000	0.0017	0.0029	0.0009	0.0008	-0.0001	-0.0008	-0.0008	-0.0002
	(0.0010)	(0.0008)	(0.0013)	(0.0029)	(0.0006)	(0.0017)	(0.0010)	(0.0030)	(0.0005)	(0.0008)
ΔX_t	-0.1997[a]	-0.2480[a]	0.0913	-0.0785	-0.4866[a]	-0.1567	-0.1663[a]	-0.4467[b]	-0.4288[a]	-0.4375[a]
	(0.0696)	(0.0571)	(0.0863)	(0.1650)	(0.0494)	(0.1252)	(0.0621)	(0.2139)	(0.0328)	(0.0479)
ΔPPi_t	0.2670[a]	1.2626[a]	0.0785	0.1211	0.0606	0.6595	0.4095[a]	1.3560[a]	0.4900[a]	1.0661[a]
	(0.1025)	(0.2403)	(0.0999)	(0.3413)	(0.0684)	(0.4829)	(0.0610)	(0.1355)	(0.0977)	(0.1356)
$\overline{R^2}$	-0.0333	0.0612	-0.0323	-0.0343	0.0719	-0.0249	0.0443	0.2858	0.0329	0.0699
AIC	-5.1832	-5.9878	-4.1832	-3.5698	-6.0163	-4.1266	-5.1264	-3.2516	-6.4208	-5.3528
Panel B										
ω	0.0000[a]	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0013[a]	0.0000	0.0000[c]
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.0000)	(0.0000)
κ	-0.0002	0.3715[b]	0.1042[a]	0.2979[b]	0.1319	0.0201	-0.0240[a]	-0.1283[a]	0.0244	0.1500[b]
	(0.0024)	(0.1864)	(0.0074)	(0.1370)	(0.1056)	(0.0479)	(0.0033)	(0.0214)	(0.0303)	(0.0735)
φ	-0.0415[a]	-0.2075	-0.2256[a]	-0.3006[b]	-0.0474	-0.0763[c]	-0.0274	0.3322[c]	0.1129	-0.0880
	(0.0091)	(0.1806)	(0.0366)	(0.1511)	(0.1321)	(0.0424)	(0.0227)	(0.1745)	(0.0758)	(0.0971)
θ	0.9916[a]	0.7658[a]	0.9917[a]	0.6706[a]	0.8890[a]	1.0095[a]	1.0191[a]	0.3733[c]	0.8971[a]	0.8593[a]
	(0.0090)	(0.0991)	(0.0104)	(0.1786)	(0.0453)	(0.0483)	(0.0005)	(0.2052)	(0.0321)	(0.0432)
$D_{t,1987}$ *			0.0034	-0.0001		0.0007[c]	0.0007[a]		0.0009	0.0051
			(0.0023)	(0.0017)		(0.0004)	(0.0002)		(0.0007)	(0.0037)
t-dist	19.3212	7713.89	2.7328[a]	24.4886	3.8532[a]	17.8347	6.3611[b]	8.5479	6.2534[c]	5.1184[b]
	(30.7840)	(4812226)	(0.2793)	(51.1349)	(1.3041)	(21.6026)	(3.1207)	(5.9853)	(3.7036)	(2.2803)

Table 4.2 Cont'd

	Chemicals		Material Manufactures							Machinery and transport equip.
	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard	Material manufactures	Mineral manufactures. ex. precious stone	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery
Panel A										
α	-0.0009	-0.0005	0.0007[a]	0.0007	-0.0003	-0.0005	0.0011	0.0003	-0.0001	-0.0021[b]
	(0.0008)	(0.0007)	(0.0002)	(0.0006)	(0.0006)	(0.0005)	(0.0008)	(0.0008)	(0.0001)	(0.0009)
ΔX_t	-0.3742[a]	-0.3045[a]	-0.2228[a]	-0.6000[a]	-0.3735[a]	-0.2784[a]	-0.2350[a]	-0.3654[a]	-0.0804[a]	-0.1212[b]
	(0.0580)	(0.0451)	(0.0293)	(0.0412)	(0.0396)	(0.0456)	(0.0494)	(0.0585)	(0.0076)	(0.0496)
ΔPPi_t	0.3163[a]	0.7592[a]	0.5686[a]	0.0647	0.9024[a]	0.3237[b]	0.9879[a]	0.2507[a]	0.0018	0.4466[b]
	(0.1194)	(0.2207)	(0.0965)	(0.0802)	(0.2554)	(0.1663)	(0.2745)	(0.0674)	(0.0200)	(0.2092)
$\overline{R^2}$	-0.0492	0.0132	0.0683	-0.0401	0.0749	0.0100	-0.0302	0.0574	0.0018	-0.0145
AIC	-4.7373	-5.8247	-5.8025	-5.7369	-5.7305	-5.7617	-5.8179	-5.3199	-9.6300	-5.5053
Panel B										
ω	0.0000[c]	0.0000	0.0000	0.0000	0.0000[c]	0.0000[a]	0.0000[b]	0.0000[a]	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
κ	0.2710[c]	0.2155[c]	0.0666[c]	0.1478[b]	0.3997[b]	0.2285[a]	0.4728[a]	-0.0390[a]	0.1189	0.1076
	(0.1463)	(0.1207)	(0.0399)	(0.0651)	(0.1885)	(0.0677)	(0.1757)	(0.0011)	(0.0873)	(0.0707)
φ	0.3955	-0.2199[c]	-0.1483[b]	-0.0680	-0.2535	-0.3566[a]	-0.4568[b]	0.0207[a]	0.0688	-0.0950
	(0.3147)	(0.1240)	(0.0608)	(0.0962)	(0.2040)	(0.0987)	(0.1987)	(0.0001)	(0.1268)	(0.0873)
θ	0.6475[a]	0.8828[a]	1.0150[a]	0.8665[a]	0.7246[a]	0.8681[a]	0.7336[a]	1.0172[a]	0.8194[a]	0.8922[a]
	(0.0749)	(0.0530)	(0.0004)	(0.0437)	(0.0715)	(0.0342)	(0.0698)	(0.0014)	(0.0762)	(0.0534)
$D_{t,1987}$ *	-0.0001	0.0004		0.0014	0.0012		0.0008	0.0013[a]		0.0017
	(0.0016)	(0.0003)		(0.0012)	(0.0009)		(0.0007)	(0.0000)		(0.0016)
t-dist	3.9878[a]	6.1914[a]	11.4424	21235372	6.7160[a]	19.8775	19.5143	9.3215[a]	14.9585	4.1157[a]
	(1.2083)	(1.7014)	(13.7394)	(1.74E+13)	(2.5660)	(17.4074)	(32.8615)	(3.4932)	(21.3464)	(1.2989)

Table 4.2 Cont'd

	Machinery and transport equipment			Miscellaneous			Others	
	Machinery & transport equipment	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
Panel A								
α	-0.0011	-0.0009	0.0003	-0.0003	0.0001	0.0006	-0.0013[c]	-0.0012[b]
	(0.0009)	(0.0010)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0007)	(0.0006)
ΔX_t	-0.0919[b]	-0.1341[b]	-0.0820[a]	-0.3488[a]	-0.3608[a]	-0.2489[a]	-0.1735[a]	-0.1979[a]
	(0.0409)	(0.0542)	(0.0294)	(0.0410)	(0.0393)	(0.0425)	(0.0371)	(0.0330)
ΔPPi_t	0.6865[a]	0.3780[b]	0.3116[a]	0.3139[c]	0.0657	-0.0043	1.0072[a]	0.8781[a]
	(0.1323)	(0.1911)	(0.0613)	(0.1783)	(0.1799)	(0.0326)	(0.2102)	(0.1830)
$\overline{R^2}$	0.0399	-0.0117	0.0043	-0.0369	-0.0676	0.0041	0.0399	0.0270
AIC	-6.1426	-5.8098	-5.9751	-6.0221	-6.0763	-6.4533	-6.2842	-6.3223
Panel B								
ω	0.0000[b]	0.0001[a]	0.0000[b]	0.0000[b]	0.0000[a]	0.0000	0.0000[c]	0.0000[b]
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
κ	0.0903[c]	0.1428[b]	0.1688[a]	-0.0077	-0.0163	0.0737	0.2527[b]	0.3352[b]
	(0.0496)	(0.0696)	(0.0595)	(0.0208)	(0.0137)	(0.0502)	(0.1176)	(0.1589)
φ	-0.0852	-0.0436	-0.1736[a]	-0.0607	-0.0326	-0.0076	-0.0980	-0.2028
	(0.0784)	(0.1037)	(0.0592)	(0.0423)	(0.0306)	(0.0846)	(0.1552)	(0.1904)
θ	0.8195[a]	0.5719[a]	0.8833[a]	0.9921[a]	0.9932[a]	0.8961[a]	0.7035[a]	0.7528[a]
	(0.0771)	(0.1499)	(0.0284)	(0.0172)	(0.0030)	(0.0574)	(0.1077)	(0.0836)
$D_{t,1987}$*	-0.0001[a]	-0.0001[c]	0.0012	0.0017[c]	0.0014[a]		-0.0001[a]	-0.0002[a]
	(0.0000)	(0.0001)	(0.0011)	(0.0009)	(0.0004)		(0.0000)	(0.0000)
t-dist	18.3891	19.9526[c]	6.1233[a]	18.4377	14.7432	8.0466[c]	19.9643	4.4312[a]
	(14.0064)	(10.2985)	(0.9477)	(22.3269)	(12.4760)	(4.5586)	(15.4335)	(1.5927)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-percernt level, respectively.* Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for some industries. $\overline{R^2}$, AIC and *t*-dist denote the adjusted R squared, Akaike Information Criterion and *t*-distribution, respectively.

4.2.1.3 BDS Statistic on Standardised Residuals for Standard Model

The GARCH-type models are intended to capture the non-linear dependence in conditional residuals of the standard model. If the GARCH-type estimation captures all the non-linearity in the data, the standardised residuals should be *iid*. To express whether the residuals are *iid*, the BDS test was performed on the standard residuals of both the EGARCH and GJR estimates.

Tables 4.3 and 4.4 contain the BDS results for the standard model, which show that the *iid* condition can be rejected for almost all of the conditional standardised residuals. This finding holds for the conditional residual from both estimation methods – a finding reported by Joseph (2003a) and Brooks (2002) in related studies. More specifically, there are only two cases (e.g., Plastics and Road vehicles industries) where the null of *iid* is accepted in the GJR model, while there is only one case that can accept the null in the EGARCH mode (e.g., Plastics). Thus, neither the EGARCH nor the GJR estimation methods are able to capture all of the non-linearity in the conditional standardised residuals.

Table 4.3 BDS tests of nonlinearity: Standardised Residuals EGARCH Estimations

	Food and live animals				**Beverages and Tobacco**	**Basic Materials**	
m	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres
				l=0.25			
2	$2.5603^{b\#}$	-0.1207	-0.8562	-1.3133	1.3839	-0.8118	0.2235
3	$3.6125^{a\#}$	-0.7920	0.5213	-1.0485	$2.5595^{b\#}$	-0.2692	0.0822
4	5.4103^{a+}	-1.4456	0.2106	-0.0846	$3.7827^{a\#}$	0.7870	0.1319
5	$6.1176^{a\#}$	1.3363	0.5314	1.1591	$3.7442^{a\#}$	0.4001	0.1417
6	$7.2242^{a\#}$	4.9723^{a}	0.6308	2.5865^{a}	2.7081^{a}	1.2763	0.0105
7	$13.6930^{a\#}$	12.7313^{a}	0.3075	-0.8183	2.5830^{a}	2.9928^{a}	-0.7170
8	$28.8005^{a\#}$	$32.6958^{a\#}$	1.2143	-2.3267^{b}	-1.4072	3.8709^{a}	-1.6673^{c}
9	$64.6216^{a\#}$	$55.3367^{a\#}$	-0.6406	-1.7744^{c}	-1.1438	-2.0129^{a}	-1.3285
10	$107.0605^{a\#}$	-2.3569^{b}	-0.5041	-1.3956^{*}	-0.8650	-1.5694	-1.0030
				l=0.5			
2	1.7048^{c}	0.9026	0.5727	-0.4991	0.7117	0.2289	0.7899
3	1.1085	0.3301	1.4404	-0.1886	2.7816^{a+}	0.8011	1.0923
4	1.3964	-0.8190	1.9651^{b*}	-0.1669	4.6601^{a+}	0.8191	0.6423
5	2.0923^{b*}	-0.6470	3.0606^{a+}	0.5191	6.2022^{a+}	0.8633	0.3026
6	2.3998^{b*}	-0.5782	4.6334^{a+}	1.0184	7.8420^{a+}	1.1108	0.1655
7	2.6183^{a*}	-0.2860	6.3854^{a+}	1.0145	9.4693^{a+}	1.2498	0.0342
8	2.1376^{b}	-1.0176	8.0834^{a+}	0.3972	11.0509^{a+}	1.2107	0.1458
9	2.6492^{a*}	-1.3710	9.9496^{a+}	-0.0744	12.7582^{a+}	1.4069	0.1849
10	3.0643^{a*}	-1.4202	12.4673^{a+}	-0.6420	16.0946^{a+}	2.3771^{b}	0.3495
				l=0.75			
2	0.6492	1.5003	0.8150	0.1031	0.6685	-0.1250	2.1987^{b*}
3	0.0433	0.9100	1.1905	0.5154	$2.5968^{a\#}$	0.6696	2.0637^{b*}
4	0.4192	0.1244	1.5119	0.5407	3.6599^{a+}	0.8536	1.5776
5	1.0088	0.1803	$2.1368^{b\#}$	0.9511	4.5818^{a+}	0.7260	1.6067
6	0.6130	0.5435	$2.7803^{a\#}$	1.2809	5.3814^{a+}	0.9554	1.4157
7	0.8483	0.7801	3.4716^{a+}	1.3876	6.1532^{a+}	1.0935	1.3520
8	0.9988	0.5852	4.0829^{a+}	1.3399	6.7791^{a+}	1.1662	1.2406
9	1.1422	0.7355	4.5302^{a+}	1.3635	7.3671^{a+}	1.0458	1.2586
10	1.2978	0.6078	4.9128^{a+}	1.4899	8.2300^{a+}	1.3824	1.3541

Table 4.3 Cont'd

	Fuels	Chemicals				Material Manufactures	
m	Fuels	Chemicals	Organic chemicals	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard
				l=0.25			
2	-0.5857	1.4178	-1.0525	2.4280$^{b\#}$	-0.0675	-1.1043	2.4729$^{b\#}$
3	-1.5670	2.1459^{b*}	-1.3206	2.1220^{b*}	-0.0914	-1.8205^{c}	4.7130^{a+}
4	-0.8000	2.4381^{b*}	-1.4309	1.8398^{c}	-0.1102	-2.2793^{b}	4.5493^{a+}
5	-0.4935	1.9634^{b}	-1.0132	1.0995	-0.1266	-1.7409^{c}	5.1593$^{a\#}$
6	1.2159	0.8487	-0.5820	1.0762	-0.1415	-0.2250	3.1350^{a}
7	3.3151^{a}	0.7046	-0.7694	0.3121	-0.1554	6.3811^{a}	3.9265^{a}
8	-2.2694^{b}	-2.1123^{b}	-1.8832^{c}	-2.7048^{a}	-0.1684	13.0789^{a}	3.0832^{a}
9	-1.9989^{b}	-1.6556^{c}	-1.5370	-2.1417^{b}	-0.1810	-2.5692^{b}	-1.3711
10	-1.5848	-1.3676	-1.2479	-1.6831^{c}	-0.1930	-2.0491^{b}	-1.0370
				l=0.5			
2	-1.1849	1.1442	-0.3092	3.0622^{a+}	-0.0675	0.2936	2.6247^{a+}
3	-1.0496	1.7504^{c*}	-0.5049	2.6475$^{a\#}$	-0.0914	0.5795	4.9241^{a+}
4	-0.1554	2.3055$^{b\#}$	-0.2443	2.4576$^{b\#}$	-0.1102	0.6092	6.3855^{a+}
5	0.4222	2.5399$^{b\#}$	-0.3271	2.7725$^{a\#}$	-0.1266	0.5058	7.8831^{a+}
6	0.5565	2.7429$^{a\#}$	-0.1540	3.1471$^{a\#}$	-0.1415	0.6932	8.8939^{a+}
7	1.0716	2.5808$^{a\#}$	-0.0665	3.4463$^{a\#}$	-0.1554	1.4531	10.1678^{a+}
8	1.4844	2.4055^{b*}	-0.4163	3.5848$^{a\#}$	-0.1684	1.9459^{c}	11.1981^{a+}
9	1.1644	2.8506$^{a\#}$	-0.4350	3.2958$^{a\#}$	-0.1810	2.1627^{b}	12.4143^{a+}
10	1.7395	2.9543$^{a\#}$	0.1054	2.4976^{b*}	-0.1930	2.6651^{a}	13.8617^{a+}
				l=0.75			
2	-0.8047	1.1606	-0.2267	2.4863$^{b\#}$	-0.0675	0.7131	0.2583
3	-0.4624	2.8334$^{a\#}$	-0.2493	1.7592^{c*}	-0.0914	0.7016	2.2906$^{b\#}$
4	-0.0471	3.5349^{a+}	0.0853	1.4539	-0.1102	0.6412	3.3864^{a+}
5	0.2156	4.2117^{a+}	-0.1508	1.9830^{b*}	-0.1266	0.5592	4.8067^{a+}
6	-0.1927	4.5656^{a+}	0.1540	2.3086$^{b\#}$	-0.1415	0.4981	6.0789^{a+}
7	0.1897	4.8569^{a+}	0.4856	2.4913$^{b\#}$	-0.1554	0.2517	7.0971^{a+}
8	0.5239	5.0811^{a+}	0.6104	2.6175$^{a\#}$	-0.1684	-0.1557	8.0280^{a+}
9	0.3115	5.4936^{a+}	0.5246	2.7705$^{a\#}$	-0.1810	-0.5973	9.0441^{a+}
10	0.4534	5.7597^{a+}	0.5385	2.8913$^{a\#}$	-0.1930	-0.5406	10.0406^{a+}

Table 4.3 Cont'd

	Material manufactures					**Machinery and transport equipment**	
m	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery	Machinery and transport equipment
				l=0.25			
2	1.6992^{c}	1.9664^{b*}	2.1327^{b}	0.8644	-1.4842	0.5264	-0.3486
3	4.8704^{a+}	3.8444^{a+}	1.3154	1.2873	-2.7890$^{a\#}$	0.9697	0.0850
4	7.7616^{a+}	5.0928^{a+}	1.0616	2.8926^{a*}	-2.8867$^{a\#}$	1.3631	0.5512
5	8.8629^{a+}	4.3610$^{a\#}$	0.1205	3.4408^{a*}	-2.1798^{b}	0.7376	-0.4175
6	9.9698^{a+}	5.6601$^{a\#}$	-0.8532	3.2132^{a}	-2.4538^{b}	-0.1479	-3.7809^{a+}
7	12.7695^{a+}	6.8907$^{a\#}$	-1.1760	1.0082	-2.6554^{a}	-1.1307	-2.7187^{a}
8	16.7136$^{a\#}$	-1.1117	-2.8019^{a}	3.8201^{a}	-2.0350^{b}	-2.0920^{b*}	-2.1890^{b}
9	-1.3779	-0.7903	-2.1513^{b}	-1.6722^{c}	-1.6948^{c}	-1.5895	-1.6598^{c}
10	-1.0396	-0.5732	-1.6540^{c}	-1.3019	-1.2780	-1.2206	-1.2738
				l=0.5			
2	2.5385$^{b\#}$	0.9622	3.2988^{a+}	0.9986	-0.8330	0.9660	-0.0590
3	5.4195^{a+}	2.6913$^{a\#}$	2.8921$^{a\#}$	1.2885	-1.3713	1.5923	0.9443
4	7.5260^{a+}	3.9045^{a+}	1.9001^{c*}	1.6664^{c}	-1.4326	1.8528^{c*}	1.7576^{c*}
5	9.4504^{a+}	4.5924^{a+}	1.5984	1.9522^{c*}	-1.0394	1.9075^{c*}	2.5098$^{b\#}$
6	11.6874^{a+}	5.2161^{a+}	1.3089	2.0738^{b*}	-0.7819	1.6888^{c}	2.7767$^{a\#}$
7	14.0481^{a+}	5.7023^{a+}	1.1796	1.6149	-1.0578	2.2990^{b*}	3.4573$^{a\#}$
8	17.0972^{a+}	6.5179^{a+}	0.7891	1.0864	-1.0698	2.5537^{b*}	4.1295^{a+}
9	20.1313^{a+}	7.3910^{a+}	0.2747	0.3061	-1.0472	3.2672$^{a\#}$	5.1197^{a+}
10	24.0993^{a+}	8.7317^{a+}	-0.0765	0.1310	-1.2402	3.5055$^{a\#}$	5.7157^{a+}
				l=0.75			
2	0.9627	0.5861	3.2675^{a+}	0.6731	-0.4862	-0.0389	-0.4441
3	3.6626^{a+}	3.0960^{a+}	2.6884$^{a\#}$	1.1361	-1.0795	0.7116	0.2922
4	5.3699^{a+}	4.5762^{a+}	1.9931^{b*}	1.4417	-0.9919	1.1586	0.8816
5	7.0465^{a+}	5.5370^{a+}	1.8152^{c*}	1.5666	-0.5110	1.7008^{c*}	1.2703
6	8.4255^{a+}	6.6853^{a+}	1.5228	1.7901^{c}	-0.1879	1.8644^{c*}	1.7650^{c*}
7	9.6843^{a+}	7.5698^{a+}	1.5617	1.9771^{b*}	-0.1985	2.4870$^{b\#}$	2.3551$^{b\#}$
8	10.9039^{a+}	8.2691^{a+}	1.5990	2.3078$^{b\#}$	-0.0763	2.5619$^{b\#}$	2.5626$^{b\#}$
9	12.1750^{a+}	9.1563^{a+}	1.4660	2.5385$^{b\#}$	-0.2751	3.1016^{a+}	2.9129$^{a\#}$
10	13.4866^{a+}	10.0359^{a+}	1.3414	2.8720$^{a\#}$	-0.1839	3.5655^{a+}	3.1220$^{a\#}$

Table 4.3 Cont'd

	Machinery & transport equipment		**Miscellaneous**			**Others**	
m	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
				l=0.25			
2	-0.0463	3.5053^{a+}	1.1979	0.8126	-0.6030	0.9801	-1.1133
3	0.4987	4.7705^{a+}	0.1420	-0.7016	-0.5264	2.1635^{b}	-0.3426
4	0.7449	8.1002^{a+}	-0.7326	0.0673	-0.2088	2.6573^{a*}	-1.0139
5	2.0876^{b}	12.4649$^{a\#}$	-0.0634	-0.1146	-0.2325	2.2150^{b}	-2.0777^{b}
6	1.2249	21.9210$^{a\#}$	1.5700	1.7390^{c}	1.2455	0.1539	-3.3469^{a*}
7	-0.8609	40.4346$^{a\#}$	1.2125	2.7721^{a}	6.5797^{a}	-2.9240^{a}	-2.8717^{a}
8	-1.8389^{c}	65.3609$^{a\#}$	-2.9646^{a}	3.7599^{a}	17.5475^{a*}	-2.2384^{b}	-2.1719^{b}
9	-1.3853	81.8720$^{a\#}$	-2.4207^{b}	-2.3359^{b}	29.7289^{a*}	-1.7723^{c}	-1.7112^{c}
10	-1.1190	99.8489$^{a\#}$	-2.0801^{b}	-2.0617^{b*}	-1.6014	-1.4104	-1.3478
				l=0.5			
2	-0.1596	0.7904	0.1100	1.0381	-0.2417	0.6041	-1.1562
3	1.2078	1.3616	0.0167	0.5352	0.0282	1.1094	-0.4486
4	1.6025	2.1546^{b*}	-0.3475	0.2508	-0.1959	1.1581	-0.5585
5	1.9570^{c*}	2.1939^{b*}	-0.4548	0.3030	0.0956	0.7108	-0.8038
6	2.2522$^{b\#}$	2.2628^{b*}	-0.3186	0.4182	0.1244	0.4134	-1.0070
7	2.4308$^{b\#}$	2.7407^{a*}	-0.3494	0.2197	0.9328	0.7668	-1.1127
8	2.8757$^{a\#}$	2.8460^{a}	-0.1294	0.3053	1.5212	1.0123	-0.7491
9	3.1445$^{a\#}$	2.9975^{a}	-0.6529	0.2679	1.5844	0.9789	-0.5247
10	3.6555$^{a\#}$	3.3815^{a}	-1.0440	0.0018	1.8483^{b}	0.6621	-0.5093
				l=0.75			
2	-0.0041	-0.5146	0.7116	1.8036^{c*}	0.0531	1.1866	-0.5585
3	1.0644	0.3299	0.9501	1.3179	0.7908	1.0957	0.1863
4	1.4829	1.0848	1.0456	1.0145	-0.0112	1.0464	0.1961
5	1.9378^{c*}	1.2448	1.2948	0.9427	0.6517	1.0802	0.0541
6	2.4783$^{b\#}$	1.2384	1.3326	1.1565	0.7346	0.8663	-0.0599
7	3.0203^{a+}	1.3631	1.1863	1.1432	1.3127	1.1475	0.0514
8	3.2364^{a+}	0.9664	0.9884	1.2658	1.5659	1.2977	0.0892
9	3.6373^{a+}	0.9449	0.7779	1.0983	1.6656^{c}	1.2453	0.0374
10	4.0233^{a+}	1.0992	0.5117	0.7787	1.9675^{b*}	1.1809	0.0020

Notes: The BDS statistic for l=0.25, 0.5 and 0.75 standard deviations and m-dimensions 2 to 10. At l=1 (m=2, 3, 4...10), the BDS statistics was typically zero and therefore is not shown. In terms of normal distribution, significantly different from zero at 1% (^{a}), 5% (^{b}) and 10% (^{c}) level, while bootstrap at 1% ($^{+}$), 5% ($^{\#}$) and 10%(*) level respectively.

Table 4.4 BDS tests of nonlinearity: Standardised Residuals GJR Estimations

	Food and live animals				Beverages and Tobacco	Basic Materials	
m	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres
				l=0.25			
2	1.8097^{c}	-0.3381	-1.3749	-1.8453^{c}	0.3639	-1.3392	-0.2144
3	2.8911^{a*}	-0.5780	-0.8166	-1.5345	0.0165	-0.8826	0.2440
4	5.0992$^{a\#}$	-0.4782	-0.7143	-0.9035	-0.1312	0.8715	0.2912
5	6.2122$^{a\#}$	2.7070^{a}	-0.1242	0.6668	-0.6439	1.1656	0.6854
6	10.2168$^{a\#}$	3.6890^{a}	-0.3145	2.4134^{b}	1.4450	0.8073	0.5102
7	21.8652^{a+}	13.8239^{a*}	-1.4908*	1.3651	0.3704	1.2161	2.4672^{b}
8	41.9996^{a+}	35.0917$^{a\#}$	-1.1711	-2.4626^{b}	-1.9103^{b}	-2.7233^{a}	-2.0087^{b}
9	69.2067$^{a\#}$	59.7674$^{a\#}$	-0.9382	-1.8888^{c}	-1.5719	-2.3241^{b}	-1.6253
10	114.7535^{a+}	-2.2181^{b}	-0.7787	-1.4879	-1.1991	-1.8155^{c}	-1.2391
				l=0.5			
2	1.4670	0.7685	-0.3943	-0.3578	-0.0114	-0.0526	0.3666
3	0.9713	0.0779	0.0241	0.0008	0.4838	0.2190	0.4184
4	1.2365	-1.1662	0.1291	0.1275	0.8346	0.0631	-0.1248
5	1.8622^{c}	-1.1664	0.2801	0.8973	0.7942	-0.0209	-0.2019
6	2.0541^{b}	-1.1778	0.2619	1.5287	0.9064	0.0849	-0.1075
7	2.3756^{b*}	-1.0469	0.3961	1.7114^{c}	0.9776	0.3203	-0.1762
8	2.3514^{b}	-1.9413^{c}	0.2806	1.1901	1.0633	0.7389	0.1191
9	2.8300^{a*}	-3.0348^{a*}	0.1606	0.7670	0.9147	1.4934	0.2089
10	3.1600^{a*}	-3.2745^{a*}	0.2018	-0.0832	1.3574	2.5288^{b}	0.2085
				l=0.75			
2	0.7440	0.5633	1.8906^{c*}	-0.4706	-0.0201	-0.6157	1.1387
3	0.2753	0.0740	2.3750$^{b\#}$	0.0950	0.3858	-0.4282	1.1405
4	0.5076	-0.6527	2.6098$^{a\#}$	0.1843	0.7421	-0.5569	0.6213
5	0.9608	-0.5780	2.6887$^{a\#}$	0.5000	0.5322	-0.8760	0.9105
6	0.7041	-0.1953	2.5833$^{a\#}$	0.7951	0.8432	-0.7202	0.8775
7	0.8724	0.0246	2.5591$^{b\#}$	0.9326	0.8973	-0.7631	0.8653
8	0.9913	-0.1185	2.4632$^{b\#}$	0.8895	0.7730	-0.8366	0.7542
9	1.1052	0.1395	2.3371$^{b\#}$	0.9137	0.7182	-1.2358	0.7605
10	1.2431	0.0963	2.3700$^{b\#}$	1.0520	0.8676	-0.9677	0.8672

Table 4.4 Cont'd

	Fuels	Chemicals				Material Manufactures	
m	Fuels	Chemicals	Organic chemicals	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard
				l=0.25			
2	1.2240	0.7685	-1.2591	0.9448	-0.0687	-0.9890	0.6786
3	0.0924	0.0983	-1.1714	-0.5102	-0.0930	0.1594	0.2385
4	0.6778	-0.4283	-1.5668	-0.5197	-0.1122	-1.8787[c]	0.1852
5	2.9181[a]	-1.3154	-0.9181	-0.4257	-0.1289	-0.0731	3.0717[a]
6	5.8784[b*]	-1.0104	-0.1054	-1.3641	-0.1440	6.2983[a]	4.9932[a*]
7	14.1164[a#]	-1.0832	-0.8441	-3.2492[a#]	-0.1581	11.2466[a*]	7.7721[a*]
8	19.1189[a*]	-2.2572[b]	-1.9230[*]	-2.4660[b]	-0.1715	12.7709[a]	11.4593[a]
9	-2.3758[b*]	-1.8531[c]	-1.5783	-1.9296[c]	-0.1842	-2.7200[a]	20.3702[a]
10	-1.8908[c]	-1.6348[*]	-1.2776	-1.4924	-0.1965	-2.1943[b]	-1.7857[c]
				l=0.5			
2	0.4539	0.6803	-0.4264	0.7981	-0.0687	0.0348	1.7012[c]
3	0.8820	0.1482	-0.4338	0.0816	-0.0930	0.4306	0.7467
4	2.1073[b*]	0.0287	-0.1285	-0.2366	-0.1122	0.4795	0.3710
5	3.0062[a#]	-0.3685	-0.2407	0.0494	-0.1289	0.6795	-0.0767
6	3.3410[a#]	-0.4870	-0.1798	0.4503	-0.1440	0.9019	-0.1558
7	3.9058[a#]	-0.6344	-0.0856	0.3210	-0.1581	1.4476	0.1540
8	4.4770[a#]	-1.0998	-0.1427	-0.1118	-0.1715	1.5243	0.1967
9	4.0892[a#]	-1.0496	-0.0722	-0.6421	-0.1842	1.2978	-0.3159
10	4.4659[a#]	-1.4933	0.4177	-1.1462	-0.1965	1.2266	-0.2011
				l=0.75			
2	0.2623	0.3202	-0.4202	0.9492	-0.0687	0.3160	2.4106[b#]
3	0.9385	0.4607	-0.5187	0.4928	-0.0930	0.1632	1.7909[c*]
4	1.5550	0.8059	-0.2741	-0.1519	-0.1122	0.2626	1.7841[c*]
5	1.9894[b*]	0.8052	-0.5592	0.1255	-0.1289	0.1947	1.4270
6	1.6525[c]	0.8529	-0.2353	0.3554	-0.1440	0.1134	0.9964
7	2.1888[b*]	0.7328	0.1855	0.4482	-0.1581	-0.1385	1.1162
8	2.6302[a#]	0.3168	0.3654	0.5297	-0.1715	-0.5548	1.1966
9	2.7426[a#]	0.3091	0.2943	0.6201	-0.1842	-1.0702	1.0349
10	3.1190[a#]	-0.1570	0.3185	0.6751	-0.1965	-0.9070	0.9941

Table 4.4 Cont'd

	Material manufactures					Machinery and transport equipment	
m	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery	Machinery and transport equipment
				l=0.25			
2	-1.1649	0.0549	1.7393[c]	-0.8808	-1.7465[c]	0.9406	-1.0726
3	0.0645	-1.3693	1.5143	-0.8477	-2.9932[a#]	0.9266	-0.4950
4	1.8067[c]	-1.6010	1.6702[c]	0.0650	-3.1290[a#]	1.4515	0.8168
5	4.1327[a*]	-1.0836	0.7146	0.5685	-2.1048[b]	0.9434	0.1295
6	5.4637[a*]	-0.8317	-0.0598	0.7378	-2.4356[b]	-0.5395	-0.1968
7	11.0374[a#]	-2.0389[b]	1.4705	-1.0808	-2.6737[a]	0.5855	0.9030
8	12.4661[a]	-1.6429	-3.0857[a]	-2.6321[a]	-2.0449[b]	-2.5138[b]	3.5283[a]
9	-2.3030[b]	-1.2072	-2.3859[b]	-2.0278[b]	-1.6954[c]	-1.9243[c]	-1.7550[c]
10	-1.8286[c]	-0.8930[#]	-1.8590[c]	-1.6478[c]	-1.2706	-1.4929	-1.3474
				l=0.5			
2	-0.2319	-0.3132	2.9487[a#]	-1.1213	-0.8529	1.1488	-0.1644
3	0.4021	-0.5948	2.3794[b#]	-1.1193	-1.2856	1.0310	0.3020
4	0.4259	-0.4166	1.3159	-0.8631	-1.4317	0.7912	0.7952
5	0.4629	-0.6647	0.9076	-0.8551	-1.0824	0.1776	1.1565
6	0.8038	-0.2039	0.2243	-0.5757	-0.7094	-0.2738	1.1895
7	1.3644	-0.0895	-0.0202	-0.6048	-0.9262	-0.2217	1.7493[c]
8	1.7411[c]	-0.3111	-0.2299	-0.4109	-0.8233	-0.4975	2.0406[b*]
9	1.8486[c]	-0.1795	-0.1800	-0.6064	-1.0000	0.0637	2.6577[a*]
10	1.4973	0.2931	-0.2131	-0.2323	-1.1977	0.1197	2.8742[a*]
				l=0.75			
2	-0.1955	-0.9082	3.0704[a#]	-0.1085	-0.4402	1.0329	-0.0086
3	-0.2707	-1.3173	2.4022[b#]	-0.2509	-0.9411	0.9143	0.1023
4	-0.5337	-0.8669	1.6364	-0.3065	-0.8545	0.6181	0.4257
5	-0.5397	-0.8996	1.3888	-0.3165	-0.4087	0.3640	0.4882
6	-0.3023	-0.6158	1.0620	-0.2307	-0.1550	0.2399	0.8051
7	-0.1621	-0.3942	1.0626	-0.2167	-0.1530	0.4636	1.1779
8	-0.0293	-0.4224	1.1738	-0.1751	-0.0178	0.2642	1.0789
9	0.0704	-0.0150	1.1204	-0.0499	-0.1250	0.4309	1.1622
10	0.1860	0.2080	1.0454	0.0600	-0.0919	0.4996	1.1911

Table 4.4 Cont'd

	Machinery and transport equipment		Miscellaneous			Others	
m	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
				***l*=0.25**			
2	-0.5236	-0.0675	0.0885	0.1418	-1.6749[c]	-0.0756	-0.5395
3	-0.6127	-0.0914	0.1730	-0.2799	-1.7216[c]	0.1258	-0.0644
4	-0.8460	-0.1102	-0.1046	0.1714	-1.2800	0.4719	-0.4753
5	-0.6375	-0.1266	-0.7755	1.0503	-1.5357	-0.3306	-1.4072
6	-1.8107[c]	-0.1415	-0.2479	1.1937	-2.8695[a]	1.4031	-1.8911[c]
7	-2.4973[b]	-0.1554	-3.6475[a]	2.9586[a]	-2.9454[a]	1.1782	-2.8095[a]
8	-2.0151[b]	-0.1684	-2.8730[a]	10.6080[a]	-2.3177[b]	-2.2215[b]	-2.1368[b]
9	-1.5258	-0.1810	-2.4257[b]	18.9594[a]	-1.9568[c]	-1.7572[c]	-1.6878[c]
10	-1.2220	-0.1930	-2.1425[b]	-1.9437[c]	-1.5200	-1.3829	-1.3372
				***l*=0.5**			
2	-0.7460	-0.0675	0.5759	0.6547	-1.6990[c]	-0.0727	-0.9867
3	0.2597	-0.0914	0.9154	-0.0299	-0.9146	0.3364	-0.3229
4	0.5689	-0.1102	0.7444	-0.2743	-1.4016	0.3012	-0.4448
5	0.7326	-0.1266	0.6349	-0.3492	-1.0833	0.0522	-0.6244
6	0.7341	-0.1415	0.6022	-0.0833	-1.0188	-0.1169	-0.8412
7	0.8371	-0.1554	0.4310	-0.3302	-0.0921	0.0598	-0.7515
8	1.1615	-0.1684	0.7125	-0.4923	0.4910	0.2339	-0.3416
9	1.5728	-0.1810	1.1945	-0.6837	0.6124	0.0299	-0.0917
10	1.9882[b]	-0.1930	1.2562	-0.8191	0.9362	-0.2263	-0.1090
				***l*=0.75**			
2	-0.7340	-0.0675	0.9415	1.2205	-0.7863	0.0648	-0.4886
3	-0.1854	-0.0914	1.2343	0.7784	-0.3408	-0.1929	0.0086
4	-0.0145	-0.1102	1.4491	0.5326	-1.2898	-0.2715	-0.0029
5	0.1525	-0.1266	1.8594[c*]	0.4593	-0.6605	-0.0773	-0.0900
6	0.5720	-0.1415	2.1464[b#]	0.7191	-0.7233	-0.1653	-0.1575
7	1.0343	-0.1554	2.0761[b#]	0.8177	0.0252	0.2054	-0.0127
8	1.0962	-0.1684	2.0894[b*]	1.0957	0.4507	0.4229	0.0548
9	1.3924	-0.1810	2.0937[b*]	1.0405	0.6172	0.4259	0.0353
10	1.6437	-0.1930	1.9180[c*]	0.8182	0.8723	0.4263	0.0643

Notes: The BDS statistic for *l*=0.25, 0.5 and 0.75 standard deviations and *m*-dimensions 2 to 10. At *l*=1 (m=2, 3, 4...10), the BDS statistics was typically zero and therefore is not shown. In terms of normal distribution, significantly different from zero at 1% (a), 5% (b) and 10% (c) level, while bootstrap at 1% (+), 5% (#) and 10%(*) level respectively.

4.2.2 Variance Equations for the Standard Model

The variance equation for the EGARCH has been specified in Chapter 3 as

$$\ln(\sigma^2_{i,t}) = \omega_i + \theta_i \ln(\sigma^2_{i,t-1}) + \varphi_i \frac{\varepsilon_{i,t-1}}{\sqrt{\sigma^2_{i,t-1}}} + \kappa_i \left[\frac{|\varepsilon_{i,t-1}|}{\sqrt{\sigma^2_{i,t-1}}} - \sqrt{\frac{2}{\pi}} \right] + \delta_i D_{i,t} \qquad (4.2)$$

The equivalent specification for the GJR model is

$$\sigma^2_{i,t} = \omega_i + \kappa_i \varepsilon^2_{i,t-1} + \theta_i \sigma^2_{i,t-1} + \varphi_i \varepsilon^2_{i,t-1} I_{i,t-1} + \delta_i D_{i,t} \qquad (4.3)$$

where

σ^2 represents conditional variance;
ε represents the residuals;
I represents 1 if ε <0 (bad news), represents 0 otherwise;
D represents a dummy variable for the 1987 (as before)

The coefficients of Eqs. 4.2 and 4.3 have more or less similar interpretations. The κ coefficient given by Eq.(4.3) is the impact of current news while θ is for the old news. The coefficient φ is predicted to be non-zero. That is, if φ>0 then there exist symmetric effects.

Considering now the coefficients in the variance equation given in Panel B of Table 4.1 and 4.2 for both estimation methods, it can be seen that the mean ω are significant in half of the cases in both estimations. However, the signs of ω are typically negative in the EGARCH, while they are zero in the GJR. Moreover, coefficient κ_i of the EGARCH (GJR) estimates that measures the effect of the last period's shock on the volatility, is statistically significant in 20 (19) out of 28 cases. In addition, the coefficients of θ_i are significant in 19 (28) cases for the EGARCH (GJR) model. This result indicates that there are strong GARCH effects in the data. The results also show that the estimation methods have meaning for the data under consideration. However, compared with the coefficient for GARCH effects, ARCH coefficients are much smaller. That is, the values of κ_i are much smaller than those of θ_i. Furthermore, less than 40% of the φ_i coefficients are significant. This shows that positive and negative innovations in the model do not have different effects on the volatility for EPs.

To explain this, consider the following. Nelson's (1991) EGARCH model predicts a negative coefficient for φ_i while under the GJR, a positive coefficient is predicted for φ_i [41]. The results show that when asymmetry exists, positive asymmetry is more common than negative asymmetry. Indeed, for the cases where φ_i is significant, six are positive whilst three are negative under the EGARCH model. Similarly, for the GJR estimates, two cases are positive whilst nine are negative. It should also be noted that for certain industries, EPs' volatility is also affected by the 1987 crash. Indeed, we find 10 (9) out of 20[42] cases where the dummy variable in the EGARCH (GJR) model are significant.

The reasons why a positive leverage effects has more impact on the EPs than negative leverage effect, are now discussed. According to Eq.(3.1) or (4.1), assume the constant is zero. This assumption is generally consistent with the results in Tables 4.1 and 4.2. Also assume PPIs as constant. If the FX rate has a larger impact on the EPs compared with the PPIs (e.g., the absolute value of coefficients for the FX rate is larger than that for PPIs), this will produce a negative shock and the error will be negative, because FX rate affects the EPs negatively while the PPIs has positive effect on the EPs. That means exporters operated PTM and reduced their EPs rather

[41] A positive leverage effect has been reported in recent empirical studies (see, e.g., Lee, 2006 and Chen and Liow, 2006) that employ the EGARCH estimation.
[42] There are 20 cases that are valid to the dummy variable, because the data is available to 1987M10.

than increase the prices according to the PPIs, so this good news have less impact on the EPs variance, because the EPs already in an optimal level. Alternatively, when the PPIs have more impact on the EPs compared with the FX rates, this bad news will warn exporters to adjust their price, so it has more impact on the EPs' variance.

4.3 Dynamic Model

As can be seen that Eq. (3.1) (or 4.1) is static. However, it is unlikely that there is only a contemporaneous effect of FX rates changes on prices (Cumby and Huizinga, 1990). In financial and economic time series, lagged effects can be caused by delayed information. Further, a recent study in FX rate exposure demonstrates that firms dynamically respond to FX rate risk (Dominguez and Tesar, 2006). According to Greene (2002), lagged values of the dependent variable appear in a dynamic model as a result of the model's theoretical basis and not because of a computational means of removing auto-correlation. Even though, there are some existing empirical studies that only use standard models (see, e.g., Knetter, 1993; Yang, 1995, 1998), ignoring lagged effects can lead to model mis-specification. Compared with the standard model in which the marginal effects are one-time events, the dynamic model refers to those effects as lasting for many time periods, until they eventually decay. Thus, in order to capture the potential lagged effect of FX rates and PPIs changes, a lagged model would appear more appropriate.

Some recent studies (see, e.g., Betts, 2000; Devereux and Engle, 2002; Gil-pareja, 2003) use a dynamic method to investigate PTM and FX rate pass-through. They do so by including lagged FX rates and PPIs[43] changes. However, they do not consider the lagged effect of EPs as the current study does in its dynamic model. Thus if, for example, UK exporters did not adjust the

[43] Unlike in this thesis, the PPIs in those studies are used as to measure domestic prices, in order to assess the FX rate pass-through effect.

EPs to an optimal level in the last period, so a large portion of FX rate effects passed through to foreign customers, thus reducing the sales volume. This could produce less profit to UK exporters and can be noticed from the exporters' financial accounting information. Therefore, exporters may realise that they have not decreased the prices to the level that foreign customers accept, and hence reduce it further (but above the cost) in the month.

This study's dynamic model includes a further, $(EP_i - IP_i)_{t-1}$. It is the difference between EPs and IPs in the last month for a certain product. Actually, this variable can be considered as an error correction term to adjust the long-run relation between IPs and EPs. (see also Chapter 5). As for this export/import difference, it captures the substantial effect between domestically and internationally-traded goods which can be affected by the changes in FX rates, so it will be equal to zero when exports and imports for the same sector are equal – a relation which can hold in demand-supply relation for the same international good. The variable is estimated with a lag. This means that the focus is on how the previous (last month's) EPs and IPs affect the current (this month's) EPs. The modification to Eq.(3.1) results in the following:

$$\Delta EP_{i,t} = \alpha + v\Delta EP_{t-1} + \beta_{1,i}\Delta X_t + \beta_{2,i}\Delta X_{t-1} + \lambda_{1,i}\Delta PPI_{i,t} + \lambda_{2,i}\Delta PPI_{i,t-1} + \psi(EP_i - IP_i)_{t-1} + \varepsilon_{i,t} \qquad (4.4)$$

where

$EP_i - IP_i$ represents the difference between export and import price.

In Eq. (4.4), changes of current EPs are a function of changes of previous EPs, the changes of current FX rates, changes of previous FX rates, changes of current PPIs, changes of previous PPIs and the difference between previous EPs and IPs. The number of lags is limited to one, since it is expected that the last period's prices will have significant effects. More importantly, to validate the use of $(EP_i - IP_i)_{t-1}$, I empirically test whether EPs and IPs are co-integrated and whether there is seasonality exist in the IPs. The results demonstrate that EPs and IPs are co-integrated, and there is no seasonal effect in the IPs (see Appendix 3 and 4, respectively).

Coefficient ψ is expected to be negative as it captures a form of adjustment. The long-term effect occurs at a rate dictated by the value of ψ. More specifically, the consideration of this variable is related to international price competition between the home country and other foreign countries. The remaining coefficients have the same interpretation as before.

4.3.1 Mean Equations for the Dynamic Model

The diagnostic statistics for both EGARCH and GJR estimation are showed in Table 4.5 and 4.6. In general, compared with EGARCH model, more series is *t*-distributed in GJR model (13 vs. 12). Additionally, there are 18 out of 28 cases have smaller AIC in GJR models. However, with respect to the goodness of fit to model criteria, the GJR estimations have higher $\overline{R^2}$ in 14 industries, but the $\overline{R^2}$ also decrease in another 14 industries. Therefore, these results cannot particularly demonstrate which model is more preferable. Further research on the residuals for dynamic model is performed later.

4.3.1.1 EGARCH Estimates

Table 4.5 shows the results for the EGARCH estimates. Panel A in the table shows that there is some strong evidence that exporters take last month's EPs into account when they set the current EPs. The lagged coefficients, excluding ($EP_i - IP_i$), are significant in 15 out of 28 cases. Moreover, the results illustrate that FX rates affect EPs immediately in 24 cases and FX rates have also lagged effects in 14 out of 28 cases. Generally speaking, the contemporaneous FX rate changes have stronger impacts than their lag. More specifically, these results show that UK exporters adjust this month's prices mainly because of this month's FX rates movement and, partly because of last month's. Similarly, compared with last month's PPIs effects, the current effects have been exhibited more significantly (15 vs. 5). That means the current cost is an important factor for UK exporters' pricing decisions. Obviously, manufacturers cannot reduce their prices lower than the total cost, otherwise, they will make a loss. In this situation, there is no point in using PTM strategy. The coefficient for $EP_i - IP_i$ is significant in 15 cases. So there is a long-run adjustment effect between imports and exports in similar industries, presumably depicting international price competition. The coefficients value depicts the speed of adjustment. The larger absolute value of the coefficient means the adjustment is quicker. For instance, the results demonstrate that the Plastics industry adjusts the difference between EPs and IPs quicker than the Inorganic chemicals industry, since the values for ψ are -0.0574 and -0.0065 respectively.

Table 4.5 Estimates of the EGARCH Dynamic Regression Coefficients under the *t*-density

	Food and live animals				Beverage and Tobacco	Basic materials		Fuels	Chemicals	
	Cereals and animal feeding stuffs	Food	Fruit & vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres	Fuels	Chemicals	Organic chemicals
Panel A										
α	0.0003	-0.0014	0.0008	0.0078[b]	0.0017	0.0002	0.0006	0.0094[b]	-0.0013[c]	-0.0026[b]
	(0.0011)	(0.0009)	(0.0017)	(0.0038)	(0.0012)	(0.0034)	(0.0013)	(0.0038	(0.0008)	(0.0013)
ΔEP^i_{t-1}	-0.2170[a]	-0.2517[a]	-0.1122[c]	-0.0156	-0.2721[a]	0.0384	-0.3529[a]	-0.0858	-0.1558[b]	-0.2823[a]
	(0.0701)	(0.0766)	(0.0615)	(0.0785)	(0.0705)	(0.0614)	(0.0714)	(0.0602	(0.0768)	(0.0564)
ΔX_t	-0.2136[a]	-0.1577[b]	0.2116[b]	-0.1096	-0.4008[a]	-0.1764	-0.0546	-0.4356[c]	-0.2759[a]	-0.4089[a]
	(0.0773)	(0.0617)	(0.1007)	(0.1628)	(0.0560)	(0.1392)	(0.0815)	(0.2422)	(0.0381)	(0.0687)
ΔX_{t-1}	-0.1506[c]	-0.1291[b]	0.0167	-0.1319	-0.1240[b]	-0.0022	-0.2063[b]	-0.1575	-0.1213[a]	-0.2790[a]
	(0.0859)	(0.0605)	(0.1087)	(0.1603)	(0.0630)	(0.1290)	(0.0871)	(0.2427	(0.0417)	(0.0797)
ΔPPi_t	0.2469[b]	1.2452[a]	0.1442	0.2617	0.1429	0.3972	0.3514[a]	0.5467[a]	0.5098[a]	0.1607[a]
	(0.1155)	(0.2644)	(0.2396)	(0.3523)	(0.1245)	(0.5387)	(0.0869)	(0.0275	(0.1264)	(0.0372)
ΔPPi_{t-1}	0.0852	0.5435[b]	0.0403	0.1717	-0.0881	1.0900[b]	0.0622	-0.1005	-0.0427	0.1192[b]
	(0.1059)	(0.2670)	(0.2517)	(0.3303)	(0.1810)	(0.4582)	(0.0971)	(0.0707)	(0.1607)	(0.0495)
$(EP^i_t - IP^i_t)_{t-1}$	0.0027	-0.0488[a]	-0.0848[a]	-0.0756[b]	-0.0154	-0.0021	0.0037	-0.0633	-0.0684[a]	-0.0561[b]
	(0.0178)	(0.0260)	(0.0310)	(0.0326)	(0.0171)	(0.0124)	(0.0121)	(0.0238	(0.0253)	(0.0225)
$\overline{R^2}$	0.0236	0.1785	0.0317	-0.0020	0.1262	-0.0333	0.1384	0.1738	0.1672	0.1837
AIC	-5.2039	-6.0797	-4.0212	-3.5674	-5.7359	-4.0172	-5.1383	-3.1469	-6.1910	-5.0466
Panel B										
ω	-0.0021	0.0782	-5.8394[b]	-1.5480	-8.4395[a]	-6.9320	-7.8976[b]	-0.0344	-9.1210[a]	-8.0152[a]
	(0.1006)	(0.1907)	(2.9798)	(1.0764)	(1.1429)	(14.5587)	(3.4442)	(0.0764)	(1.5226)	(1.3297)
κ	-0.0552	-0.0017	0.5698	0.1746	0.8722[a]	-0.0066	0.3193	-0.1864[a]	0.5703[c]	0.7148[a]
	(0.0506)	(0.0941)	(0.5541)	(0.1225)	(0.2214)	(0.2154)	(0.2063)	(0.0149)	(0.1412)	(0.1320)
φ	0.0218	0.0432	-0.0790	0.1893[b]	0.0392	0.0090	0.0965	0.0828	-0.0942	-0.2492[a]
	(0.0409)	(0.0661)	(0.2328)	(0.0898)	(0.1417)	(0.1393)	(0.1166)	(0.0669)	(0.0951)	(0.0873)
θ	0.9969[a]	1.0094[a]	0.0589	0.7832[a]	0.1124	-0.0040	0.0467	0.9711[a]	0.0529	0.0678
	(0.0073)	(0.0127)	(0.4615)	(0.1588)	(0.1383)	(2.1078)	(0.4212)	(0.0119)	(0.1714)	(0.1675)
$D_{t,1987}$ *			1.0242	-0.5951		-1.0981	-9.9003[a]		-1.4034	-0.2709
			(28.8276)	(1.7419)		(946.4973)	(2.2637)		(16.4575)	(12.0641)
t-dist	152.7781	43.4591	2.3203[a]	18.9474	18.5711	6.2348[b]	9.7014	5.9969	17.6542	18.8223
	(1909.843	(136.9002)	(0.6402)	(28.6204)	(20.6134)	(2.8518)	(7.7661)	(5.6561)	(12.2336)	(12.2312)

Table 4.5 Cont'd

	Chemicals		Material Manufactures							Machinery & transport equipment
	Inorganic chemicals	Plastics	Iron & steel	Paper and paperboard	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery
Panel A										
α	-0.0001	-0.0014	0.0024^{b}	-0.0009	-0.0054^{b}	-0.0012	0.0023^{b}	-0.0003	-0.0002	-0.0039^{a}
	(0.0008)	(0.0012)	(0.0011)	(0.0022)	(0.0026)	(0.0011)	(0.0012)	(0.0012)	(0.0002)	(0.0010)
ΔEP_{t-1}	-0.3210^{a}	-0.2311^{a}	-0.0242	-0.3290^{a}	-0.3435^{a}	-0.2548^{a}	-0.3525^{a}	-0.0459	-0.0567	-0.0173
	(0.0606)	(0.0576)	(0.0773)	(0.0598)	(0.0512)	(0.0754)	(0.0570)	(0.0684)	(0.0953	(0.0662)
ΔX_t	-0.3905^{a}	-0.1435^{b}	-0.2159^{a}	-0.2497^{a}	-0.3583^{a}	-0.2560^{a}	-0.1827^{a}	-0.3781^{a}	-0.0824	-0.1113^{b}
	(0.0560)	(0.0567)	(0.0570)	(0.0684)	(0.0643)	(0.0476)	(0.0504)	(0.0559)	(0.0081)	(0.0456)
ΔX_{t-1}	-0.2010^{a}	-0.2097^{a}	-0.0238	-0.1972^{a}	-0.0836	-0.1227^{b}	-0.1508^{a}	0.0219	0.0043	-0.0514
	(0.0558)	(0.0582)	(0.0570)	(0.0763)	(0.0612)	(0.0532)	(0.0431)	(0.0618)	(0.0102	(0.0511)
ΔPPi_t	0.2080	0.2157	0.3657^{a}	0.1309	1.4031^{a}	0.5098^{a}	0.6320^{b}	0.2630^{a}	0.0068	0.3356^{c}
	(0.1503)	(0.3183)	(0.1256)	(0.1255)	(0.3527)	(0.1665)	(0.2714)	(0.0787)	(0.0212	(0.1930)
ΔPPi_{t-1}	0.0958	0.1147	0.3454^{a}	-0.0223	-0.0014	0.0414	0.3486	0.0236	0.0191	0.1370
	(0.1590)	(0.2693)	(0.1133)	(0.1283)	(0.4455)	(0.1553)	(0.2791)	(0.0754)	(0.0245	(0.2220)
$(EP_i - IP_i)_{t-1}$	-0.0065^{a}	-0.0574^{a}	0.0206	-0.0226	-0.0850^{c}	-0.0125	-0.0462^{a}	-0.0081	-0.0005	-0.0529^{a}
	(0.0024)	(0.0199)	(0.0129)	(0.0165)	(0.0442)	(0.0204)	(0.0163)	(0.0139)	(0.0035)	(0.0136)
$\overline{R^2}$	-0.0446	0.1729	0.0936	0.2070	0.2599	-0.0023	0.0989	0.0578	-0.0315	0.0014
AIC	-4.8131	-5.7250	-5.8062	-5.3077	-5.3067	-5.7814	-5.8564	-5.2620	-9.5982	-5.5399
Panel B										
ω	-0.3285^{a}	-8.6539^{c}	-0.4638	-8.2127^{a}	-8.2005^{a}	-0.4890^{b}	-8.9435^{a}	-0.5376^{b}	-0.5583	-0.5231^{c}
	(0.1214)	(4.4380)	(0.3905)	(1.2093)	(1.1584)	(0.2053)	(1.7769)	(0.2621)	(0.3574)	(0.3111)
κ	0.2808^{a}	0.0652	0.1222	0.4338^{b}	0.5429^{a}	0.2244^{c}	0.6097^{a}	0.1328	0.2889^{a}	0.2036^{b}
	(0.1025)	(0.1505)	(0.1154)	(0.1752)	(0.1799)	(0.1231)	(0.1950)	(0.0841)	(0.1062)	(0.0931)
φ	-0.0396	0.1842^{c}	0.2219^{b}	0.1383	0.0213	0.1741	0.2471^{c}	-0.0479	0.0145	0.0518
	(0.0641)	(0.0972)	(0.0918)	(0.1168)	(0.1084)	(0.1151)	(0.1275)	(0.0780)	(0.0811)	(0.0738)
θ	0.9863^{a}	0.0103	0.9570^{a}	0.0490	0.0625	0.9653^{a}	0.0185	0.9475^{a}	0.9738^{a}	0.9550^{a}
	(0.0101)	(0.5101)	(0.0400)	(0.1509)	(0.1439)	(0.0206)	(0.2054)	(0.0288)	(0.0256)	(0.0345)
$D_{t,1987}$ *	3.0444^{a}	-0.2793		-1.9990	-0.5413		-15.5287^{a}	3.2730^{a}		2.5360^{a}
	(0.8672)	(17.5408)		(4.1955)	(8.6711)		(4.3505)	(0.7615)		(0.9308)
t-dist	4.8550^{a}	17.7956	8.2985	17.2824	19.2523	3.9988^{b}	4.9229^{a}	4.6410^{a}	16.2352	4.2032^{a}
	(1.5073)	(16.4053)	(5.4361)	(14.5797)	(18.4970)	(1.6902)	(1.8133)	(1.3977)	(28.8330)	(1.4606)

Table 4.5 Cont'd

	Machinery and transport equipment			Miscellaneous			Others	
	Machinery & transport equipment	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
Panel A								
α	-0.0011	-0.0026[a]	4.1E-05	-0.0005	0.0004	0.0022	-0.0008	-0.0006
	(0.0009)	(0.0010)	(0.0004)	(0.0005)	(0.0006)	(0.0016)	(0.0007)	(0.0007)
ΔEP_{t-1}	-0.0144	-0.0058	0.0011	-0.0415	-0.0466	-0.1043	-0.1385[b]	-0.0994[a]
	(0.0624)	(0.0596)	(0.0357)	(0.0639)	(0.0587)	(0.0874)	(0.0705)	(0.0379)
ΔX_t	-0.0898[b]	-0.1118[b]	-0.0015	-0.3358[a]	-0.3681[a]	-0.1867[a]	-0.1879[a]	-0.1214[a]
	(0.0427)	(0.0480)	(0.0139)	(0.0397)	(0.0378)	(0.0478)	(0.0341)	(0.0340)
ΔX_{t-1}	-0.1089[b]	-0.0923[c]	0.0031	-0.0429	-0.0118	-0.0668	-0.0102	-0.0922[b]
	(0.0444)	(0.0485)	(0.0204)	(0.0478)	(0.0460)	(0.0605)	(0.0335)	(0.0377)
ΔPPi_t	0.6801[a]	0.4047[c]	0.0103	0.3550[b]	0.0118	0.0189	0.7122[a]	0.5824[a]
	(0.1613)	(0.2174)	(0.0289)	(0.1674)	(0.1646)	(0.0398)	(0.2059)	(0.1937)
ΔPPi_{t-1}	0.1601	0.3008	0.0167	-0.0218	0.0440	-0.0192	0.4124[c]	0.1995
	(0.1690)	(0.2317)	(0.0343)	(0.1880)	(0.1868)	(0.0447)	(0.2345)	(0.2131)
$(EP_t - IP_t)_{t-1}$	-0.0577[b]	-0.0331[b]	-0.0029	-0.0001	-0.0201[a]	-0.0277	-0.0431[a]	-0.0416[a]
	(0.0231)	(0.0135)	(0.0115)	(0.0047)	(0.0067)	(0.0373)	(0.0157)	(0.0161)
$\overline{R^2}$	0.0797	0.0158	-0.0745	-0.0741	-0.1181	-0.0055	0.0146	0.0320
AIC	-6.1995	-5.8986	-6.0886	-6.0030	-6.0633	-6.2574	-6.3082	-6.2958
Panel B								
ω	-8.8488[b]	-8.3745[a]	-0.2949[a]	-0.1433	-0.0400	-8.9628[a]	-0.8479[c]	-5.0337[a]
	(3.6807)	(2.5722)	(0.1099)	(0.1052)	(0.0636)	(2.0253)	(0.4848)	(1.7783)
κ	0.0186	0.2120	0.1616[c]	-0.0556	-0.0481	0.1146	0.3774[a]	0.4099[b]
	(0.1947)	(0.2033)	(0.0977)	(0.0809)	(0.0590)	(0.1652)	(0.1203)	(0.2000)
φ	0.0981	0.0249	0.3806[a]	0.0906[c]	-0.0692	0.3289[b]	-0.0714	0.1380
	(0.1293)	(0.1353)	(0.1359)	(0.0478)	(0.0454)	(0.1356)	(0.0914)	(0.1207)
θ	0.0169	0.0405	0.9768[a]	0.9826[a]	0.9940[a]	0.0426	0.9368[a]	0.4768[b]
	(0.4081)	(0.2967)	(0.0130)	(0.0067)	(0.0039)	(0.2206)	(0.0496)	(0.1894)
$D_{t,1987}$ *	-11.1318[a]	-8.7624[a]	2.1178[b]	2.1780[a]	1.5215[a]		-1.3444	-14.0505
	(2.0555)	(2.0250)	(1.0409)	(0.7760)	(0.5573)		(1.0360)	(25.0262)
t-dist	4.4788[b]	3.4394[a]	2.2042[a]	8.0437[b]	7.6224[c]	18.2342	5.2154[a]	4.9981[b]
	(1.8207)	(0.9756)	(0.1653)	(3.8517)	(3.9082)	(20.2516)	(1.8516)	(2.3900)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-percernt level, respectively.* Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for those industries. $\overline{R^2}$, AIC and t-dist denote the adjusted R squared, Akaike Information Criterion and t-distribution, respectively.

4.3.1.2 GJR Estimates

Panel A in Table 4.6 shows that the lagged EPs changes still influence the current EPs changes. There are 11 significant cases of lagged EPs changes although the coefficient sign varies. Also, 21 out of 28 contemporaneous FX rate changes are significant. As before, all of the coefficients are negative. However, only 11 of the lagged FX rate changes are significant. So the contemporaneous FX rate changes have a more substantial effect on EPs changes. It is worth noting that the coefficients for the FX rate changes are highest for Fuels for both the EGARCH and GJR estimates, i.e., -0.4356 and -0.6168 respectively. In the case of GJR results, when the FX rates increase by 10%, the UK manufacturers reduce the prices by about 6%, so only 4% of the FX rates will pass through to the foreign customers. Also, the lagged FX rates' coefficient is -0.3016. So if last month's FX rates increased by 10%, then it will lead to a 3% deduction on the current EPs as well. Why do UK manufacturers not keep the same price when Sterling appreciates? It seems to be because the UK Fuels industry is not too competitive in the international market, and/or that the degree of substitutability is high.

Again, as cost effects, the current PPIs affect the PTM strategy more efficiently than the last periods' PPIs (16 vs. 4). Finally, 16 of the coefficients $(EP_i - IP_i)_{t-1}$ are significant, suggesting that a large number of those industries are impacted by the IPs/EPs relation.

Table 4.6 Estimates of the GJR Dynamic Regression Coefficients under the *t*-density

	Food and live animals				Beverage and Tobacco	Basic materials		Fuels	Chemicals	
	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres	Fuels	Chemicals	Organic chemicals
Panel A										
α	6.2E-05	-0.0018[b]	0.0010	0.0078[b]	0.0013[a]	0.0015	0.0001	0.0026	-0.0014[a]	-0.0023[b]
	(0.0010)	(0.0009)	(0.0008)	(0.0039)	(0.0006)	(0.0026)	(0.0016)	(0.0059)	(0.0005)	(0.0010)
ΔEP_{t-1}	-2.1944[a]	-0.2515[a]	-0.0897	-0.0385	-0.1362[b]	0.0416	-0.3317[a]	0.0230	-0.0945	-0.1925[a]
	(0.0645)	(0.0737)	(0.0548)	(0.0846)	(0.0737)	(0.0678)	(0.0487)	(0.0639)	(0.0662)	(0.0497)
ΔX_t	-0.1905[a]	-0.1744[a]	0.0952	-0.0908	-0.4756[a]	-0.1533	-0.0722	-0.6168[a]	-0.4240[a]	-0.4526[a]
	(0.0731)	(0.0597)	(0.0907)	(0.1650)	(0.0495)	(0.1386)	(0.0955)	(0.2288)	(0.0328)	(0.0468)
ΔX_{t-1}	-0.1502[c]	-0.1372[b]	0.0629	-0.1200	0.0161	0.0008	-0.1900[c]	0.3016[c]	-0.0153	-0.1214[b]
	(0.0865)	(0.0581)	(0.0958)	(0.1683)	(0.0609)	(0.1304)	(0.1112)	(0.2761)	(0.0405)	(0.0554)
ΔPPi_t	0.2454[b]	1.0491[a]	0.4549[b]	0.2502	0.0695	0.2214	0.3615[a]	1.3068[a]	0.4873[a]	0.1930[a]
	(0.1128)	(0.2724)	(0.1922)	(0.3473)	(0.0664)	(0.5797)	(0.1047)	(0.1321)	(0.1263)	(0.0311)
ΔPPi_{t-1}	0.1102	0.7844[a]	0.2029	0.1497	-0.0879	0.8783[c]	0.0458	0.1094	0.0805	0.1016[a]
	(0.1060)	(0.2669)	(0.1902)	(0.3291)	(0.0729)	(0.4934)	(0.1172)	(0.1277)	(0.1499)	(0.0314)
$(EP_t - IP_t)_{t-1}$	0.0074	-0.0506[b]	-0.0559[b]	-0.0697[b]	-0.0036	-0.0152	-0.0048	-0.0327	-0.0490[b]	-0.0470[a]
	(0.0202)	(0.0242)	(0.0235)	(0.0331)	(0.0144)	(0.0106)	(0.0141)	(0.0414)	(0.0210)	(0.0159)
$\overline{R}^2$	0.0250	0.1854	-0.0038	-0.0010	0.0935	-0.0381	0.1410	0.2840	0.0726	0.1500
AIC	-5.2309	-6.0291	-4.1815	-3.5529	-6.0217	-4.1046	-5.1049	-3.2105	-6.4136	-5.3416
Panel B										
ω	1.2E-06	-1.6E-06	7.2E-07	0.0004	1.2E-06	1.7E-05	0.0002	0.0013	1.1E-06	3.5E-06[b]
	(8.6E-07)	(1.9E-06)	(5.5E-06)	(0.0002)	(1.2E-06)	(1.2E-05)	(0.0002)	(0.0008)	(9.0E-07)	(1.7E-06)
κ	-0.0296[a]	0.0344	0.0328	0.2773[b]	0.1379	0.0225	0.0263	-0.1229	0.0483	-0.0547[b]
	(0.0039)	(0.0354)	(0.0340)	(0.1344)	(0.1006)	(0.0220)	(0.1146)	(0.0795)	(0.0301)	(0.0267)
φ	-0.0046	-0.0578	-0.0807	-0.2820[c]	-0.1198	-0.1033[a]	-0.0948	0.2309	0.0455	0.0046
	(0.0192)	(0.0740)	(0.0679)	(0.1543)	(0.1138)	(0.0388)	(0.1190)	(0.1468)	(0.0685)	(0.0401)
θ	1.0069[a]	1.0006[a]	0.9970[a]	0.6358[a]	0.9066[a]	1.0043[a]	0.4626	0.3644	0.9017[a]	1.0121[a]
	(0.0099)	(0.0602)	(0.0083)	(0.1944)	(0.0384)	(0.0094)	(0.6168)	(0.4052)	(0.0300)	(0.0172)
$D_{t,1987}$ *			0.0018	-0.0004		0.0012[b]	-0.0004[a]		0.0007	0.0028[b]
			(0.0012)	(0.0020)		(0.0005)	(0.0001)		(0.0006)	(0.0012)
t-dist	19.8023	20.0143	3.5698[a]	21.3031	4.1082[a]	16.9519	19.9970	17.3520	7.3997	3.2755[a]
	(36.0731)	(33.6572)	(1.0757)	(38.1077)	(1.3755)	(14.4895)	(24.9515)	(23.2094)	(5.2396)	(0.6593)

Table 4.6 Cont'd

	Chemicals		Material Manufactures							Machinery & transport equipment
	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery
Panel A										
α	-0.0002	-9.4E-04	0.0020[b]	6.4E-04	-0.0015	-0.0013	0.0018[c]	-0.0002	-0.0002	-0.0028[b]
	(0.0008)	(7.3E-04)	(0.0009)	(0.0006)	(0.0013)	(0.0010)	(0.0010)	(0.0013)	(0.0002)	(0.0014)
ΔEP_{t-1}	-0.3462[a]	-0.1935[a]	-0.0702	-0.2583[a]	-0.1826[a]	-0.2208[a]	-0.3599[a]	-0.0497	-0.0598	0.0099
	(0.0683)	(0.0639)	(0.0722)	(0.0699)	(0.0670)	(0.0685)	(0.0671)	(0.0695)	(0.0966)	(0.0794)
ΔX_t	-0.3726[a]	-0.2858[a]	-0.1836[a]	-0.6219[a]	-0.3814[a]	-0.2365[a]	-0.2252[a]	-0.3772[a]	-0.0815[a]	-0.1122
	(0.0564)	(0.0454)	(0.0541)	(0.0472)	(0.0445)	(0.0464)	(0.0469)	(0.0584)	(0.0080)	(0.0719)
ΔX_{t-1}	-0.2281[a]	-0.1388[a]	-0.0271	-0.2171[a]	-0.0070	-0.1140[a]	-0.1304[a]	0.0033	0.0040	-0.0927
	(0.0539)	(0.0451)	(0.0562)	(0.0631)	(0.0475)	(0.0433)	(0.0502)	(0.0642)	(0.0108)	(0.0801)
ΔPPi_t	0.1781	0.2163	0.3858[a]	0.0756	0.8244[a]	0.4917[a]	1.0399[a]	0.2803[a]	0.0061	0.1700
	(0.1606)	(0.2729)	(0.1104)	(0.0846)	(0.2832)	(0.1653)	(0.3169)	(0.0781)	(0.0207)	(0.3066)
ΔPPi_{t-1}	0.1532	0.2904	0.3777[a]	0.0865	0.3695	0.0304	0.3149	-0.0047	0.0199	-0.0007
	(0.1858)	(0.2756)	(0.1032)	(0.0956)	(0.2846)	(0.1492)	(0.3240)	(0.0765)	(0.0252)	(0.3126)
$(EP_i - IP_i)_{t-1}$	-0.0072[a]	-0.0394[a]	0.0170[c]	-0.0177[b]	-0.0205	-0.0085	-0.0298[c]	-0.0074	-0.0003	-0.0405[b]
	(0.0026)	(0.0137)	(0.0097)	(0.0082)	(0.0265)	(0.0168)	(0.0175)	(0.0139)	(0.0036)	(0.0205)
$\overline{R}^2$	-0.0507	0.1329	0.1126	0.0746	0.1940	0.0030	0.0880	0.0590	-0.0281	0.0084
AIC	-4.8231	-5.8791	-5.8439	-5.7918	-5.7453	-5.8097	-5.9305	-5.2501	-9.5965	-5.3699
Panel B										
ω	1.1E-05[c]	2.7E-06	4.7E-06[c]	2.2E-07	6.0E-06	7.5E-06	7.2E-06[c]	2.4E-05[c]	1.3E-07	0.0001[a]
	(6.5E-06)	(2.7E-06)	(2.7E-06)	(7.1E-07)	(3.7E-06)	(4.6E-06)	(4.0E-06)	(1.4E-05)	(1.2E-07)	(3.9E-05)
κ	0.3425[b]	0.1783[b]	0.1461[a]	0.0679	0.3772[c]	0.2827[c]	0.2751[b]	0.0284	0.1581[c]	0.4034[b]
	(0.1474)	(0.0901)	(0.0146)	(0.0438)	(0.2032)	(0.1476)	(0.1119)	(0.0499)	(0.0914)	(0.1898)
φ	0.1599	-0.1600[c]	-0.2671[a]	-0.0256	-0.2157	-0.3834[c]	-0.2076	0.0746	0.0025	-0.2763
	(0.2494)	(0.0944)	(0.0437)	(0.0709)	(0.2092)	(0.2025)	(0.1338)	(0.1049)	(0.1329)	(0.1916)
θ	0.6525[a]	0.8896[a]	0.9836[a]	0.9237[a]	0.7259[a]	0.8386[c]	0.7744[a]	0.8457[a]	0.8073[a]	0.3138[b]
	(0.0818)	(0.0491)	(0.0354)	(0.0334)	(0.0774)	(0.0521)	(0.0745)	(0.0667)	(0.0754)	(0.1525)
$D_{t,1987}$ *	0.0008	0.0003		0.0014	0.0011		0.0008	0.0028		-0.0002
	(0.0021)	(0.0004)		(0.0010)	(0.0009)		(0.0007)	(0.0018)		(0.0005)
t-dist	5.2852[b]	6.1537[a]	19.9360	360.3286	7.0621[b]	3.7404[a]	16.4106	4.0864[a]	15.4653	19.7045[a]
	(2.1743)	(2.3132)	(30.8205)	(12611.8700)	(2.8289)	(1.3218)	(15.2716)	(1.1936)	(26.3521)	(11.8580)

Table 4.6 Cont'd

	Machinery and transport equipment			Miscellaneous			Others	
	Machinery & transport equipment	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
Panel A								
α	-0.0003	-0.0019	0.0007	0.0001	0.0005	0.0014	0.0004	-0.0007
	(0.0015)	(0.0012)	(0.0006)	(0.0005)	(0.0005)	(0.0010)	(0.0015)	(0.0006)
ΔEP_{t-1}	0.0471	0.0172	-0.0055	-0.0691	-0.0606	-0.1331	0.0243	-0.0581
	(0.1061)	(0.0868)	(0.0599)	(0.0596)	(0.0512)	(0.0870)	(0.1172)	(0.0613)
ΔX_t	-0.0673	-0.1075[c]	-0.0732[b]	-0.3407[a]	-0.3661[a]	-0.2488[a]	-0.1132	-0.2011[a]
	(0.0670)	(0.0615)	(0.0298)	(0.0376)	(0.0349)	(0.0418)	(0.0794)	(0.0335)
ΔX_{t-1}	-0.1046	-0.1034[c]	-0.0318	-0.0699	-0.0284	-0.0488	-0.0553	-0.0093
	(0.0719)	(0.0621)	(0.0371)	(0.0441)	(0.0406)	(0.0497)	(0.0825)	(0.0328)
ΔPPi_t	0.7217[a]	0.2373	0.1426[c]	0.2749[b]	0.1569	-0.0081	0.8895[b]	0.7568
	(0.2151)	(0.1927)	(0.0766)	(0.1384)	(0.1332)	(0.0312)	(0.3950)	(0.2058)
ΔPPi_{t-1}	0.3149	0.2010	0.1278	-0.0027	0.0057	-0.0330	0.1682	0.1347
	(0.3281)	(0.3134)	(0.0850)	(0.1884)	(0.1363)	(0.0335)	(0.4551)	(0.2110)
$(EP_i - IP_i)_{t-1}$	-0.0783[b]	-0.0377[a]	-0.0215	-0.0059[c]	-0.0138[a]	-0.0305	-0.0605	-0.0331[b]
	(0.0363)	(0.0132)	(0.0159)	(0.0033)	(0.0044)	(0.0283)	(0.0377)	(0.0141)
$\overline{R^2}$	0.0989	0.0239	-0.0205	-0.0715	-0.1336	-0.0524	0.0733	0.0223
AIC	-6.0763	-5.8199	-5.9972	-6.0386	-6.1645	-6.4475	-6.0719	-6.3129
Panel B								
ω	7.6E-05[c]	6.8E-05[b]	3.2E-06[b]	1.5E-06[a]	1.3E-06[a]	2.3E-06	7.9E-05	5.4E-06
	(4.3E-05)	(3.3E-05)	(1.5E-06)	(4.4E-07)	(2.6E-07)	(1.9E-06)	(5.2E-05)	(4.0E-06)
κ	0.0688	0.1411	0.1587[a]	-0.0205[a]	-0.0334[c]	0.0675	0.0946	0.2546[c]
	(0.1483)	(0.0889)	(0.0260)	(0.0012)	(0.0197)	(0.0494)	(0.1986)	(0.1370)
φ	0.0021	-0.0073	-0.1664[a]	-0.0633[a]	-0.0197	-0.0047	0.0034	-0.0524
	(0.2154)	(0.1383)	(0.0248)	(0.0001)	(0.0298)	(0.0916)	(0.3276)	(0.1650)
θ	0.5095[c]	0.4714[b]	0.8921[a]	1.0111[a]	1.0033[a]	0.8922[a]	0.5143[c]	0.7779[a]
	(0.2747)	(0.2204)	(0.0224)	(0.0083)	(0.0068)	(0.0578)	(0.3116)	(0.0818)
$D_{t,1987}$ *	-0.0002	-0.0001	0.0015	0.0014[a]	0.0016[a]		-0.0002	-0.0001[b]
	(0.0002)	(0.0003)	(0.0015)	(0.0005)	(0.0002)		(0.0002)	(0.0001)
t-dist	19.9996	19.9309[c]	3.3808[a]	9.2770	5.9528[a]	9.1399[c]	19.9992	4.1522[a]
	(36.9226)	(11.9144)	(0.5727)	(6.4727)	(2.6399)	(5.1571)	(18.5179)	(1.5210)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the p-value is statistically significant at a 1-, 5- or 10-percernt level, respectively.*Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for some industries. $\overline{R^2}$, AIC and t-dist denote the adjusted R squared, Akaike Information Criterion and t-distribution, respectively.

Table 4.7 BDS tests of nonlinearity: Standardised Residuals EGARCH Dynamic model

	Food and live animals				**Beverages and Tobacco**	**Basic Materials**	
m	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres
				l=0.25			
2	-0.9187	-0.8217	0.7593	-0.5145	3.1401[a#]	-0.9317	0.3981
3	-1.0966	-1.5899	1.7021[c]	-1.4974	3.7323[a#]	-1.2380	0.1541
4	-0.6344	-2.1878[b]	1.9964[b]	-1.0278	3.5156[a#]	0.0303	0.5811
5	-1.3025	-0.7149	1.4249	0.0775	3.4438[a*]	-0.4287	1.4867
6	-1.1010	7.9206[a]	0.9177	1.0543	3.4147[a]	0.0455	-1.1334
7	0.7830	20.2389[a#]	-0.3827	-3.2747[a]	6.0917[a]	-1.0591	-2.8132[a]
8	4.3025[a]	35.4566[a#]	-1.1017	-2.4033[b]	15.3969[a*]	-2.6111[a]	-2.0680[b]
9	-2.5067[b]	60.7269[a#]	-0.8317	-1.8420[c]	25.7677[a#]	-2.1705[b]	-1.6438
10	-2.0036[b]	-2.3640[b]	-0.6063[*]	-1.4473[*]	-1.0391	-1.6889[c]	-1.2501
				l=0.5			
2	-0.8037	-0.1635	-0.9222	0.6885	1.8223[c*]	0.3203	0.0559
3	-1.6338	-0.6750	-0.1693	0.4971	3.1665[a#]	0.5704	0.1990
4	-1.3651	-1.5568	0.4422	0.2105	4.5781[a+]	0.7961	0.2150
5	-0.7045	-1.5020	1.3407	0.6652	6.1841[a+]	0.7377	0.8630
6	-0.4506	-0.6983	2.5281[b#]	0.9733	7.8739[a+]	0.7827	1.3392
7	-0.4780	0.7236	3.7211[a*]	0.8860	10.0618[a+]	1.0055	1.5209
8	-0.5541	1.7145[c]	4.6863[a*]	0.4858	11.9429[a+]	1.4680	1.8540[c]
9	-0.6917	3.0568[a]	5.8161[a*]	0.1488	14.5780[a+]	2.1414[b]	2.2224[b]
10	-0.3427	3.6216[a]	7.0818[a*]	-0.0771	17.3756[a+]	3.5056[a*]	2.2323[b]
				l=0.75			
2	-0.7977	-0.7321	-0.0171	0.5243	1.4290	-0.0379	-0.2094
3	-1.7825[c]	-1.2263	0.3918	0.3144	2.4100[b#]	0.0862	0.0766
4	-1.3803	-1.9636[b*]	0.6770	0.1828	3.0935[a+]	0.5682	-0.0749
5	-0.9182	-1.5045	1.2586	0.4058	3.8372[a+]	0.3262	0.3463
6	-0.9861	-0.8799	1.9826[c#]	0.6026	4.9099[a+]	0.4281	0.6666
7	-0.9822	-0.2856	2.7134[a#]	0.5862	5.9475[a+]	0.5509	0.9383
8	-0.6415	-0.3209	3.3054[a+]	0.4867	6.6471[a+]	0.6366	1.0745
9	-0.3339	0.0299	3.6929[a+]	0.5406	7.3331[a+]	0.6272	1.0979
10	-0.1107	0.1601	4.0542[a+]	0.6511	8.2681[a+]	0.9791	1.3829

Table 4.7 Cont'd

	Fuels	**Chemicals**				**Material Manufactures**	
m	Fuels	Chemicals	Organic chemicals	Inorganic chemicals	Plastics	Iron & steel	Paper and paperboard
				l=0.25			
2	-0.7410	0.2813	0.8798	-0.2824	-0.4917	1.0096	3.2878^{a+}
3	-1.2540	0.9061	1.6275	0.3307	0.5617	-0.6433	5.5310^{a+}
4	-0.9687	0.7118	$3.0625^{a\#}$	1.2892	0.8734	-1.0899	5.9687^{a+}
5	-2.4350^{b}	1.1459	5.3567^{a+}	0.8130	0.7967	-1.7206^{c}	6.3755^{a+}
6	-3.6923^{a*}	-0.0279	7.8709^{a+}	1.9654^{b}	1.9607^{b}	-1.3746	8.9651^{a+}
7	$-4.0079^{a\#}$	-0.8413	12.8583^{a+}	0.9354	0.9843	-3.0603^{a}	$9.6014^{a\#}$
8	-3.1475^{a*}	-2.1368^{b}	20.9189^{a+}	-3.0810^{a}	-2.1633^{b}	-2.4117^{b}	$2.9032^{a\#}$
9	$-2.7199^{a\#}$	-1.6365	33.6906^{a+}	-2.4261^{b}	-1.6776^{c}	-2.0080^{b}	-1.2572^{a}
10	-2.1932^{b*}	-1.3159	-0.7104	-1.9662^{c}	-1.2847	-1.5825	-0.9551
				l=0.5			
2	-0.0293	1.2430	1.0450	1.1133	0.7968	0.3914	3.1184^{a+}
3	0.3270	1.8410^{c*}	$2.1521^{b\#}$	0.6038	1.8851^{c*}	0.2414	5.7951^{a+}
4	0.4841	2.0998^{b}	3.6408^{a+}	0.5073	$2.7578^{a\#}$	0.3619	7.0294^{a+}
5	0.5453	2.0158^{b*}	4.9792^{a+}	0.6153	3.5182^{a+}	0.7338	8.6426^{a+}
6	0.6950	2.2603^{b*}	6.4837^{a+}	0.9506	4.1724^{a+}	1.1925	10.1144^{a+}
7	0.7914	2.4054^{b*}	8.1310^{a+}	0.9095	5.1736^{a+}	1.1028	11.7273^{a+}
8	0.9157	2.3783^{b*}	10.0045^{a+}	1.0182	6.2574^{a+}	0.5285	13.2768^{a+}
9	0.3803	3.0129^{a*}	11.7777^{a+}	1.2044	7.9841^{a+}	-0.5704	14.8501^{a+}
10	-0.1458	3.6678^{a*}	13.4984^{a+}	1.5849	9.6278^{a+}	-0.8902	17.2880^{a+}
				l=0.75			
2	0.1929	1.1308	0.4057	1.1533	0.5145	0.2285	0.9636
3	0.9223	$2.4512^{b\#}$	1.3300	0.8016	1.1370	0.3673	3.1220^{a+}
4	1.2737	2.9797^{a+}	2.8249^{a+}	0.7502	1.7466^{c*}	0.2287	4.0341^{a+}
5	1.7110^{c}	3.5111^{a+}	3.8657^{a+}	1.0047	$2.1877^{b\#}$	0.1773	5.1028^{a+}
6	1.6098	3.8352^{a+}	4.7254^{a+}	1.3153	$2.5802^{a\#}$	0.2673	6.2066^{a+}
7	1.9436^{c*}	4.0618^{a+}	5.4265^{a+}	1.5289	3.1543^{a+}	0.0282	7.1399^{a+}
8	$2.3815^{b\#}$	4.0902^{a+}	6.0928^{a+}	1.5713	3.7525^{a+}	-0.4026	8.2072^{a+}
9	2.1918^{b*}	4.2590^{a+}	6.5774^{a+}	1.6045	4.3867^{a+}	-0.7494	9.2515^{a+}
10	2.2855^{b*}	4.3167^{a+}	7.2119^{a+}	1.6230	4.9985^{a+}	-0.7315	10.4260^{a+}

Table 4.7 Cont'd

	Material manufactures					Machinery and transport equipment	
m	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery	Machinery and transport equipment
				l=0.25			
2	5.9966[a+]	-2.3719[b#]	0.8617	-1.8623[c]	-1.2543	-0.8156	-1.1732
3	8.7624[a+]	-2.7041[a#]	1.6854[c]	-1.8775[c]	-1.4057	-0.5644	-1.0736
4	12.7061[a+]	-3.1541[a+]	2.4190[b]	-1.1401	0.3602	-0.8490	-0.5950
5	17.5471[a+]	-2.0892[b]	3.4970[a]	-0.9851	3.6023[a]	-1.2802	-1.7885[c]
6	25.7617[a+]	-1.7761[c]	4.8349[a]	1.3356	1.2074	-1.6266	-1.8059[c]
7	29.9303[a+]	-1.8656[c]	1.3677	5.2437[a]	-1.1401	-3.1714[a]	-0.8330
8	13.8811[a#]	-1.5140	-2.6188[a]	4.0790[a]	-3.0369[a]	-2.6228[a]	-2.0157[b]
9	15.2297[a*]	-1.0977	-2.0218[b]	-1.8313[c]	-2.5079[b]	-2.0282[b]	-1.5236
10	-1.0650	-0.8133	-1.5879	-1.4295	-1.9634[b]	-1.5891	-1.2065
				l=0.5			
2	3.8447[a+]	-1.7188[c]	0.7621	-1.2597	-0.8461	0.1316	-0.7300
3	6.4440[a+]	-1.9571[b*]	1.5094	-1.7832[c*]	-1.1069	0.0093	0.5470
4	8.4753[a+]	-1.5440	2.5142[b#]	-1.5677	-1.0859	-0.3054	1.2844
5	10.5520[a+]	-1.4538	3.8737[a+]	-1.5810	-0.6442	-0.2572	1.9485[c*]
6	12.4866[a+]	-1.1824	5.0167[a+]	-1.3886	-0.5797	-0.1905	2.5507[b#]
7	14.8153[a+]	-0.9659	6.1499[a+]	-1.3577	-0.4242	0.2581	3.5112[a#]
8	18.0393[a+]	-0.9750	7.2681[a+]	-1.0499	-0.2493	-0.0169	4.6737[a+]
9	22.3101[a+]	-0.8733	8.0478[a+]	-0.8284	-0.4607	0.2192	5.8569[a+]
10	26.6332[a+]	-0.7625	8.7614[a+]	-0.5383	-1.8467[c]	0.2055	6.9577[a+]
				l=0.75			
2	1.0281	-1.0175	0.8920	-1.4119	-0.6439	0.3582	-0.2916
3	4.0844[a+]	-1.2856	1.7904[c*]	-1.8383[c*]	-0.7823	0.0035	0.5993
4	5.5972[a+]	-0.9596	2.7724[a#]	-1.7580[c]	-0.8467	-0.5862	1.0063
5	7.2657[a+]	-1.0839	3.9058[a+]	-1.7001[c]	-0.3889	-0.5433	1.2421
6	8.6483[a+]	-0.8257	4.8788[a+]	-1.4558	-0.1011	-0.5355	1.6213
7	9.8724[a+]	-0.7409	5.8097[a+]	-1.3016	-0.1740	-0.3438	2.1983[b*]
8	10.9832[a+]	-0.9769	6.6698[a+]	-1.1061	-0.0909	-0.6464	2.3016[b#]
9	12.2060[a+]	-0.6662	7.3386[a+]	-0.8585	-0.1512	-0.5138	2.6720[a#]
10	13.4902[a+]	-0.4359	7.9984[a+]	-0.6306	-0.0133	-0.4820	2.9206[a#]

Table 4.7 Cont'd

	Machinery and transport equipment		Miscellaneous			Others	
m	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
				l=0.25			
2	0.6291	3.6991^{a+}	0.2736	1.0036	0.5895	0.6868	-0.3829
3	1.4631	4.7038^{a+}	0.4484	0.4072	2.4923^{b*}	1.2139	0.0786
4	1.7933^{c}	7.1596$^{a\#}$	-0.2684	0.5686	4.2353$^{a\#}$	1.8269^{c}	0.2672
5	2.8260^{a*}	10.4935$^{a\#}$	0.9349	0.6937	4.2712$^{a\#}$	0.4509	1.4683
6	3.3817^{a}	17.8625$^{a\#}$	3.6857^{a}	1.0551	5.0113^{a*}	-0.0899	0.3333
7	3.6972^{a}	31.6192$^{a\#}$	3.3289^{a}	0.7128	5.8948^{a}	-3.2573^{a}	2.1976^{b}
8	2.7517^{a}	42.0625$^{a\#}$	-2.8878^{a}	-2.1485^{b}	-1.9314^{c}	-2.4967^{b}	2.8489^{a}
9	-1.3366	47.4153$^{a\#}$	-2.3955^{b}	-1.7918^{c}	-1.5583	-1.9546^{c}	-1.4672
10	-1.0304	63.1893$^{a\#}$	-2.1022^{b}	-1.5542	-1.1771	-1.5207	-1.1055
				l=0.5			
2	0.3077	0.7431	-0.2110	1.3547	0.2427	0.3454	-0.7331
3	2.0565^{b*}	1.2639	-0.1982	0.7331	1.3529	0.0165	-0.1449
4	2.5513$^{b\#}$	2.0903^{b+}	-0.5176	0.5033	1.6586^{c}	-0.4286	0.0244
5	3.4862^{a+}	2.0932^{b*}	-0.5224	0.6018	2.5599$^{b\#}$	-0.3250	0.6726
6	4.1963^{a+}	2.1947^{b*}	-0.4872	0.4863	3.4877$^{a\#}$	-0.7376	1.1340
7	4.6193^{a+}	2.5308^{b*}	-0.3941	0.2470	4.7382^{a+}	-0.5382	1.6194
8	5.0468^{a+}	2.6496^{a}	-0.2145	0.3162	5.4704^{a+}	-0.4186	2.1523^{b*}
9	5.5633^{a+}	3.0779^{a}	-0.1467	0.0682	6.5364^{a+}	-0.7033	2.8100$^{a\#}$
10	7.1112^{a+}	4.1298^{a*}	-0.2055	-0.3462	7.8385^{a+}	-0.8691	3.5117$^{a\#}$
				l=0.75			
2	0.4210	-0.1797	0.5565	0.6718	1.0485	0.3293	-0.6249
3	1.6221	-0.1106	0.6180	0.2875	1.9786^{b*}	0.1467	-0.3110
4	2.0402^{b*}	0.5552	0.6247	-0.1027	1.6252	0.0425	-0.0876
5	2.7610$^{a\#}$	0.5541	0.9473	0.2396	2.7313$^{a\#}$	0.2263	0.3637
6	3.3346^{a+}	0.5727	1.1911	0.5943	3.4756^{a+}	0.0206	0.8536
7	3.9722^{a+}	0.7296	1.1780	0.6739	4.3224^{a+}	0.1266	1.3486
8	4.2209^{a+}	0.2859	1.0405	0.9683	5.0355^{a+}	0.2319	1.7602^{c*}
9	4.7460^{a+}	0.2920	0.9134	0.9532	5.6527^{a+}	0.2859	2.1549$^{b\#}$
10	5.2426^{a+}	0.4410	0.6375	0.8312	6.3280^{a+}	0.2675	2.5832$^{a\#}$

Notes: The BDS statistic for l=0.25, 0.5 and 0.75 standard deviations and m-dimensions 2 to 10. At l=1 (m=2, 3, 4…10), the BDS statistics was typically zero and therefore is not shown. In terms of normal distribution, significantly different from zero at 1% (^{a}), 5% (^{b}) and 10% (^{c}) level, while bootstrap at 1% ($^{+}$), 5% ($^{\#}$) and 10%(*) level respectively.

Table 4.8 BDS tests of nonlinearity: Standardised Residuals GJR Dynamic model

	Food and live animals				Beverages and Tobacco	Basic Materials	
m	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat	Beverages and Tobacco	Metal Ores	Textile fibres
				l=0.25			
2	-0.8216	-0.0720	-1.1010	-0.7914	-0.0443	0.1711	3.9762[a+]
3	-0.6874	-0.8448	-1.1894	-1.5430	1.1648	0.2967	3.8060[a+]
4	-0.4748	-1.8743[c]	-1.1139	-1.5716	0.2564	1.1208	3.9181[a#]
5	-1.4911	-2.1080[b]	-0.6687	-1.1350	0.4000	1.4107	3.3570[a*]
6	0.1700	1.3296	-0.5335	0.2620	2.1537[b]	1.3138	2.4176[b]
7	2.6493[a]	12.0849[a*]	-1.8257[c]	-0.9331	5.7531[a]	1.0065	-0.7321
8	3.6590[a]	30.7056[a*]	-1.4355	-2.6262[a]	14.8575[a*]	-2.4609[b]	-2.0916[b]
9	-2.3687[b]	52.5776[a#]	-1.1523	-2.0162[b]	24.8939[a*]	-2.0511[b]	-1.6636[c]
10	-1.8731[c]	-2.1578[b]	-0.8946	-1.5945[*]	-1.4755	-1.5894	-1.2575[*]
				l=0.5			
2	-0.9272	-0.0541	-0.7662	0.5634	1.1100	0.6446	2.7388[a#]
3	-1.4014	-0.5060	-0.6535	0.2673	1.6769[c]	0.9807	2.7874[a#]
4	-1.0826	-1.5163	-0.9670	0.0440	2.1592[b*]	1.1631	2.8414[a#]
5	-0.5205	-1.3718	-1.0133	0.4590	1.9042[c]	1.1778	3.4352[a#]
6	-0.4162	-0.5875	-1.4116	0.7886	1.9701[b]	1.2315	3.9526[a#]
7	-0.4899	0.1011	-1.2620	0.7693	1.7422[c]	1.4210	4.0607[a#]
8	-0.5892	0.5572	-1.2693	0.4445	1.0816	1.5694	4.3877[a#]
9	-0.8713	1.5802	-1.5264[*]	0.2755	0.6883	1.9521[c]	4.1934[a#]
10	-0.8266	1.9998[b]	-1.6250[#]	0.0808	0.6876	3.3201[a*]	3.7776[a#]
				l=0.75			
2	-0.8400	-0.9458	0.8655	0.0925	0.8303	-0.0884	2.3504[b#]
3	-1.5905	-1.4710	1.3895	0.0348	1.1457	0.3550	2.5910[a#]
4	-1.1040	-2.1544[b*]	1.3222	-0.0232	1.4944	0.8829	2.6807[a#]
5	-0.6089	-1.5921	1.3450	0.2415	1.1615	0.7117	3.1020[a#]
6	-0.7317	-0.7583	1.2521	0.5081	1.6339	0.7774	3.4078[a+]
7	-0.5631	-0.0666	1.2343	0.5524	1.8947[c*]	0.9162	3.6161[a+]
8	-0.1624	-0.1754	1.0139	0.4218	1.7205[c]	0.9613	3.6829[a+]
9	0.1610	0.1916	0.7404	0.4464	1.5206	0.8938	3.7397[a+]
10	0.3424	0.3321	0.5638	0.5174	1.5244	1.2352	3.9901[a+]

Table 4.8 Cont'd

	Fuels	Chemicals				Material Manufactures	
m	Fuels	Chemicals	Organic chemicals	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard
				l=0.25			
2	-0.6885	1.0283	0.6488	-0.6555	-1.0976	0.2684	-0.8444
3	-0.8332	-0.0058	-0.1166	-1.1189	-0.5074	-0.7055	-1.2797
4	-1.4055	0.1442	0.4832	0.2484	-0.3237	-0.6151	-2.5885[a]
5	-2.3057[b]	0.2567	1.4270	0.6608	0.4551	3.4755[a]	-2.1982[b]
6	-3.1241[a]	0.9228	2.0343[b]	-0.4540	-0.5635	6.3284[a]	-2.8384[a]
7	-4.3129[a#]	2.7053[a]	3.9585[a]	-3.5158[a]	-1.0336	1.3195	-4.0839[a]
8	-3.3531[a*]	-2.5422[b]	-1.8044[c]	-2.6411[a]	-2.5432[b]	-2.8765[a]	-3.0856[a]
9	-2.9125[a#]	-2.0916[b]	-1.4937	-2.0462[b]	-2.0387[b]	-2.4194[b]	-2.5448[b]
10	-2.3774[b*]	-1.8179[c]	-1.2297	-1.6305[b]	-1.5659	-1.9237[c]	-1.9924[b]
				l=0.5			
2	-0.0100	0.6425	0.6928	0.2109	-0.8103	0.3949	0.5313
3	0.0551	0.3362	0.4437	-0.4109	-0.7076	0.4538	-0.1161
4	0.1029	0.3340	0.4872	-0.6443	-0.8384	0.7661	-0.6011
5	0.1632	-0.2587	0.3441	-0.4724	-1.0213	1.3398	-0.9380
6	0.1575	-0.2039	0.5865	-0.3541	-1.0318	2.2838[b*]	-1.2105
7	-0.0770	-0.1880	0.9725	-0.0997	-0.8627	2.7343[a#]	-1.1642
8	0.1560	-0.6669	1.0476	-0.0662	-1.0888	2.3360[b]	-1.0787
9	-0.2988	-0.6996	0.9779	0.0681	-1.0319	1.2893	-1.3355
10	-0.6887	-1.0987	1.2834	0.2101	-1.3875	0.8105	-1.7371[c]
				l=0.75			
2	-0.3875	0.6863	1.4127	0.5986	-0.7996	0.3650	1.1597
3	0.2713	0.6344	1.1952	-0.0656	-0.5782	0.5136	0.4125
4	0.3752	0.8772	1.5191	-0.5619	-0.4259	0.4550	-0.0828
5	0.8256	0.6051	1.0663	-0.5028	-0.4017	0.3101	-0.1719
6	0.7220	0.5904	1.5370	-0.3105	-0.5571	0.4643	-0.5524
7	0.9094	0.4097	2.0929[b*]	-0.1104	-0.7960	0.1673	-0.2166
8	1.3671	0.0506	2.4206[b#]	-0.0641	-0.9700	-0.3447	-0.0716
9	1.0753	0.0117	2.4410[b#]	0.0509	-0.9226	-0.6724	-0.2560
10	1.1486	-0.3194	2.4849[b#]	0.0784	-0.8065	-0.6665	-0.1784

Table 4.8 Cont'd

	Material manufactures					**Machinery and transport equipment**	
m	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles	Electronic machinery	Machinery & transport equipment
				l=0.25			
2	-0.2265	-0.6614	0.2837	-1.8401[c]	-1.7148[c]	-0.4413	-2.1189[b*]
3	-0.0590	-0.2393	-0.7798	-2.1453[b*]	-1.5510	0.1949	-0.6655
4	0.0570	0.9402	-1.9685[b]	-1.3730	0.9382	1.5379	0.2239
5	-0.5472	1.2766	-3.7648[a*]	-0.8848	4.7231[a#]	1.5535	0.2296
6	-3.0884[a]	0.8722	-4.7649[a*]	0.6485	4.7450[a]	2.4380[b]	0.3350
7	-1.4320	1.3800	-4.1659[a]	3.0165[a]	7.0239[a]	0.6152	0.7358
8	-3.5703[a]	-3.1575[a]	-3.1384[a]	3.8865[a]	14.1206[a*]	-2.2697[b]	-1.8984[c]
9	-2.7711[a]	-2.7075[a]	-2.4137[b]	-1.6791[c]	25.1599[a*]	-1.7446[c]	-1.4559
10	-2.1853[b]	-2.1262[b]	-1.9385[c]	-1.3093	-2.0152[b]	-1.3661	-1.1636
				l=0.5			
2	-0.1213	-0.3701	1.0360	-0.9856	-0.8272	-0.0672	-1.3481
3	0.5382	-0.4854	0.2117	-1.4342	-1.1909	0.3005	0.0345
4	0.5381	-0.3614	-0.2185	-1.0092	-1.3939	0.2674	0.9868
5	0.4728	-0.4805	-0.4237	-0.7774	-0.9578	0.4706	1.8441[c*]
6	0.7867	-0.4472	-0.7868	-0.6288	-0.8036	0.5550	2.5198[b#]
7	1.6179	-0.2594	-0.5651	-0.6576	-0.6780	0.9031	3.3349[a#]
8	2.2500[b]	0.0580	-0.5452	-0.2936	-0.5972	0.4404	4.4998[a+]
9	3.0075[a*]	0.5183	-0.9354	-0.0189	-0.7614	0.5872	5.7157[a+]
10	3.3892[a*]	1.2311	-0.9104	0.6632	-1.6089	0.6182	7.2373[a+]
				l=0.75			
2	-0.2548	-0.6588	0.5642	-1.2122	-0.5572	-0.3202	-1.6248
3	-0.1519	-0.9308	0.2362	-1.5785	-0.6407	-0.2015	-0.7665
4	-0.3174	-0.9739	0.2822	-1.4556	-0.7224	-0.5190	-0.3601
5	-0.4032	-1.4106	0.5493	-1.3652	-0.3704	0.0441	0.1913
6	-0.1918	-1.4114	0.5496	-1.1243	-0.0442	0.4315	0.6407
7	-0.1405	-1.4576	0.6469	-0.9683	-0.0903	1.0031	1.3683
8	-0.0028	-1.5318	0.7994	-0.7574	-0.0057	0.9134	1.5427
9	0.1050	-1.8845[c*]	0.7604	-0.5178	-0.0342	1.3367	1.9169[c*]
10	0.2003	-1.5499	0.6337	-0.2768	0.1209	1.6013	2.2082[b*]

Table 4.8 Cont'd

	Machinery and transport equipment		**Miscellaneous**			**Others**	
m	Machinery	Road vehicles	Clothing	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
				***l*=0.25**			
2	-0.4773	-0.0677	-0.1249	1.1939	-3.8306^{a+}	0.2164	-0.4296
3	0.0845	-0.0916	-0.0596	0.2212	-2.6893^{a*}	0.3121	-0.7272
4	0.6856	-0.1105	-0.7795	0.2604	-1.7226^{c}	-0.0378	-1.4238
5	1.5186	-0.1269	-0.3812	0.2624	-1.9169^{c}	-0.8802	-2.2679^{b}
6	-1.2338	-0.1418	-0.1393	-1.1475	-2.3021^{b}	-3.3004^{a*}	-3.2314^{a*}
7	-2.5654^{b}	-0.1557	-3.5506^{a}	-3.0976^{a}	-3.6529^{a}	-2.9282^{a}	-2.8606^{a}
8	-2.0777^{b}	-0.1689	-2.8385^{a}	-2.4394^{b}	-2.9050^{a}	-2.2647^{b}	-2.2133^{b}
9	-1.5773	-0.1814	-2.3865^{b}	-2.0672^{b}	-2.4783^{b}	-1.7280^{c}	-1.7344^{c}
10	-1.2157	-0.1935	-2.1102^{b}	-1.8247^{c}	-1.9519^{c}	-1.3184	-1.3358
				***l*=0.5**			
2	-0.5222	-0.0677	0.5634	1.2137	-0.4754	0.7998	-0.6699
3	0.5306	-0.0916	0.4379	0.9454	-0.2005	1.4898	-0.3844
4	0.5949	-0.1105	0.3351	0.4375	-1.2635	2.0542^{b*}	-0.7551
5	1.0662	-0.1269	0.2731	0.6542	-1.4013	2.7076$^{a\#}$	-0.7044
6	1.6463^{c}	-0.1418	0.4395	0.7021	-1.4947	2.8163$^{a\#}$	-0.9047
7	2.0480^{b*}	-0.1557	0.1981	0.5852	-1.0905	3.2626$^{a\#}$	-1.0269
8	2.6428^{a*}	-0.1689	0.5096	0.5313	-1.0987	3.9683$^{a\#}$	-1.0204
9	3.0948^{a*}	-0.1814	1.2505	0.5776	-1.2590	4.6213$^{a\#}$	-1.3242
10	4.3564$^{a\#}$	-0.1935	1.8324	0.8093	-1.4841	4.9682$^{a\#}$	-1.4736
				***l*=0.75**			
2	-0.3382	-0.0677	0.9114	1.2570	-0.0815	0.1146	-0.3245
3	0.2434	-0.0916	0.7635	0.8783	0.1318	0.7668	-0.2366
4	0.3363	-0.1105	0.6947	0.5064	-0.9357	1.5876	-0.3922
5	0.8480	-0.1269	1.1569	0.6716	-0.5356	2.4724$^{b\#}$	-0.3012
6	1.3306	-0.1418	1.5031	0.9397	-0.4706	3.0240^{a+}	-0.2895
7	1.9187^{c*}	-0.1557	1.4897	1.1236	0.2441	3.7779^{a+}	-0.1580
8	2.0015^{c*}	-0.1689	1.5046	1.4218	0.5685	4.2282^{a+}	-0.0701
9	2.4621$^{b\#}$	-0.1814	1.5113	1.4034	0.6364	4.6434^{a+}	-0.0038
10	2.8934$^{a\#}$	-0.1935	1.3451	1.1830	0.8880	5.0881^{a+}	0.0860

Notes: The BDS statistic for l=0.25, 0.5 and 0.75 standard deviations and m-dimensions 2 to 10. At l=1 (m=2, 3, 4…10), the BDS statistics was typically zero and therefore is not shown. In terms of normal distribution, significantly different from zero at 1% (^{a}), 5% (^{b}) and 10% (^{c}) level, while bootstrap at 1% ($^{+}$), 5% ($^{\#}$) and 10%(*) level respectively.

4.3.2 Variance Equations for the Dynamic Model

Panel B of Tables 4.5 and 4.6 shows the results for the variance equation for the EGARCH estimates. Again, the mean coefficients ω are negative (zero) in most cases under the EGARCH (GJR) estimation. Also, the ω is significant in 19 (11) out of 28 cases under the EGARCH (GJR). The coefficient for κ_i is statistically significant in 15 out of 28 of the export sectors for both models. Also, the coefficients of θ_i are significant in 15 (26) out of 28 EPs in the EGARCH (GJR) model, which indicates that the EGARCH models capture the GARCH effects better than GJR models. More importantly, compared with GARCH effects, ARCH effects are much smaller, since the values of κ_i are much smaller than that of θ_i. Furthermore, there are eight (seven) cases in the EGARCH (GJR) model that have a significant coefficient of φ_i, which expresses that there is no difference between positive and negative innovation of the considered explanatory variables on the volatility for EPs. Once again, the results confirm the findings of the standard model. That is, the positive shocks are more powerful than the negative ones. Since significant φ_i occurs in seven cases with positive signs against one case with a negative sign in the EGARCH model. Further, there are seven cases carrying negative signs and positive sign does to show up in the GJR model respectively.

The dummy variable for the 1987 crash seems to have a moderate impact on the volatility of EPs changes. Only 10(6) out of the 20 included in the estimations are significant in EGARCH (GJR).

4.3.3 Comparison for EGARCH and GJR in the Dynamic Model

4.3.3.1 Diagnostic Tests

A series of diagnostic tests was also performed on the conditional residuals to test model adequacy, and the results are given in Table 4.9. A first look at the diagnostic tests indicates that the standardised residuals are statistically close to zero. However, the variances of the standardised residuals of both models differ in magnitude. For example, the variance ranges between 1.5940 (for the Scientific and photographic) and 0.4282 (for Fruit and vegetables) under the EGARCH model. Comparative values for the GJR model are 1.1193 (for Clothing and footwear) to 0.0010 (for Metal ores).[44] The EGARCH model, therefore, exhibits much more variation in the standardised residuals. The standardised residuals for both are significantly skewed and fat-tailed. Indeed, skewness is significant in 40% (46%) of the cases for the EGARCH (GJR) model. In all but three cases (and in respect of the GJR), all the distributions are significantly skewed to the right. Kurtosis is significant in 89% (86%) of the cases under the EGARCH (GJR) model. On the basis of those measures, it is not surprising that the J-B statistic is highly significant. All three measures almost uniformly indicate statistical significance for the same export sectors, irrespective of the estimated model.

Regarding the regression diagnostic tests on the residuals, the ARCH LM test and the Correlogram Squared Residual (Q^2) test were performed in both 2 and 12 lags, to ensure that there was no ARCH effect in the residuals. In this respect, GJR seems better than EGRACH. In terms of the ARCH LM test, the GJR model only has two and one case that show ARCH effects, while the EGARCH model has three and eight cases in lag 2 and 12 correspondingly.

[44] There is also variation in the conditional variances of both models. The conditional variance of the EGARCH ranges between -0.2492 and 0.3806 whilst that of the GJR ranges between -0.2802 and 0.1599. So the models generate different measures of conditional standardised residuals and volatility.

Table 4.9 Diagnostic Tests and Sign Tests

	Mean	Variance	Skewness	Kurtosis	J-B	LM(2)	LM(12)	$Q^2(2)$	$Q^2(12)$	Wald(1)	Sign	Negative	Positive
Food and Live Animals													
Cereals and Animal Feeding Stuffs													
EGARCH	-0.0207	1.0517	0.5546[a]	3.8291[a]	151.6407[a]	0.3699	0.2684	0.7623	0.2684	5.8339[b]	-0.2852	7.9681[c]	8.0002
											(0.3550)	(4.8624)	(7.8087)
GJR	-0.0353	1.0461	0.4648[a]	3.3072[a]	112.6070[a]	0.3611	0.2739	0.748	4.0227	1.0652	-0.2546	7.7496[c]	7.4716
											(0.3332)	(4.5528)	(7.1024)
Food													
EGARCH	-0.0616	1.111	0.2798	0.3031	2.8517	0.8464	0.8594	1.6151	8.8555	0.0085	0.0290	8.7726	13.7121
											(0.2868)	(15.3419)	(19.019)
GJR	-0.0231	1.1141	0.3247[c]	0.48	4.5923	1.0633	1.0377	2.0116	10.974	0.3362	0.0257	-788.4049	12.8521
											(0.3001)	(1259.138)	(19.6849)
Fruit & Vegetable													
EGARCH	-0.0009	0.4282	-0.1014	2.6331[a]	66.5475[a]	2.1441	2.7196[a]	4.4684	29.375[a]	0.2753	0.0230	0.6957	-1.2622
											(0.1328)	(2.0703)	(2.0736)
GJR	-0.0309	0.9777	0.2089	2.4152[a]	57.3225[a]	4.0861[a]	1.1975	9.2643[b]	16.6701	0.6799	-0.1538	3.1719	2.5819
											(0.2958)	(5.4303)	(5.8817)
Meat													
EGARCH	0.0086	1.0036	0.2843[c]	0.3132	4.0205	0.1666	0.6002	0.3113	8.6276	0.0716	-0.1213	-0.7671	0.9
											(0.1913	(3.9291)	(4.5585)
GJR	0.004	1.0036	0.3038[a]	0.2886	4.3169	0.0651	0.4987	0.1406	7.0647	0.3197	-0.2028	1.1666	0.5837
											(0.1926)	(3.6471)	(4.2476)
Beverages and Tobacco													
Beverages and Tobacco													
EGARCH	-0.0332	1.0945	0.3304[c]	2.0804[a]	33.5516[a]	2.7722	3.4021[a]	5.2733[c]	34.501[a]	0.003	0.79	-4.8684	-4.1394
											(0.4807)	(12.1589)	(17.1944)
GJR	-0.0238	1.0141	-1.0747[a]	7.0466[a]	382.1824[a]	0.0998	0.1903	0.2024	2.8442	0.3428	-8.E-06	-0.0027	0.0159[a]
											(0.0001)	(0.0029)	(0.0060)
Basic Materials													
Metal Ores													
EGARCH	-0.0169	0.9985	-0.182	1.7304[a]	29.8356[a]	0.1712	0.4415	0.3354	5.6629	0.2271	0.2083	1.1292	-5.3090
											(0.2652)	(3.8795)	(5.3228)
GJR	0.0015	0.001	-0.0558	1.7092[a]	27.9967[a]	0.3879	0.4382	0.7365	5.9073	1.2297	0.2014	0.8370	-6.5425[c]
											(0.2111)	(4.5489)	(3.8356)
Textiles Fibres													
EGARCH	0.0038	1.0016	-0.2461	0.6959[b]	6.9328[b]	0.1449	0.6311	0.29	8.6413	1.9242	0.0527	-1.2852	3.6050
											(0.2178)	(9.9936)	(11.6157)
GJR	0.0052	0.8856	-0.2254	1.1094[a]	13.6834[a]	1.7641	0.8785	3.9566	12.8211	0.6876	0.0039	-9.7544	15.6664

Table 4.9 Cont'd

	Mean	Variance	Skewness	Kurtosis	J-B	LM(2)	LM(12)	$Q^2(2)$	$Q^2(12)$	Wald(1)	Sign	Negative	Positive
											(0.2088)	(10.9218)	(12.5899)
Fuels													
Fuels													
EGARCH	0.0266	0.9964	0.0104	1.2347[a]	14.5505[a]	0.3594	1.5327	0.8651	18.957[c]	3.3120[c]	0.0617	0.3020	1.9743
											(0.2646)	(3.1177)	(4.6255)
GJR	0.0110	1.0335	0.0892	1.0528[a]	10.8789[a]	0.0355	1.2988	0.091	15.583	1.5332	0.1524	-1.9473	-1.2714
											(0.2595)	(3.6411)	(3.5711)
Chemicals													
Chemicals													
EGARCH	0.0292	1.1017	-0.1722	2.4147[a]	56.7659[a]	5.8055[a]	3.6604[a]	11.48[a]	57.451[a]	2.4528	-0.0289	-11.0932	15.6625
											(0.2885)	(17.7827)	(20.3514)
GJR	0.0474	0.9849	0.107	0.6981[b]	5.0869[c]	0.4183	0.8026	0.9091	11.116	3.0316[c]	0.3051	-24.1233	-0.6941
											(0.2255)	(20.6938)	(17.1594)
Organic Chemical													
EGARCH	0.05	1.1287	0.1772	2.9311[a]	83.1769[a]	0.8311	3.0965[a]	1.7287	54.0621[a]	0.8401	-0.1993	1.1819	4.2960
											(0.3322)	(11.7147)	(8.5113)
GJR	0.0491	0.8897	-0.0152	2.2133[a]	46.7509[a]	2.7458[c]	1.7435[c]	5.1118[c]	20.6311[c]	3.8245[c]	0.1580	-24.6862	-3.1753
											(0.2452)	(15.4531)	(6.3278)
Inorganic Chemicals													
EGARCH	-0.0262	1.0372	-0.1366	3.5251[a]	119.2773[a]	0.3268	0.34447	0.672	5.0042	7.1125[a]	0.1851	1.2120	-2.0601
											(0.3329)	(1.9920)	(3.9736)
GJR	-0.0259	0.9849	0.0914	2.0399[a]	40.0242[a]	0.2006	0.4387	0.4095	6.0194	0.0013	0.1317	2.7588[c]	-1.2847
											(0.2516)	(1.5087)	(4.0483)
Plastics													
EGARCH	0.0038	1.0565	0.1343	1.5462[a]	23.4986[a]	0.0742	1.1628	0.154	18.499	2.7694[c]	0.0048	0.4065	-5.2192
											(0.2598)	(14.5521)	(12.042)
GJR	-0.0108	1.037	-0.4682[a]	4.4168[a]	194.5044[a]	0.1642	0.1421	0.3515	1.954	1.1499	0.0004	-0.0404	-0.2580[a]
											(0.0017)	(0.1024)	(0.1253)
Material Manufactures													
Iron and Steel													
EGARCH	-0.0639	1.0282	-0.0412	1.4797[a]	15.4660[a]	0.1978	0.4725	0.4399	6.7245	0.5274	0.2318	3.3648	1.0259
											(0.2909)	(6.8908)	(21.1193)
GJR	-0.0358	1.0533	0.1273	1.1109[a]	9.1459[b]	0.1754	0.6059	0.3855	8.5066	17.9885[a]	0.3068	-3.1902	-4.2998
											(0.2889)	(11.4417)	(18.5639)
Paper and Paperboard													
EGARCH	-0.0213	1.1143	0.2201	2.2618[a]	50.6614[a]	7.2893[a]	4.7346[a]	14.279[a]	93.243[a]	4.1760[b]	0.1278	4.0996	8.7516
											(0.2811)	(8.8546)	(15.5657)

Table 4.9 Cont'd

	Mean	Variance	Skewness	Kurtosis	J-B	LM(2)	LM(12)	$Q^2(2)$	$Q^2(12)$	Wald(1)	Sign	Negative	Positive
GJR	-0.0693	1.0059	0.1916	0.0341	1.4129	1.3567	0.7927	2.5665	8.655	0.0344	-0.2737	12.8103[a]	17.6839
											(0.1968)	(3.9936)	(12.1176)
Material Manufactures													
EGARCH	0.012	1.1152	-0.0141	2.2456[a]	48.8787[a]	12.7765[a]	7.4604[a]	23.796[a]	127.37[a]	2.8075[c]	-0.2956	-2.0923	27.6676
											(0.3063)	(11.1261)	(18.0752)
GJR	-0.0291	1.0497	-0.8342[a]	4.6666[a]	234.3501[a]	0.2981	0.2446	0.5974	2.9131	0.4618	-0.2046	5.3072	-9.4176
											(0.3230)	(6.4653)	(8.5969)
Mineral Manufactures Less Precious Stones													
EGARCH	0.0899	0.9736	0.6761[a]	2.0762[a]	43.2282[a]	0.826	1.3159	1.5849	15.075	2.4327	0.4134	-8.4209	-10.893[c]
											(0.2790)	(13.1372)	(6.7223
GJR	0.0421	1.0016	0.0715	0.7260[b]	5.2229[c]	0.6935	0.9204	1.3355	11.174	1.0623	-0.0024	0.0158	-0.0086
											(0.0046)	(0.1074)	(0.114)
Miscellaneous Metal Manufactures													
EGARCH	0.076	0.9793	0.7374[a]	2.2741[a]	70.0984[a]	0.1267	5.4109[a]	0.2633	76.941[a]	1.3046	0.0821	-5.0925	-3.4391
											(0.2477)	(15.005)	(10.9821)
GJR	0.0067	1.0075	0.2808[c]	0.6625[b]	7.1974[b]	1.4922	0.7264	2.9239	9.5149	0.3801	-0.2671	19.2147[b]	19.1491[c]
											(0.2212)	(9.2467)	(10.8553)
Non-ferrous Metals													
EGARCH	-0.0121	1.0231	-0.1977	3.2802[a]	104.1593[a]	0.8138	0.2887	1.6046	4.4679	1.0462	0.3096	-8.9334	-22.9957[a]
											(0.301)	(7.8161)	(7.1201)
GJR	-0.0238	0.9844	-0.1433	3.6142[a]	125.4228[a]	0.6135	0.2479	1.2217	3.8615	3.1762[c]	0.4476	-10.9853	-23.6183[a]
											(0.3)	(7.8458)	(5.1443)
Textiles													
EGARCH	0.0188	1.0193	0.2352	0.8913[a]	9.6917[a]	0.0787	0.7444	0.163	8.9974	1.798	-0.3406	79.5113[c]	111.3640
											(0.2270)	(46.0958)	(95.3767)
GJR	0.0104	1.0226	0.2464	0.9988[a]	11.8349[a]	0.0218	0.786	0.0445	9.445	0.8607	-0.3502	80.5089[c]	121.6397
											(0.2227)	(46.0008)	(95.7608)
Machinery and Transport Equipment													
Electronic Machinery													
EGARCH	-0.0095	0.9782	0.0972	3.1404[a]	94.4613[a]	0.0949	0.5758	0.1969	7.1056	3.1704[c]	0.1533	3.9359	0.4850
											(0.3345)	(11.9913)	(13.1267)
GJR	-0.0008	1.1066	0.0951	3.5399[a]	119.9117[a]	0.3333	1.0097	0.6499	14.542	2.0899	0.1371	7.5383	-5.3947
											(0.3752)	(10.8842)	(13.54)
Machinery and Transport Equipment													
EGARCH	0.0881	0.939	0.4658[a]	1.4451[a]	28.2076[a]	0.2025	1.0465	0.4223	1.0465	4.2466[b]	0.1478	1.9338	2.2926
											(0.2139)	(15.1659)	(19.5045)
GJR	-0.0038	0.693	0.4277[a]	1.3174[a]	23.5398[a]	0.2025	1.0465	0.4223	15.608	2.4973	0.0011	-0.0477	0.0304
											(0.0014)	(0.0934)	(0.1192)

Table 4.9 Cont'd

	Mean	Variance	Skewness	Kurtosis	J-B	LM(2)	LM(12)	$Q^2(2)$	$Q^2(12)$	Wald(1)	Sign	Negative	Positive
Machinery													
EGARCH	0.0445	0.9325	0.6887[a]	3.8220[a]	157.4811[a]	1.0465	0.8246	2.1595	11.645	4.1244[b]	-0.1202 (0.2828)	6.7840 (15.7167)	0.3085 (16.1181)
GJR	0.0233	1.0312	0.7612[a]	3.4737[a]	137.2487[a]	0.0914	0.6185	0.1852	8.8141	3.9448[b]	0.1639 (0.3193)	8.8206 (15.6136)	-3.2159 (17.4753)
Miscellaneous													
Clothing													
EGARCH	0.0587	1.053	0.5395[a]	1.9223[a]	46.3674[a]	0.788	0.5746	1.6259	7.5904	0.8854	-0.1729 (0.2569)	11.3328 (7.9347)	18.7469[c] (11.1622)
GJR	-0.0073	1.0195	0.2965[c]	0.7527[b]	8.7608[b]	0.2969	0.6609	0.5928	8.491	1.4338	-0.0014 (0.2267)	5.5903 (6.4848)	11.5106 (10.8987)
Clothing and Footwear													
EGARCH	-0.004	1.03	-0.0856	1.1271[a]	12.4009[a]	0.2133	0.3896	0.4094	4.9269	0.8665	-0.0950 (0.2545)	0.1328 (8.9660)	6.7670 (7.3246)
GJR	0.0031	1.1193	0.1353	0.9919[a]	9.5593[a]	2.0745	0.8357	3.783	10.083	4.9022[b]	-0.0465 (0.2598)	0.6949 (9.8619)	3.1767 (8.3343)
Scientific and Photographic													
EGARCH	0.03	1.594	0.6546[a]	1.4825[a]	27.5453[a]	2.1023	4.064[a]	4.1154	55.455[a]	8.5361[a]	-0.3095 (0.3759)	13.5285 (23.7049)	13.1476 (26.1865)
GJR	0.0767	1.0249	0.5176[a]	1.6457[a]	26.6175[a]	0.7499	0.4911	1.6568	6.9231	1.2923	-0.2050 (0.3496)	35.7135 (22.3769)	30.1119 (35.1816)
Others													
Finished Manufactures													
EGARCH	0.0706	1.0037	0.5705[a]	2.8973[a]	92.5202[a]	0.1859	0.736	0.3798	8.9498	7.3307[a]	-0.4317 (0.2911)	26.4134 (18.0387)	23.0075 (24.2633)
GJR	0.0031	0.6456	0.9554[a]	4.8604[a]	260.2470[a]	0.0213	0.8138	0.0457	12.816	1.5894	-0.2285 (0.2579)	14.1083 (14.5822)	21.1139 (18.2816)
Finished Manufactures less Erratic													
EGARCH	0.096	0.954	0.578[a]	1.4404[a]	32.5478[a]	0.048	1.0484	0.1	16.015	0.1935	-0.1995 (0.2614)	2.3868 (20.2388)	4.9478 (15.9115)
GJR	0.0642	0.9686	0.772[a]	2.8079[a]	97.9766[a]	0.4235	1.5139	0.8596	17.98	0.0879	-0.2888 (0.284)	16.3648 (18.2737)	4.4459 (15.9485)

Notes: Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p*-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. J-B is the Jarque-Bera test of the normality of the regression residuals. LM (2) and LM (12) are the LM statistic for residual autocorrelation at 2 and 12 lag respectively. Q^2 (2) and Q^2 (12) are the Ljung-Box Q-statistic on the squared residuals for autocorrelation. Wald(1) is the Wald statistic for Null hypothesis that the $\kappa + \theta = 1$.

As for the Correlogram Squared Residual (Q^2) test, the GJR model captured most ARCH effects except two and one case in lag 2 and 12. However, there are four and nine cases showing ARCH effects in the EGARCH model in lag 2 and 12. Thus, the GJR model is better in respect of removing the ARCH effects.

Moreover, the Wald test was computed to determine whether the sum of the coefficient of ARCH and GARCH is equal to one (e.g., the presence of IGARCH). The results can reject the null hypothesis in 11 (6) out of 28 cases. This means that a high level of volatility exists in the majority of export sectors and the shock decays are very slow. Therefore, it is necessary to conduct further research to assess the asymmetric impact on the volatility.

4.3.3.2 Further Investigations on Asymmetry

To test various aspects of the asymmetric effects, the statistical tests suggested in Engle and Ng (1993), these being the Sign Bias Static, the Negative Size Bias Static and the Positive Size Bias Static, were utilised. These tests are designed to detect asymmetries in the conditional variance. Under the assumption that the series follows an *iid* process, the squared normalised residuals should not be predictable on the basis of observed variables. The regressions for the volatility specification tests are as follows:

Sign Bias Static: $$z_t^2 = a + bS_{t-1}^- + u_t \quad (4.5)$$

Negative Size Bias Static: $$z_t^2 = a + bS_{t-1}^- \varepsilon_{t-1} + u_t \quad (4.6)$$

Positive Size Bias Static: $$z_t^2 = a + b(1 - S_{t-1}^-)\varepsilon_{t-1} + u_t \quad (4.7)$$

Where

$z =$ the normalised residual corresponding to observation t under the volatility model hypothesis. That is, $z_t \equiv \varepsilon_t / \sqrt{\sigma^2}$.
σ^2 represents conditional variance of ε;
$S_{t-1}^- =$ a dummy that takes the value of unity if ε_{t-1} is negative and zero otherwise. u_t is the residual and $u_t \sim iid\, N(0,1)$.

The Sign Bias statistic tests the asymmetric impact of positive and negative innovation on volatility not predicted by the model. If the positive and negative shocks to ε_{t-1} have different impact on the conditional variance, b should be statistically significant, which indicates asymmetries. The Negative Size Bias statistic tests how well the model captures the impact of a different magnitude or size of negative shocks on the volatility. Similarly, the Positive Size Bias statistic tests whether the response of volatility to large and small shocks is different. If asymmetric effects exist in positive and negative shocks, the coefficient b is statistically significant. Eqs. 4.5 to 4.7 are computed using the Newey West estimation method.

Table 4.9 shows that there is no asymmetric impact on the volatility of the dynamic model under either estimation approach. None of the coefficients of the Sign test are significant. Moreover, the evidence suggests that shocks of different sizes and magnitude have no effect on the volatility of EPs changes. There are two (five) cases where the Negative Size statistic based on the EGARCH (GJR) estimates are significant. Also, three (five) of the coefficients based on the EGARCH (GJR) estimates are significant in the case of the Positive Size test. Therefore, in general, the results express that asymmetry is very weak. Overall, the results suggest that there are steady changes in EPs with a volatility that is relatively constant.

4.4 Conclusion

In order to investigate the relationship between FX rates, PPIs and EPs, both the EGARCH and GJR estimation methods were used. This model is an improvement on existing models both in its specification and estimation methods. For example, earlier models are not dynamically specified and no existing study has used GARCH-type models to estimate the relation. The empirical results show that FX rates and PPIs significantly impact on exporter prices. The effect is immediate with minimal delay. The FX rate effect is always negative. The findings confirmed that PTM applies for the case of UK exporters – a result consistent with other studies that use alternative estimation methods (see, e.g., Krugman, 1987; Yang, 1997; 1998) for other countries. Furthermore, PTM operates variously across different sectors. This study's findings consistently reveal that PTM is more pronounced in the Beverage and tobacco, Fuels, and Chemicals sectors, but that some industries (Food and live animal, and Basic materials) seem insensitive to FX rate fluctuation.

The results also show that asymmetry effects are minimal in EPs. This suggests that the volatility of EPs changes is not strong. So, exporters appear to relatively gentle in their response to FX rate changes. However, neither the EGARCH nor the GJR estimation methods are able to capture all of the non-linearity in the condition of standardised residuals.

CHAPTER 5

Co-integration and Error Correction Model

5.1 Introduction

Engle and Granger (1987) state that if two or more non-stationary series have a unit root, i.e., I (1) and they are also co-integrated, then it is possible to specify an error correction formulation for the relationship amongst the set of time series. Simply, co-integration implies a long-term equilibrium relationship amongst the set of time series. A set of time series may, of course, deviate from their long-run relationship in the short-term, but if they have the same stochastic trend in the long-term, they will be co-integrated. From the earlier empirical results of this study, the ADF tests indicated that the log level univariate time series are non-stationary and that all of them contain one unit root (see section 3.5.4 for more details) on first differencing. It is, therefore, necessary to test whether the sets of time series in the PTM exposure model are also co-integrated. This approach suggests that if co-integration is found, then the dynamic model in Chapter 4 is mis-specified as the long-run relation amongst the variables would have been omitted. Furthermore, to omit long-run equilibrium relations when it is necessary implies that the relation associated about equilibrium relations amongst the sets of series cannot be inferred. Indeed, McKenzie (1997) indicates that a co-integration approach seems to be ideal for many economic theories that are couched in long-run equilibrium terms. On finding a co-integrating relationship amongst the sets of time series, the relation is modelled further by using ECMs. To account for the time-varying effects, the ECMs are estimated using both EGARCH and GJR methods. A GARCH-type approach has not previously been estimated in empirical studies of PTM models. The first set of estimates is presented in terms of the nominal values of the series. To capture the effects of real prices, a further set of estimates are presented in real terms.

In Section 5.2, the theory associated with co-integration is discussed in order to provide a conceptual understanding of the empirical estimates that will follow. Section 5.3 provides the ECM results for EGARCH and GJR estimates. Section 5.4 presents the PTM results using the real values of the series, i.e., after adjusting for inflationary effects. Finally, the conclusion is presented in section 5.5.

5.2 Co-integration

At one time conventional wisdom was that non-stationary variables should be differenced to make them stationary before including them in multivariate models. However, Granger (1981) and Engle and Granger (1987) introduced the concept of co-integration, which provides a unified framework for estimating time series that are non-stationary in levels. They show that it is quite possible for a linear combination of a set of time series to be stationary. If sets of time series of the same order are integrated, typically order one (denoted, I(1)), then there is a likelihood that they can be co-integrated.

5.2.1 Integration, Co-integration and Error Correction

Co-integration normally requires that the non-stationary time series are integrated of the same order (Granger, 1981). In fact, the unit root tests have shown that the univariate series have one unit root in levels and that differencing them once induces stationarity (see, Chapter 3). In this case, the data is said to be integrated of order 1, denoted $x_t \sim I(1)$. When a set of time series has n time series or variables, there may be as many as n-1 linearly independent co-integrating vectors. The number of linearly independent co-integrating vectors that exist in the equilibrium system is also called co-integrating rank (see, e.g., Greene, 2002).

According to Engle and Granger (1987), in a bivariate system with at least one co-integrating vector, the co-integrating vector can be estimated by regressing one variable against the other(s) in levels and then using the residuals for the co-integrating regressions to test for unit root. Co-integration can then be tested using the ADF statistics. This approach for testing for co-integration is not particularly useful when there are more than two variables in the system. A better approach is to use the Johansen (1988) maximum likelihood full information method.

Furthermore, the Granger representation theorem states that for any set of I (1) variables, error correction and co-integration are equivalent representations (Engle and Granger, 1987) in the sense that the series can be modelled by using an ECM. As a consequence, when variables have one unit root, they can be co-integrated, which means that they can also be modelled using an ECM.

5.2.2 Johansen Tests for Co-integration

As already indicated, the Engle-Granger co-integrating regression can be used to test for co-integration but this approach is not too useful when there are more than two variables in the system. The Johansen (1988) multivariate co-integration analysis is the most popular method, since it can be tested in any system with more than two variables. Furthermore, some studies on FX rate pass-through (see, e.g., Sedgley and Smith, 1994) have shown that FX rates and IPs are co-integrated for quarterly data. It is, therefore, necessary to determine whether the prices for the UK export sectors are also co-integrated as, to find co-integration would imply that a better specification of the PTM model is an ECM. Therefore, the Johansen's multivariate co-integration approach will be applied to the study's PTM model, comprising of EPs, FX rate and PPIs time series.

Since it has been shown that the univariate series are stationary on first differencing, it is possible to test for co-integration using the Johansen (1988) maximum likelihood co-integration tests[45]. There is no inclusion of a linear deterministic trend into the estimate since the ADF statistics indicated that for most of the uinvariate series, only a drift was required. Moreover, the Johansen technique was applied by initially setting up a vector auto-regressive regression (VARs) with a maximum lag of 13, since monthly data are being used. This was tested down from the lag of 13 to one for each set of each export sector. The chosen VAR was the one with the largest test statistics, provided the LM statistics indicated by the ARCH effects and the residual auto-correlation were not present (p-value ≥ 0.10) in the residuals of the chosen VAR. Otherwise, the

[45] The tests employed include i) the λ_{max} statistic which tests the null hypothesis of exactly r co-integrating vectors against the alternative of $r+1$ co-integrating vectors and ii) the Trace statistic which tests the null hypothesis that there are at most r co-integrating vectors.

next appropriate VAR was chosen. Since there are three variables in the PTM model, the number of ranks should be less than two (i.e., r = n-1 =3-1=2).

Table 5.1 shows the results for the Johansen co-integration tests. The results for the λ_{max} statistic are given in Panel A, which indicate that the hypothesis that there are no co-integrating vectors can be rejected in 24 out of 28 of the set of export sectors. Except for those industries, the null hypothesis that there are up to two or three co-integrating vectors can be rejected in another three cases. Thus, the results demonstrate that 27 out of 28 export sectors have at least one co-integration vector. In particular, only the Chemicals export sector is not co-integrated. Therefore, a long-run equilibrium relation exists amongst 27 of the export sectors. More importantly, the trace statistic in Panel B confirms that those 27 industries are co-integrated.

Some previous studies (see, e.g., Mihailov, 2005; Hyder and Shah, 2004) also found co-integration between the FX rate and EPs, which is consistent with the results from this study. However, so far this study is the only one to investigate the long-term relationship among EPs, FX rate and PPIs based on both co-integration and ECMs. This means that since PPI also forms part of the co-integrating relationship, to exclude this variable would result in a mis-specified ECM.

Based on the Granger representation theorem, those 27 industries are likely to have an error-correction representation. Thus, a model in first differences would fail to capture information regarding the long-run properties of the data sets. An ECM for each of the 27 co-integrated sets of series is therefore estimated, in order to capture the long- term relationship amongst EPs, FX rates and PPIs. This analysis is performed in a subsequent section.

Table 5.1 Results for Johansen's Maximum Likelihood Co-integration Tests

	Panel A: λ_{max}			Panel B: Trace			
	$r=0$	$r\leq1$	$r\leq2$	$r=0$	$r\leq1$	$r\leq2$	m
Food and live animals							
Cereals and animal feeding stuffs	20.901[b]	11.037	1.345	33.283[b]	12.382	1.345	6
Food	21.037[c]	11.511	6.366[b]	38.913[a]	17.876[b]	6.366[b]	3
Fruit and vegetables	12.912	5.270	4.246[b]	22.427	9.515	4.246[b]	2
Meat	28.369[a]	6.375	4.965[b]	42.709[a]	14.340[c]	4.965[b]	3
Beverages and tobacco							
Beverages and tobacco	46.007[a]	6.019	0.009	52.035[a]	6.028	0.009	10
Basic Materials							
Metal Ores	51.353[a]	4.077	0.253	55.682[a]	4.330	0.253	2
Textile fibres	24.632[b]	4.527	1.958	31.116[b]	6.485	1.958	13
Fuels							
Fuels	19.142[b]	10.082[c]	0.695	29.920[a]	10.777[c]	0.695	11
Chemicals							
Chemicals	18.346	5.284	1.738	25.369	7.022	1.738	2
Organic chemicals	15.214	9.950	4.071[b]	29.236[c]	14.022[c]	4.071[b]	5
Inorganic chemicals	18.915[c]	7.003	2.629	28.546[c]	9.631	2.629	11
Plastics	27.425[a]	4.702	3.118[c]	35.245[a]	7.820	3.118[c]	12
Material Manufactures							
Iron and steel	23.530[b]	7.161	0.227	30.917[b]	7.388	0.227	13
Paper and paperboard	11.909	9.454	3.527[c]	24.890	12.981	3.527[c]	5
Material manufactures	31.308[a]	3.881	0.545	35.734[a]	4.427	0.545	1
Mineral manufactures less precious stones	39.098[a]	11.679	0.219	50.996[a]	11.898	0.219	13
Miscellaneous metal manufactures	19.381[b]	6.707	2.756	28.844[b]	9.463	2.756	1
Non-ferrous metals	29.125[a]	9.698	4.623	43.446[a]	14.321	4.623	5
Textiles	26.998[a]	14.209[c]	0.626	41.833[a]	14.834[c]	0.626	13
Machinery and transport equipment							
Electronic machinery	35.288[a]	3.405	0.573	39.265[a]	3.978	0.573	9
Machinery and transport equipment	41.044[a]	12.834[c]	2.322	56.200[a]	15.155[c]	2.322	3
Machinery	30.010[a]	10.672	1.999	42.681[a]	12.671	1.999	2
Road vehicle	28.481[a]	7.028	4.796[b]	40.305[a]	11.824	4.796[b]	5
Miscellaneous							
Clothing	44.096[a]	16.192[b]	3.732[c]	64.020[a]	19.924[b]	3.732[c]	13
Clothing and footwear	44.737[a]	17.249[b]	3.866[c]	65.852[a]	21.115[a]	3.866[b]	13
Scientific and photographic	25.381[b]	5.599	1.854	32.834[b]	7.453	1.854	11
Others							
Finished manufactures	34.001[a]	5.351	0.340	39.691[a]	5.690	0.340	9
Finished manufactures less erratic	34.296[a]	5.363	0.232	39.892[a]	5.596	0.232	13

[a], [b] and [c] indicate that the p-value is statistically significant at a 1-, 5- or 10% level, respectively. r is the number of co-integrating vectors and m is the lag length for the VAR. The critical values are those provided by Osterwald-Lenum (1992). The periods covered by the above results are similar to those shown in Table 3.1.

5.2.3 Setting Restrictions on Co-integrating Vectors

Since the co-integration has been found, it is now possible to consider certain co-integration restrictions on the co-integration vectors. To do this, the number of co-integrating vectors is set to one, i.e., r=1 and bivariate tests (restrictions) are applied on the co-integrating vectors $(1, -\varsigma)$. Of course, there is more than one co-integrating vector for some of the sets of series. The number of co-integrating vectors is set to r since it is easier to formulate the restrictions for this case. If the null hypothesis $\varsigma=1$ cannot be rejected, it means that those two series are stationary. In particular, the proportion between those two series is non-zero and remains about the same. Also, the space span is equal to the co-integration vector. If the space span among series EPs, FX rates and PPIs is certain and non-zero, when sterling appreciates, the EPs must decrease by a certain proportion. Similarly, when PPIs increase, the EPs must increase proportionally. In this study, this corresponds to the equilibrium relation as follows:

$$\vartheta_{1,i}EP_t + \vartheta_{2,i}FX_t + \vartheta_{3,i}PPI_t = 0 \tag{5.1}$$

Eq. (5.1) seeks to test whether the space spanned by the co-integrating vectors is equal to zero. Therefore, we can specify $H = 3 \times 1$ restriction columns on the space spanned by the co-integrating vectors. The null hypothesis is that the space spanned by the columns of the matrix H is contained in the space of co-integrating vectors. Thus, in this case, it is necessary to test whether there exists a co-integration vector $\vartheta = (\vartheta_{1,i}$, $\vartheta_{2,i}$ and $\vartheta_{3,i})$, such that $\vartheta_{1,i} + \vartheta_{2,i} = 0$ and $\vartheta_{3,i}=0$, so that then H= (1, -1, 0). Thus, the following hypotheses are tested: H_1 = [1, -1, 0], i.e., $\vartheta_{1,i} = -\vartheta_{2,i}$; H_2 = [0, 1, -1], i.e., $\vartheta_{2,i} = -\vartheta_{3,i}$; and H_3 = [-1, 0, 1], i.e., $\vartheta_{3,i} = -\vartheta_{1,i}$. H_1 tests whether EPs and FX rates are stationary, which in turn implies proportionality between the two series. If

H_1 cannot be rejected, which means the estimated coefficients for $\vartheta_{1,i}$ and $\vartheta_{2,i}$ are equal with opposite signs, so that $\vartheta_{1,i} + \vartheta_{2,i} = 0$ is stationary. More importantly, this result implies that the EPs are driven by the movement in FX rates. Furthermore, if there is a stable relationship between FX rates and PPIs, H_2 should be accepted. Finally, empirical support for H_3 would suggest that the long-run marginal propensity to EPs from PPIs equals 1.

Restrictions are imposed on the space spanned by the co-integrating vectors, which are tested using the likelihood ratio (LR) test (see Johansen and Juselius, 1990). However, according to the results from Table 5.2, the findings of one co-integrating vector for most systems already reject this presumption. The LR statistic rejected all three hypotheses (p-value≤ 0.10) in 23 out of 28 cases. More specifically, these results show that the H_1 is accepted in only three cases, which are Fuels, Inorganic chemicals, and Paper and paperboard export sectors. Those three cases support the null hypothesis that when sterling changes, EPs will change by a certain proportion with opposite direction. In the same way, it implies that manufacturers use PTM strategy to control certain FX rates' impact on EPs and so pass the rest of the FX rates' effect to EPs. As a result, in the long term, the movements of FX rate and EPs are about the same, since EPs follow FX rates' movement. Furthermore, H_2 is accepted in the Fuels, Organic chemicals, and Paper and paperboard sectors, while H_3 is accepted in the Fruit and vegetables, Inorganic chemicals, and Material manufactures sectors. Notably, all three hypotheses are accepted only in the Paper and paperboard sector.

However, as for those 23 industries that cannot accept any one of these hypotheses, they do not have constant relation among the FX rate, EPs and PPIs. More specifically, this means that the changes among FX rate, EPs and PPIs are not in equilibrium.

Table 5.2 Results for the Co-integration Restriction Test

	H_1	H_2	H_3
Food and live animals			
Cereals and animal feeding stuffs	19.5214[a]	18.4415[a]	14.3647[a]
Food	14.4451[a]	13.9807[a]	11.2913[a]
Fruit and vegetables	7.5771[b]	8.3807[b]	3.7866
Meat	18.4122[a]	20.4079[a]	14.0131[a]
Beverages and tobacco			
Beverages and Tobacco	40.4773[a]	30.3021[a]	35.889[a]
Basic Materials			
Metal Ores	49.2951[a]	44.8578[a]	30.5585[a]
Textile fibres	21.1182[a]	22.0164[a]	19.571[a]
Fuels			
Fuels	0.848	2.3954	9.9466[a]
Chemicals			
Chemicals	13.0682[a]	13.7257[a]	15.4978[a]
Organic chemicals	4.6448[c]	1.8591	9.154[b]
Inorganic chemicals	0.933	9.5289[a]	1.2307
Plastics	22.7965[a]	23.5799[a]	23.3599[a]
Material Manufactures			
Iron and steel	15.2974[a]	11.0725[a]	9.9515[a]
paper and paperboard	2.3895	2.4672	2.1322
Material manufactures	27.4828[a]	22.6361[a]	7.1706[b]
Mineral manufactures less precious stones	29.0721[a]	25.792[a]	36.6313[a]
Miscellaneous metal manufactures	12.5032[a]	10.2945[a]	15.485[a]
Non-ferrous metals	19.6619[a]	14.3633[a]	12.6095[a]
Textiles	18.8302[a]	11.2888[a]	25.0389[a]
Machinery and transport equipment			
Electronic machinery	28.7423[a]	30.1771[a]	22.6679[a]
Machinery and transport equipment	36.7144[a]	18.0221[a]	11.1225[a]
Machinery	27.534[a]	9.9198[a]	9.9537[a]
Road vehicles	18.6226[a]	14.5236[a]	16.3524[a]
Miscellaneous			
Clothing	40.1878[a]	38.3132[a]	30.777[a]
Clothing and footwear	40.6219[a]	39.0535[a]	30.9997[a]
Scientific and photographic	16.5249[a]	16.6559[a]	18.9272[a]
Others			
Finished manufactures	31.3718[a]	30.0972[a]	32.6851[a]
Finished manufactures less erratic	30.7202[a]	29.2783[a]	33.5142[a]

[a, b] and [c] indicate that the *p*-value is statistically significant at a 1-, 5- or 10% level, respectively. Hypothesis are: H_1=[1, -1, 0]; H_2=[0, 1, -1]; H_3=[-1, 0, 1]

For instance, the change between FX rate and EPs at time *t* could be different from their change at *t*+1. Nevertheless, the LR statistic is known to lack power (see Pesaran and Pesaran, 1997) and this might explain why the statistic is rejected so often. As such, the results from this study do not necessarily mean that series are non-stationary. Support for the stationarity hypothesis has been provided by the ADF statistics (see Chapter 3).

5.2.4 Impulse Responses

The impulse response of each set of the series is also assessed when there is a shock to the system.

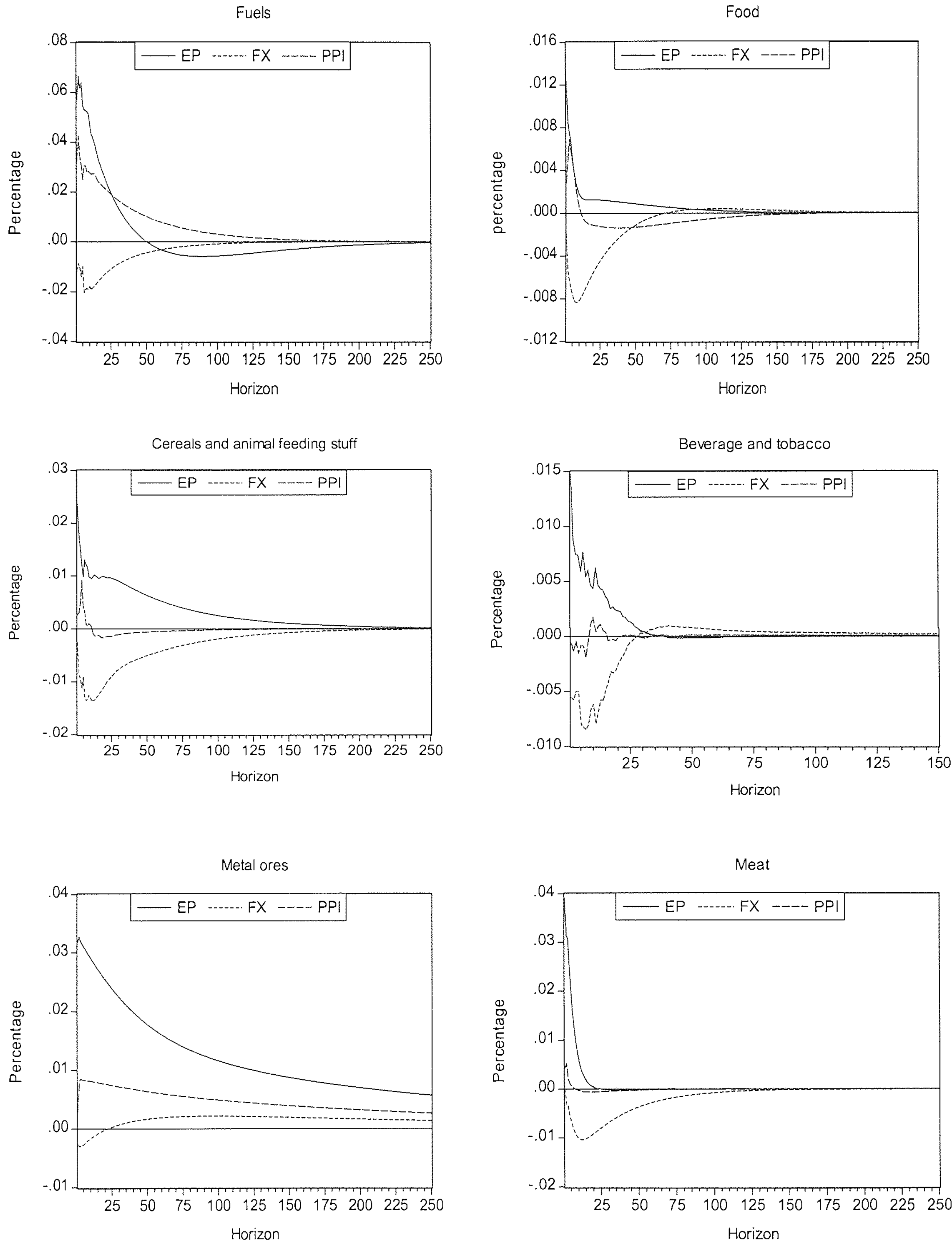
A similar analysis has been performed on the FX rate pass-through for quarterly PPIs and IPs in UK (see, McCarthy, 1999). As before, the impulse response analysis in this study includes FX rate, EPs and PPIs series, which are not combined together in earlier studies on PTM.

Theoretically, there are two ways to test impulse responses. The traditional one is orthogonalised impulse response analysis. This approach employs the Cholesky decomposition to orthogonalised the shocks, and the results depend on the order in which the variables enter the VAR system (Pesaran and Shin, 1998). Based on Koop *et al.*, (1996), Pesaran and Shin (1998) proposed generalised impulse response analysis as an alternative method. Its main advantage is that the results are not affected by the order in which the variables entering the system are shocked. For this reason, the generalised impulse response approach was adopted in this study, and in order to perform this analysis, the same lag length that was identified in the VAR for the co-integration tests, was used.

Fig. 5.1 exhibits that a one standard deviation shock to EPs has the greatest impact on the variable itself. Moreover, compared with PPIs, the effect of shock is more pronounced on FX rates. In general, once EPs are shocked, the variable itself deviates from zero dramatically and reverts to equilibrium in the end. Similarly, the FX rate is also away from zero once shocked but the extent is less severe than for EPs. However, the impact of the EPs' shock to PPIs is the smallest and the response trace goes back to equilibrium the quickest. Thus, the impact of the shock varies among the sets in the series. For example, the Cereals and animal feeding stuffs series exhibits the greatest effect once shocked. This series does not revert to equilibrium until some 225 months later. While the FX rate series in the Cereals and animal feeding stuffs export sector reverts to equilibrium after 185 months once shocked, PPIs in the Cereals and animal feeding stuffs export sector dies out after 100 months. Note that the shock to the EP series always has a strong negative effect on the variable itself. The mixed effects of a shock on FX rates can last up to 20 months, and then provide positive impacts thereafter, while the effects on PPIs are totally mixed.

Thus, in general, even the impacts of the shocks on EPs, FX rates and PPIs vary in terms of time horizons and positive/negative directions. The shock effect eventually dies out in the system. The speed of response of EPs itself is the fastest, followed by FX rates, while the speed of response of PPIs is the slowest. These results imply that FX rate is very sensitive to PTM and has a very strong relationship with the shock to EPs. The results suggest that the equilibrium relation suggested by the co-integration results is not very stable. A shock to a variable can have a substantial impact of (say) export prices in the short run even if there is some stability in the long term. Thus, there are likely to be periods when exporters do not use PTM in a systematic or consistent manner.

Figure 5.1 Responses to Generalised One S.D. Innovations



5.3 Error Correction Model

While co-integration measures long-term equilibrium relationship among variables, the ECMs help us to understand both the short-run and long-run dynamics of the sets of series. The specific econometric issues are discussed below before the results are presented.

5.3.1 Methodology

The ECM used in the study is a restricted VAR that focuses only on the variables of economic interest. As such the only interest is in the ability of FX rates and PPIs to explain EPs, with EPs being the dependent variable. Since co-integration in the series was found, it is now possible to estimate the ECM for each set of the series as shown in the Eq. (5.2) below:

$$\Delta EP_{i,t} = \alpha_0 + \delta_{0,i} ECT_{t-1} + \sum_{j=0}^{p} \beta_{j,i} \Delta FX_{t-j} + \sum_{j=0}^{p} \lambda_{j,i} \Delta PPI_{t-j} + \sum_{j=1}^{p} \nu_{j,i} \Delta EP_{t-j} + \varepsilon_{i,t} \qquad (5.2)$$

Here, the ECT_{t-1} is the error-correction term (ECT) obtained from a linear combination of the level series. That is, $ECT_{t-1} = (EP - FX - PPI)_{t-1}$. The lag is imposed in the model. If EPs, FX rates and PPIs deviate from the long-run equilibrium, the error correction term will be non-zero. The coefficient $\delta_{0,i}$ measures the speed of adjustment of the endogenous variable towards the equilibrium. Furthermore, the ECM is interesting, not just because it can model equilibrium behaviour, but also because it can capture any contemporaneous effects that may occur. Notice also that the system is fully dynamic.

As mentioned earlier, BDS tests show that the data is non-linear, so GARCH-type estimations are preferable to OLS. Therefore, EGARCH and GJR are again employed to estimate the ECMs. Since we have a dynamic model, all of the variables except the constant and ECTs are given up to 13 lags. To obtain the reduced ECMs, the insignificant coefficients of the full ECMs were sequentially eliminated as long as this action reduced the standard error of the regressions (SERs) and minimised the AIC. The results are presented below.

5.3.2 Results for the Error Correction Model

5.3.2.1 Mean Equation for ECM-EGARCH

Before reporting the coefficient estimates of the mean equation, it is useful to examine their diagnostic tests for model adequacy. The diagnostic statistics are showed in Table 5.3. A first look at the ARCH(2) statistic, which is significant in only 4 out of 28 cases, so the EGRACH successfully capture the heterosdasticity in most cases. Moreover, the Q-stat(2) shows that the residuals of the EGARCH model are serially-correlated in only 3 out of 28 cases. Nevertheless, the J-B statistics demonstrate that the residuals are not normally distributed in 25 out of 28 cases and the *t*-distribution assumption is significant in 19 out of 28 cases, so the data fit is not perfect for the EGARCH model. The SER, AIC and $\overline{R^2}$, will be discussed later with the GJR model, and be used as criteria to compare these two types of models.

Table 5.3 ECM Estimates of the EGARCH Regression Coefficients under the *t*-density

Food and live animals

Cereals and animal feeding stuffs

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-8}	ΔX_{t-10}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_{t-2}
-0.0601[a]	-0.0137[a]	-0.2471[a]	-0.1596[a]	-0.0682[b]	-0.2388[a]	-0.1046[a]	-0.1907[a]	-0.1322[a]	0.1389[a]	-0.4310[a]
(0.0081)	(0.0018)	(0.0400)	(0.0286)	(0.0320)	(0.0281)	(0.0261)	(0.0285)	(0.0295)	(0.0355)	(0.0582)
ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔE_{t-3}	ΔE_{t-5}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-11}	ΔE_{t-12}
0.6597[a]	-0.4871[a]	-0.1551[a]	0.1982[a]	-0.0884[b]	-0.1167[a]	0.1662[a]	-0.1720[a]	-0.0651[a]	-0.0670[a]	0.1913[a]
(0.0550)	(0.0470)	(0.0467)	(0.0386)	(0.0399)	(0.0191)	(0.0227)	(0.0284)	(0.0207)	(0.0199)	(0.0215)
ΔE_{t-13}										
0.1631[a]										
(0.0277)										
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3460	9.1888[a]	4.793[c]	41.3113	0.0253	-5.4512	-0.1047				
			(271.3781)							

Food

α	ECT_{t-1}	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-7}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}
-0.0437[a]	-0.0092[a]	-0.1743[a]	-0.1300[a]	0.1221[a]	-0.0926[a]	-0.2306[a]	0.0670[b]	1.6563[a]	0.6144[a]	0.8921[a]
(0.0130)	(0.0028)	(0.0306)	(0.0325)	(0.0447)	(0.0354)	(0.0291)	(0.0273)	(0.1857)	(0.1618)	(0.1715)
ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-9}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-7}	ΔE_{t-8}
0.4092[b]	-0.8420[a]	0.3945[b]	0.6123[a]	-0.8441[a]	-0.3518[a]	-0.2373[a]	-0.1459[a]	-0.1898[a]	-0.1456[a]	-0.1534[a]
(0.1700)	(0.1451)	(0.1540)	(0.1202)	(0.1062)	(0.0346)	(0.0407)	(0.0465)	(0.0321)	(0.0348)	(0.0390)
ΔE_{t-10}										
-0.1541[b]										
(0.0304)										
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1723	0.8820	16.3313[a]	10.0262	0.0124	-6.3624	0.1982				
			(7.1134)							

Fruit and vegetables

α	ECT_{t-1}	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-8}	ΔX_{t-10}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-1}
-0.1414[a]	-0.0305[a]	-0.1701[a]	-0.1633[a]	-0.3352[a]	-0.4532[a]	-0.1619[a]	-0.1913[a]	-0.1255[a]	0.2538[a]	0.3328[a]
(0.0253)	(0.0055)	(0.0401)	(0.0478)	(0.0471)	(0.0562)	(0.0314)	(0.0572)	(0.0418)	(0.0574)	(0.0475)
ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}
0.2519[b]	0.1896[c]	-0.1257[a]	-0.1587[a]	-0.1945[a]	-0.1621[a]	0.2659[a]	-0.1295[a]	-0.2899[a]	-0.2209[a]	-0.1434[a]
(0.1044)	(0.1004)	(0.0540)	(0.0547)	(0.0550)	(0.0528)	(0.0604)	(0.0419)	(0.0292)	(0.0214)	(0.0260)

Table 5.3 Cont'd

ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-6}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-12}	ΔE_{t-13}				
-0.1866[a]	-0.1372[a]	-0.1857[a]	-0.1716[a]	-0.1289[a]	0.0613[a]	0.2604[a]				
(0.0243)	(0.0193)	(0.0138)	(0.0193)	(0.0209)	(0.0167)	(0.0173)				
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.7448	5.0955[c]	6.5167[b]	35.1094	0.0361	-4.4852	-0.0720				
			(195.7593)							
Meat										
α	ECT_{t-1}	ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-11}	ΔPPi_{t-5}	ΔPPi_{t-10}	ΔE_{t-1}	ΔE_{t-5}	ΔE_{t-11}
-0.1037[a]	-0.0229[a]	-0.2307[c]	-0.4771[a]	-0.3335[a]	0.3942[a]	0.6349[a]	-0.3908[c]	-0.2416[a]	-0.1056[b]	0.1591[a]
(0.0349)	(0.0076)	(0.1308)	(0.1086)	(0.1220)	(0.1174)	(0.2392)	(0.2041)	(0.0512)	(0.0466)	(0.0490)
ΔE_{t-12}	ΔE_{t-13}									
0.3133[a]	0.1553[a]									
(0.0453)	(0.0489)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.6380	0.6351	1.7355	172.5201	0.0365	-3.8658	0.2206				
			(4332.8780)							
Beverages and tobacco										
Beverages and tobacco										
ECT_{t-1}	ΔX_t	ΔE_{t-1}	ΔE_{t-2}							
-0.0004[b]	-0.4143[a]	-0.2343[a]	-0.1278[a]							
(0.0002)	(0.0540)	(0.0716)	(0.0495)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
4.2735[b]	0.1700	75.56[a]	8.0931[c]	0.0153	-5.8020	0.1267				
			(4.1933)							
Basic materials										
Metal Ores										
ΔX_t	ΔX_{t-3}	ΔX_{t-5}	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔPPi_{t-7}	ΔE_{t-6}	ΔE_{t-10}			
-0.2377[c]	0.2239[b]	-0.3045[a]	1.5300[a]	-0.9748[b]	-1.0026[c]	0.2334[a]	0.1298[b]			
(0.1297)	(0.1038)	(0.1140)	(0.4393)	(0.4847)	(0.5672)	(0.0636)	(0.0549)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3221	0.4469	17.6728[a]	8.4745[c]	0.0313	-4.1530	0.0460				
			(5.1310)							
Textile fibres										
ΔX_t	ΔX_{t-2}	ΔX_{t-5}	ΔX_{t-8}	ΔPPi_t	ΔE_{t-1}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-11}		
-0.1832[b]	-0.1755[b]	-0.1530[b]	0.1342[c]	0.3410[a]	-0.2676[a]	-0.1466[a]	-0.1155[b]	0.1149[b]		
(0.0792)	(0.0813)	(0.0763)	(0.0767)	(0.0755)	(0.0566)	(0.0546)	(0.0480)	(0.0544)		

Table 5.3 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2897	2.4065	15.6005[a]	6.4962[c]	0.0182	-5.1941	0.2187				
			(3.7575)							

Fuels

Fuels

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-8}	ΔX_{t-10}	ΔX_{t-11}	ΔX_{t-12}
-0.2604[a]	-0.0568[a]	-0.5326[a]	0.7249[a]	-0.4335[a]	0.2769[a]	-0.3182[a]	-0.6300[a]	0.4710[a]	-0.6621[a]	-0.3805[a]
(0.0284)	(0.0063)	(0.0984)	(0.1094)	(0.1431)	(0.0993)	(0.1042)	(0.1010)	(0.0926)	(0.1328)	(0.1238)
ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-6}
1.2778[a]	-0.2487[a]	0.5770[a]	-0.2757[a]	-0.2740[a]	-0.2322[a]	-0.2204[a]	0.1833[a]	0.1967[a]	-0.0864[a]	-0.1363[a]
(0.0758)	(0.0823)	(0.0819)	(0.0693)	(0.0959)	(0.0729)	(0.0708)	(0.0344)	(0.0390)	(0.0297)	(0.0347)
ΔE_{t-7}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}							
0.2301[a]	0.1321[a]	0.1721[a]	0.0599[c]							
(0.0412)	(0.0373)	(0.0450)	(0.0334)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.8409	2.0374	5.8502[c]	220.8733	0.0477	-3.5534	0.3242				
			(9616.5150)							

Chemicals

Chemicals

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-7}	ΔX_{t-8}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-7}
0.0530[a]	0.0119[a]	-0.3673[a]	-0.1006[a]	-0.0932[a]	0.0784[b]	0.0769[a]	0.7423[a]	0.3825[a]	-0.2692[b]	0.5071[a]
(0.0197)	(0.0043)	(0.0343)	(0.0381)	(0.0262)	(0.0350)	(0.0276)	(0.1206)	(0.1402)	(0.1266)	(0.1266)
ΔPPi_{t-8}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-7}						
-0.2774[a]	-0.1725[a]	-0.1011[b]	-0.1505[a]	-0.1252[a]						
(0.1062)	(0.0492)	(0.0456)	(0.0434)	(0.0438)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
5.1783[a]	4.5997	188.3829[a]	2.0457[a]	0.0119	-6.3460	0.1524				
			(0.4312)							

Organic chemicals

ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-8}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-10}	ΔPPi_{t-11}
-0.4882[a]	-0.1851[a]	0.1389[a]	-0.1672[a]	-0.1188[a]	0.9493[a]	0.6418[a]	-0.3922[b]	0.2960[c]	-0.3089[c]	0.6082[a]
(0.0524)	(0.0612)	(0.0496)	(0.0476)	(0.0407)	(0.2149)	(0.1920)	(0.1789)	(0.1527)	(0.1792)	(0.1791)
ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-7}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}					
-0.3846[a]	-0.1335[a]	-0.0717[c]	0.0648[c]	0.0927[b]	-0.1383[a]					
(0.0385)	(0.0323)	(0.0380)	(0.0364)	(0.0408)	(0.0403)					

Table 5.3 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3221	1.2140	17.6728[a]	4.6829[b]	0.0217	-5.3463	0.2218				
(2.1268)										
Inorganic chemicals										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-5}	ΔPPi_{t-1}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔE_{t-1}
-0.0632[a]	-0.0136[a]	-0.3215[a]	-0.1226[b]	-0.0747[c]	-0.1704[a]	0.6216[a]	0.3934[c]	-0.6347[a]	0.5460[a]	-0.3381[a]
(0.0189)	(0.0041)	(0.0510)	(0.0589)	(0.0449)	(0.0511)	(0.1588)	(0.2187)	(0.2089)	(0.2071)	(0.0687)
ΔE_{t-2}	ΔE_{t-3}	DIC(-5)								
-0.1426[b]	-0.1904[a]	-0.1443[a]								
(0.0656)	(0.0549)	(0.0547)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.4424	0.9630	81.6273[a]	4.2504[a]	0.0485	-4.7936	-0.2319				
			(1.5223)							
Plastics										
α	ΔX_t	ΔX_{t-1}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-8}	ΔPPi_{t-13}	ΔE_{t-1}
-0.0017[c]	-0.1774[a]	-0.2284[a]	0.1217[a]	0.5841[b]	0.5031[c]	-0.6374[b]	0.5389[c]	-0.7721[a]	0.5597[b]	-0.2755[a]
(0.0010)	(0.0490)	(0.0535)	(0.0417)	(0.2811)	(0.2687)	(0.2636)	(0.2793)	(0.2436)	(0.2184)	(0.0578)
ΔE_{t-6}	ΔE_{t-8}	ΔE_{t-9}								
-0.0911[c]	0.1079[b]	-0.1058[b]								
(0.0508)	(0.0513)	(0.0521)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2185	2.0400	65.5545[a]	3.3425[a]	0.0141	-5.7877	0.1578				
			(1.1351)							
Material manufactures										
Iron and steel										
ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-11}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}
-0.0005[a]	-0.3238[a]	-0.1542[a]	-0.1750[a]	0.0342[a]	0.0734[a]	-0.1388[a]	0.0400[a]	0.4649[a]	0.5430[a]	-0.1723[a]
(0.0001)	(0.0247)	(0.0188)	(0.0147)	(0.0116)	(0.0175)	(0.0264)	(0.0139)	(0.0373)	(0.0373)	(0.0442)
ΔPPi_{t-3}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-13}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-8}	ΔE_{t-9}	ΔE_{t-10}
0.5417[a]	-0.6639[a]	-0.2367[a]	0.3277[a]	-0.1601[a]	-0.3372[a]	-0.1005[a]	-0.1569[a]	0.1811[a]	-0.1145[a]	0.2042[a]
(0.0463)	(0.0492)	(0.0450)	(0.0478)	(0.0330)	(0.0373)	(0.0194)	(0.0303)	(0.0248)	(0.0221)	(0.0231)
ΔE_{t-12}	ΔE_{t-13}									
0.1559[a]	0.1228[a]									
(0.0285)	(0.0243)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				

Table 5.3 Cont'd

0.0386	6.5821[b]	1.0896	12.6846	0.0141	-6.5012	0.0185				
			(16.5640)							
Paper and paperboard										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-9}	ΔX_{t-10}	ΔX_{t-12}
-0.2818[a]	-0.2003[a]	-0.0874[c]	-0.1686[a]	0.0661[b]	-0.1289[a]	-0.1346[a]	-0.1180[a]	-0.1433[a]	0.2412[a]	0.1623[a]
(0.0251)	(0.0376)	(0.0458)	(0.0377)	(0.0272)	(0.0428)	(0.0357)	(0.0270)	(0.0360)	(0.0411)	(0.0281)
ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-2}
-0.0670[b]	0.3544[a]	0.0995[b]	-0.2772[a]	0.3901[a]	0.3407[a]	0.1691[a]	-0.1475[b]	-0.2686[a]	-0.5233[a]	-0.2481[a]
(0.0333)	(0.0577)	(0.0445)	(0.0578)	(0.0422)	(0.0539)	(0.0470)	(0.0690)	(0.0567)	(0.0256)	(0.0354)
ΔE_{t-3}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-12}					
-0.1050[a]	-0.1743[a]	0.0912[a]	0.0742[b]	-0.0465[c]	0.1630[a]					
(0.0292)	(0.0222)	(0.0326)	(0.0331)	(0.0248)	(0.0240)					
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.5708	3.5640	888.8606[a]	3.9019[a]	0.0184	-5.6955	0.1646				
			(0.9867)							
Material manufactures										
ΔX_t	ΔX_{t-3}	ΔX_{t-9}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔE_{t-1}			
-0.4459[a]	0.1187[a]	0.0882[b]	0.0814[b]	1.1795[a]	0.6485[b]	-0.7490[a]	-0.2057[a]			
(0.0390)	(0.0440)	(0.0363)	(0.0412)	(0.3336)	(0.2952)	(0.2378)	(0.0524)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.8096	0.4525	90.6841[a]	7.2913[b]	0.0191	-5.7860	0.2142				
			(3.0975)							
Mineral manufactures less precious stones										
α	ECT_{t-1}	ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-7}	ΔX_{t-8}	ΔPPi_{t-1}	ΔPPi_{t-4}	ΔPPi_{t-6}
0.0276[a]	0.0063[a]	-0.3000[a]	-0.1265[a]	0.1468[a]	-0.2661[a]	0.1971[a]	0.0930[a]	-0.2043[c]	-0.3124[a]	-0.5702[a]
(0.0075)	(0.0016)	(0.0266)	(0.0286)	(0.0242)	(0.0267)	(0.0224)	(0.0269)	(0.1084)	(0.0815)	(0.0705)
ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-8}	ΔE_{t-11}		
0.5725[a]	-0.2388[a]	0.3049[a]	0.5488[a]	-0.4349[a]	-0.1783[a]	-0.0780[a]	-0.1258[a]	0.2212[a]		
(0.0638)	(0.0919)	(0.0723)	(0.0938)	(0.0286)	(0.0198)	(0.0270)	(0.0231)	(0.0267)		
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.9067	0.9284	2.7720	15.0123	0.0188	-5.8802	0.0403				
			(33.3468)							
Miscellaneous metal manufactures										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-11}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-7}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}
-0.1784[a]	-0.1500[a]	-0.1786[a]	-0.0963[c]	-0.0865[c]	0.0776[c]	0.6884[b]	0.8212[a]	-0.5468[b]	-0.3174[a]	-0.1520[a]

Table 5.3 Cont'd

(0.0493)	(0.0468)	(0.0527)	(0.0517)	(0.0468)	(0.0418)	(0.2795)	(0.2745)	(0.2638)	(0.0554)	(0.0511)
ΔE_{t-13}	ΔE_{t-7}	ΔE_{t-12}								
-0.1319[b]	-0.0828[c]	0.2205[a]								
(0.0533)	(0.0442)	(0.0431)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.2964	0.6250	107.7311[a]	3.6357[a]	0.0137	-5.9161	0.2181				
			(1.1672)							
Non-ferrous metals										
ΔX_t	ΔX_{t-5}	ΔX_{t-7}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-7}	ΔPPi_{t-9}	ΔE_{t-4}	ΔE_{t-5}
-0.3096[a]	-0.1724[a]	0.1286[b]	0.1450[a]	0.4269[a]	0.1351[c]	-0.1903[a]	0.1872[b]	-0.1412[c]	-0.0998[b]	-0.0831[b]
(0.0553)	(0.0513)	(0.0556)	(0.0513)	(0.0703)	(0.07210)	(0.0738)	(0.0739)	(0.0770)	(0.0413)	(0.0420)
ΔE_{t-8}	ΔE_{t-9}	ΔE_{t-11}								
0.0898[b]	0.1133[b]	0.0740[c]								
(0.0368)	(0.0447)	(0.0381)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0830	2.2091	1897.896[a]	2.6318[a]	0.0222	-5.2725	0.0748				
			(0.6751)							
Textiles										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-8}
0.0070[a]	0.0016[a]	-0.0730[a]	-0.0129[a]	-0.0107[a]	0.0271[a]	0.0196[a]	-0.0245[a]	-0.0191[a]	0.0191[a]	0.0277[a]
(0.0011)	(0.0002)	(0.0043)	(0.0037)	(0.0038)	(0.0046)	(0.0023)	(0.0036)	(0.0044)	(0.0036)	(0.0025)
ΔX_{t-9}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-10}
0.0242[a]	0.0261[a]	0.1092[a]	0.1108[a]	0.0166[b]	-0.1084[a]	-0.0468[a]	-0.0808[a]	-0.0707[a]	-0.0556[a]	0.0464[a]
(0.0022)	(0.0027)	(0.0084)	(0.0097)	(0.0066)	(0.0065)	(0.0072)	(0.0109)	(0.0098)	(0.0114)	(0.0087)
ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-12}	ΔE_{t-13}
-0.0350[a]	-0.3091[a]	-0.0901[a]	0.1779[a]	0.2562[a]	-0.2175[a]	0.1692[a]	0.1404[a]	0.0803[a]	0.1528[a]	0.1370[a]
(0.0080)	(0.0193)	(0.0206)	(0.0184)	(0.0204)	(0.0236)	(0.0183)	(0.0166)	(0.0231)	(0.0225)	(0.0177)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.8259	0.7065	16.0582[a]	16.1935	0.0027	-10.0603	-0.3003				
			(17.5408)							
Machinery and transport equipment										
Electronic machinery										
ΔX_t	ΔX_{t-2}	ΔX_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-3}	ΔE_{t-13}		
-0.2276[a]	-0.1022[c]	-0.1514[a]	-0.4367[b]	-0.5261[b]	0.4803[b]	0.4551[b]	-0.1273[b]	0.2059[a]		
(0.0604)	(0.0554)	(0.0531)	(0.1814)	(0.2165)	(0.2016)	(0.2091)	(0.0553)	(0.0539)		

Table 5.3 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2954	1.0427	130.5416[a]	2.9986[a]	0.0171	-5.4673	0.0669				
			(0.8309)							
Machinery and transport equipment										
ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-8}	ΔPPi_{t-10}	ΔE_{t-6}	ΔE_{t-13}		
0.0004[c]	-0.1515[a]	-0.0990[b]	0.1069[b]	0.7193[a]	-0.5929[a]	0.5367[a]	0.1030[c]	0.1233[b]		
(0.0002)	(0.0409)	(0.0448)	(0.0443)	(0.1588)	(0.1680)	(0.1640)	(0.0533)	(0.0558)		
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2089	1.7701	36.0923[a]	4.1119[a]	0.0111	-6.2500	0.1361				
			(1.5773)							
Machinery										
ΔX_t	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔPPi_t	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-11}	ΔE_{t-2}	ΔE_{t-11}	ΔE_{t-13}
-0.2132[a]	-0.1150[a]	-0.0923[c]	0.1134[b]	0.4907[b]	-0.3412[c]	-0.4733[b]	0.4882[a]	-0.1376[a]	0.0988[b]	0.2271[a]
(0.0445)	(0.0431)	(0.0513)	(0.0462)	(0.2180)	(0.1904)	(0.1863)	(0.1749)	(0.0439)	(0.0441)	(0.0485)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
2.5258[c]	0.1956	162.5542[a]	2.6750[a]	0.0135	-5.9781	0.0739				
			(0.6761)							
Road vehicles										
ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-8}	ΔX_{t-9}	ΔX_{t-10}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-3}
-0.1698[a]	-0.1281[a]	0.0660[c]	0.0723[b]	-0.0655[b]	-0.0988[a]	0.0508[c]	-0.0961[a]	0.1022[a]	0.7165[a]	-0.1451[c]
(0.0343)	(0.0290)	(0.0352)	(0.0310)	(0.0297)	(0.0325)	(0.0300)	(0.0298)	(0.0292)	(0.0959)	(0.0839)
ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-7}
-0.2887[a]	0.1591[c]	0.3179[a]	-0.2333[a]	0.3893[a]	-0.4650[a]	0.4599[a]	-0.3282[a]	-0.0513[c]	-0.0481[b]	-0.2227[a]
(0.0906)	(0.0825)	(0.0800)	(0.0864)	(0.0833)	(0.0813)	(0.0757)	(0.0698)	(0.0273)	(0.0244)	(0.0233)
ΔE_{t-8}	ΔE_{t-9}	ΔE_{t-12}								
-0.1795[a]	0.0821[b]	0.2370[a]								
(0.0301)	(0.0324)	(0.0250)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3673	1.3218	76.1168[a]	6.5726[b]	0.0144	-6.0712	0.1538				
			(3.1571)							
Miscellaneous										
Clothing										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-11}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-7}	ΔPPi_{t-9}	ΔPPi_{t-12}	ΔE_{t-3}
-0.3501[a]	-0.0952[b]	-0.1035[b]	0.1372	-0.0671[c]	0.1045[a]	0.3041[c]	0.4246[a]	-0.3246[c]	0.3610[b]	-0.1658[a]
(0.0458)	(0.0440)	(0.0437)	(0.0450)	(0.0376)	(0.0389)	(0.1839)	(0.1533)	(0.1838)	(0.1656)	(0.0400)

Table 5.3 Cont'd

ΔE_{t-4}	ΔE_{t-7}	ΔE_{t-12}								
0.0864[b]	-0.1126[a]	0.2917[a]								
(0.0420)	(0.0405)	(0.0376)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
3.9463[b]	3.3814	558.7919[a]	2.6420[a]	0.0161	-5.8981	0.1375				
			(0.6192)							
Clothing and footwear										
α	ECT_{t-1}	ΔX_t	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-10}	ΔX_{t-11}	ΔPPi_{t-2}	ΔPPi_{t-7}
-0.0365[b]	-0.0079[c]	-0.3358[a]	-0.1511[a]	0.1172[a]	-0.1171[a]	0.1090[a]	-0.0811[b]	0.0908[b]	0.3503[b]	0.4858[a]
(0.0185)	(0.0041)	(0.0399)	(0.0338)	(0.0418)	(0.0365)	(0.0371)	(0.0397)	(0.0366)	(0.1682)	(0.1403)
ΔPPi_{t-8}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-12}
-0.3656[b]	0.4458[a]	0.3824[b]	-0.1107[a]	0.1050[b]	-0.1467[a]	0.1235[a]	0.0808[c]	-0.1295[a]	0.1982[a]	0.2063[a]
(0.1750)	(0.1602)	(0.1740)	(0.0367)	(0.0421)	(0.0415)	(0.0370)	(0.0426)	(0.0354)	(0.0394)	(0.0390)
ΔE_{t-13}										
0.0954[a]										
(0.0367)										
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.6151	3.8735	960.8884[a]	2.2198[a]	0.0150	-6.0169	0.1811				
			(0.4409)							
Scientific and photographic										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-8}	ΔX_{t-12}	ΔX_{t-13}
-0.2359[a]	-0.0604[b]	0.0750[a]	-0.0774[a]	-0.1053[a]	-0.1380[a]	-0.1061[a]	0.1077[a]	0.1265[a]	0.0911[a]	0.1349[a]
(0.0132	(0.0243)	(0.0256)	(0.0145)	(0.0288)	(0.0247)	(0.0233)	(0.0159)	(0.0143)	(0.0160)	(0.0187)
ΔPPi_{t-1}	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-5}
-0.0303[a]	0.0896[a]	0.0730[a]	0.1352[a]	0.0430[a]	0.0329[c]	0.0634[a]	0.0784[a]	-0.2170[a]	-0.1486[a]	-0.0799[b]
(0.0086)	(0.0141)	(0.0093)	(0.0161)	(0.0164)	(0.0175)	(0.0167)	(0.0136)	(0.0286)	(0.0316)	(0.0337)
ΔE_{t-6}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-13}						
-0.1389[a]	0.0615[a]	0.2384[a]	0.1551[a]	0.2698[a]						
(0.0389)	(0.0169)	(0.0336)	(0.0325)	(0.0291)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0059	1.2795	322.7504[a]	4.9522[b]	0.0108	-6.7977	-0.0140				
			(2.0590)							
Others										
Finished manufactures										
ΔX_t	ΔX_{t-2}	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-6}	ΔPPi_{t-8}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-13}		

Table 5.3 Cont'd

-0.2209[a]	-0.1312[a]	0.0847[b]	0.7070[a]	0.5796[b]	-0.8370[a]	-0.1097[a]	0.1545[a]	0.0891[c]
(0.0415)	(0.0383)	(0.0346)	(0.2001)	(0.2391)	(0.2158)	(0.0386)	(0.0484)	(0.0502)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$		
0.365	1.5386	162.9066[a]	4.2152[a]	0.0110	-6.4314	0.1438		
			(1.3934)					

Finished manufactures less erratic

ΔX_t	ΔPPi_t	ΔE_{t-2}	ΔE_{t-8}			
-0.1655[a]	0.7327[a]	-0.1499[a]	0.1237[a]			
(0.0389)	(0.1414)	(0.0488)	(0.0509)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.1960	0.5821	16.402[a]	19.7917	0.0117	-6.2695	0.0235
			(28.9773)			

Notes: Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p*-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. ARCH (2) is the modified LM statistic for autoregressive conditional heteroscedasticity in residuals at 2 lags. Q-stat(2) is the Ljung-Box Q-statistic for autocorrelation residuals at 2 lags. J-B is the Jarque-Bera test of the normality of the regression residuals. *t*-dist is the *t*-distribution. SER is the standard error of regression. AIC is the Akaike Information Criterion. $\overline{R^2}$ is the adjusted R squared.

The table also shows the results for the EGARCH mean equation estimation. All the sets of export sectors are modelled using an ECM even if only 27 of them are in fact co-integrated based on the Johansen (1988) tests. Moreover, error-correction modelling provides an alternative approach to testing for long-run equilibrium relations. However, I also examine whether the Chemical sector that was not co-integrated also exhibits a valid error-correction representation. For now, however, the focus is on the estimates for the mean equation, and the results for the conditional variance are discussed in a separate section.

The results indicate that 13 out of the 28 export sectors, exhibit significant ECTs. The signs of the coefficients also vary, which is unexpected. Theoretically, the coefficients for the ECT should be negative. More specifically, nine cases have negative signs which are consistent with prediction, while four cases have positive signs[46].The signs of the ECTs depend on the changes in the other variables of the system. This is because the ECTs imply that EPs, FX rates and PPIs have an equilibrium relationship. When EPs are too high/low and disturb the equilibrium, the ECTs is expected to be negative/positive, so as to reduce/increase the EPs and help the system return to equilibrium. However, the decrease/increase in EPs (or re-equilibration) is not immediate, occurring over time periods at a rate dictated by the coefficient of ECT_{t-1}. Thus, the larger the absolute value of the industries' ECT coefficients, the quicker the EP returns to its equilibrium. To illustrate this, consider the ECT values for Beverage and tobacco, and Fuels, which are -0.0004 and -0.0568 respectively. This implies that the VAR system in Fuels goes back to the equilibrium faster than that in Beverage and tobacco. So, Fuels EPs are relatively sensitive and respond to the FX rate and PPIs relatively quicker.

[46] Many studies find negative ECTs. However, in the model in this study, FX rate and PPIs affect EPs negatively and positively, so the net effect could be negative or positive. Banik and Biswas (2005) and Lutkepohl and Wolters (1998) also found positive ECTs in their empirical results.

It is worth noting that the Chemicals sector exhibits significant ECTs although the null hypothesis of the co-integration tests cannot be rejected for this sector. Moreover, Kremers *et al.*, (1992, p. 337) argue that ECM is a special case of Johansen's co-integration

> "... in which the co-integrating vectors appear in only the equation of interest".

Thus, the ECM considers only one dependant variable and imposes equilibrium conditions as depicted in theoretical terms. This means that it may not necessarily find a significant error-correction term for all the specified ECMs even if Johansen indicates that the sets of variables are co-integrated. This also means that a valid ECM can be found when indeed the Johansen co-integration test suggested that the sets of series are not co-integrated (see Joseph and Solomon, 1997). Furthermore, the ECM can break-down even if there is evidence of co-integration. Thus, even if the series are not co-integrated suggesting that a long-run relation does not exist, it is also necessary to consider the short-run conditions imposed by the lag explanatory variables.

Furthermore, there is strong evidence to show that the impact of the FX rate, PPIs and EPs on the EPs are not contemporaneous. Those coefficients are significant for up to lag 13, even when they have different signs and the lags are intermittent. Moreover, compared with the PPIs and EPs, the FX rate exhibits more and larger lag effect on the EPs.

5.3.2.2 Mean Equation for ECM-GJR

Table 5.4 shows the results for the mean equation and diagnostic tests. First of all, the diagnostic statistics reveal that GJR estimations are to be considered more preferable than those obtained by using the EGARCH model.

Table 5.4 ECM Estimates of the GJR Regression Coefficients under the *t*-density

Food and live animals

Cereals and animal feeding stuffs

ΔX_t	ΔX_{t-1}	ΔX_{t-6}	ΔPPi_{t-1}	ΔE_{t-1}	ΔE_{t-12}	ΔE_{t-13}
-0.2050[a]	-0.1872[b]	-0.1989[a]	0.2115[b]	-0.2149[a]	0.1455[a]	0.1126[b]
(0.0697)	(0.0782)	(0.0759)	(0.0845)	(0.0580)	(0.0519)	(0.0554)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.0383	0.6019	2.1748	9.2373	0.0261	-5.2844	0.1122
			(7.3161)			

Food

ECT_{t-1}	ΔX_t	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔE_{t-1}
0.0002	-0.2029[a]	1.2889[a]	0.5658[c]	-0.7818[b]	0.5923[c]	-0.2492[a]
(0.0002)	(0.0615)	(0.2955)	(0.3051)	(0.3399)	(0.3127)	(0.0808)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
1.4892	2.1730	1.7331	19.9688	0.0125	-6.1735	0.2021
			(40.8772)			

Fruit and vegetables

α	ECT_{t-1}	ΔX_{t-6}	ΔX_{t-8}	ΔX_{t-10}	ΔPPi_{t-9}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-10}	ΔE_{t-13}
-0.1727[a]	-0.0376[a]	-0.3870[a]	-0.2859[a]	-0.1663[c]	-0.2406[b]	-0.1685[a]	-0.1166[b]	-0.1109[c]	0.1878[a]
(0.0528)	(0.0114)	(0.0872)	(0.1087)	(0.0958)	(0.1174)	(0.0620)	(0.0584)	(0.0575)	(0.0588)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$			
0.1202	0.5479	24.0133[a]	9.2793	0.0329	-4.3612	0.1084			
			(5.8236)						

Meat

ΔX_{t-6}	ΔX_{t-7}	ΔPPi_t	ΔPPi_{t-5}	ΔPPi_{t-10}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-5}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}
-0.6242[a]	-0.4762[a]	0.5979[b]	0.5453[c]	-0.6427[b]	-0.3355[a]	-0.0919[c]	-0.2366[a]	-0.2225[a]	-0.1582[a]	-0.1325[b]
(0.1349)	(0.1188)	(0.3032)	(0.2970)	(0.2722)	(0.0622)	(0.0553)	(0.0500)	(0.0684)	(0.0595)	(0.0537)
ΔE_{t-12}										
0.2031[a]										
(0.0651)										
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.9465	0.3884	0.5549	20.1392	0.0370	-3.7939	0.2034				
			(36.4273)							

Beverages and tobacco

Beverages and tobacco

ECT_{t-1}	ΔX_t	ΔX_{t-2}	ΔPPi_{t-11}	ΔE_{t-1}	ΔE_{t-9}	ΔE_{t-13}

Table 5.4 Cont'd

-0.0004[a]	-0.4804[a]	0.1485[a]	0.0856	-0.1526[b]	-0.0716[c]	0.0924[b]			
(0.0001)	(0.0398)	(0.0384)	(0.0676)	(0.0664)	(0.0414)	(0.0366)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$			
0.2963	0.1471	128.4647[a]	2.9530[a] (1.0616)	0.0152	-6.1726	0.0903			
Basic materials									
Metal ores									
α	ECT_{t-1}	ΔX_{t-5}	ΔE_{t-6}						
-0.0807[b]	-0.0183[b]	-0.2293[b]	0.1940[a]						
(0.0384)	(0.0086)	(0.1005)	(0.0672)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$			
0.1294	0.5299	1.9107	19.3123 (22.4036)	0.0314	-4.1599	0.0283			
Textile fibres									
ΔX_t	ΔX_{t-2}	ΔPPi_t	ΔE_{t-1}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-11}			
-0.1917[b]	-0.2294[b]	0.3409[a]	-0.3093[a]	-0.1669[b]	-0.1268[b]	0.1347[b]			
(0.0902)	(0.0979)	(0.0913)	(0.0477)	(0.0674)	(0.0598)	(0.0631)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$			
1.1942	2.7193	4.4322	19.9979 (29.1997)	0.0183	-5.1385	0.2074			
Fuels									
Fuels									
α	ECT_{t-1}	ΔX_{t-10}	ΔX_{t-11}	ΔPPi_t	ΔPPi_{t-5}	ΔE_{t-10}			
-0.1924[a]	-0.0419[a]	0.4187[c]	-0.4726[b]	1.4206[a]	0.3414[b]	0.1811[a]			
(0.0557)	(0.0123)	(0.2402)	(0.1909)	(0.1429)	(0.1409)	(0.0453)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$			
0.3006	0.4969	7.5174[b]	16.4821 (18.0137)	0.0451	-3.3856	0.3925			
Chemicals									
Chemicals									
ECT_{t-1}	ΔX_t	ΔPPi_t	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-7}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-7}
0.0002[b]	-0.4467[a]	0.4532[a]	0.3998[a]	-0.2177[b]	0.3197[a]	-0.0827[c]	-0.0778[c]	-0.0878[c]	-0.1016[b]
(0.0001)	(0.0291)	(0.0980)	(0.1206)	(0.1094)	(0.0947)	(0.0436)	(0.0437)	(0.0437)	(0.0396)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$			
0.0929	0.2586	13.3171[a]	5.0954[c] (2.6540)	0.0123	-6.5330	0.0756			

Table 5.4 Cont'd

Organic chemicals										
ECT_{t-1}	ΔX_t	ΔX_{t-2}	ΔX_{t-6}	ΔX_{t-8}	ΔX_{t-10}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-3}	ΔPPi_{t-5}
0.0005[a]	-0.6526[a]	0.1506[a]	-0.1059[a]	-0.0669[c]	-0.1085[a]	-0.0564[b]	0.2213[a]	0.6667[a]	0.3252[a]	0.4018[a]
(0.0001)	(0.0282)	(0.0354)	(0.0287)	(0.0342)	(0.0259)	(0.0265)	(0.0319)	(0.0691)	(0.1127)	(0.1150)
ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-11}	ΔE_{t-1}	ΔE_{t-5}	ΔE_{t-8}	ΔE_{t-9}	ΔE_{t-11}	
-0.6424[a]	0.3902[a]	0.9566[a]	-0.3812[a]	0.4344[a]	-0.0921[b]	-0.0562[c]	-0.1229[a]	-0.0525[a]	-0.1780[a]	
(0.1445)	(0.1323)	(0.1367)	(0.1199)	(0.1204)	(0.0364)	(0.0332)	(0.0445)	(0.0201)	(0.0258)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.5149	0.7831	0.0979	25.2974	0.0256	-5.4599	-0.0807				
			(64.3655)							
Inorganic chemicals										
ECT_{t-1}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔE_{t-1}							
0.0004	-1.9210[c]	1.7930	-0.2244[c]							
(0.0015)	(1.0412)	(1.1128)	(0.1319)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
3.7695[b]	5.9302[c]	1313.112[a]	19.8905	0.0430	-3.6992	0.0353				
			(19.7866)							
Plastics										
ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-13}	ΔPPi_{t-1}	ΔPPi_{t-8}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-8}	ΔE_{t-9}	
0.0002	-0.1183[a]	-0.2394[a]	0.0771	0.7284[a]	-0.5889[b]	0.5994[b]	-0.2726[a]	0.1303[b]	-0.1038[c]	
(0.0003)	(0.0429)	(0.0556)	(0.0481)	(0.2519)	(0.2625)	(0.2403)	(0.0615)	(0.0536)	(0.0537)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0010	0.8831	40.6771[a]	18.9420	0.0141	-5.7356	0.1595				
			(13.8535)							
Material manufactures										
Iron and steel										
α	ECT_{t-1}	ΔX_t	ΔX_{t-5}	ΔX_{t-11}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-6}	ΔE_{t-12}		
-0.0576[a]	-0.0129[a]	-0.2026[a]	-0.1381[a]	-0.0981[b]	0.4482[a]	0.4111[a]	-0.3405[a]	0.1478[a]		
(0.0116)	(0.0025)	(0.0464)	(0.0513)	(0.0463)	(0.0954)	(0.0850)	(0.0977)	(0.0542)		
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.5663	0.2147	0.2230	20.0119	0.0134	-5.9437	0.1643				
			(52.2840)							
Paper and paperboard										
ΔX_t	ΔX_{t-1}	ΔPPi_{t-5}	ΔE_{t-1}							
-0.5687[a]	-0.2083[a]	0.2606[a]	-0.3016[a]							

Table 5.4 Cont'd

(0.0455)	(0.0610)	(0.0869)	(0.0629)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.8269	0.5239	0.8698	19.1450	0.0187	-5.8504	0.1238				
			(41.8242)							
Material manufactures										
ECT_{t-1}	ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-10}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔPPi_{t-5}
0.0008[a]	-0.3029[a]	0.0835[a]	0.1118[a]	-0.1361[a]	-0.0396[c]	0.1758[a]	1.2527[a]	0.8358[a]	-1.4459[a]	1.8036[a]
(0.0001)	(0.0148)	(0.0268)	(0.0236)	(0.0333)	(0.0233)	(0.0170)	(0.2106)	(0.2678)	(0.1572)	(0.2848)
ΔPPi_{t-6}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔE_{t-1}	ΔE_{t-6}	ΔE_{t-8}	ΔE_{t-12}			
0.5029[a]	-0.7689[a]	0.6045[a]	-0.5209[a]	-0.3222[a]	-0.1531[a]	-0.1415[a]	-0.1851[a]			
(0.1615)	(0.1399)	(0.1674)	(0.1470)	(0.0472)	(0.0545)	(0.0442)	(0.0282)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3945	3.9990	6.0243[b]	8.3152	0.0207	-5.8226	0.0771				
			(6.6187)							
Mineral manufactures less precious stones										
ΔX_t	ΔX_{t-4}	ΔX_{t-8}	ΔPPi_{t-6}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-12}			
-0.3531[a]	-0.1267[a]	0.0868[b]	-0.4494[a]	0.3672[a]	0.2898[b]	-0.1605[a]	0.1160[b]			
(0.0354)	(0.0431)	(0.0387)	(0.1338)	(0.1113)	(0.1142)	(0.0441)	(0.0563)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.3021	1.2116	26.2513[a]	19.9603	0.0187	-6.0376	0.0529				
			(29.0285)							
Miscellaneous metal manufactures										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔPPi_t	ΔPPi_{t-7}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-12}
-0.2555[a]	-0.1733[a]	-0.1493[a]	1.1807[a]	0.6126[c]	0.6969[b]	-0.6535[b]	-0.4263[a]	-0.1301[c]	-0.1348[b]	0.0977[c]
(0.0440)	(0.0482)	(0.0488)	(0.2995)	(0.3197)	(0.3260)	(0.3313)	(0.0642)	(0.0679)	(0.0646)	(0.0511)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1040	0.2022	11.4239[a]	12.2180	0.0142	-6.0234	0.1556				
			(9.2447)							
Non-ferrous metals										
ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-9}	ΔX_{t-10}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-5}
-0.4458[a]	0.1192[b]	0.1828[a]	-0.1736[a]	-0.1369[b]	0.1310[b]	0.1011[c]	-0.0983[c]	0.1509[a]	0.2106[a]	-0.1280[c]
(0.0538)	(0.0484)	(0.0544)	(0.0599)	(0.0620)	(0.0551)	(0.0587)	(0.0572)	(0.0581)	(0.0703)	(0.0669)
ΔPPi_{t-7}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-13}					
0.1871[a]	-0.1975[a]	0.1158[b]	-0.1414	0.1276[a]	-0.0861[a]					
(0.0663)	(0.0623)	(0.0555)	(0.0503)	(0.0457)	(0.0378)					

Table 5.4 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0356	0.9784	95.5257^{a}	4.2531^{a}	0.0231	-5.4112	-0.0028				
			(1.1681)							
Textiles										
α	ΔX_t	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-7}	ΔX_{t-10}	ΔPPi_t	ΔPPi_{t-10}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-6}
-0.0002^{b}	-0.0795^{a}	0.0221^{b}	-0.0231^{a}	0.0241^{a}	-0.0148^{c}	0.0288^{c}	-0.0479^{a}	-0.1136^{b}	0.2022^{a}	-0.1230^{a}
(0.0001)	(0.0077)	(0.0108)	(0.0083)	(0.0083)	(0.0082)	(0.0161)	(0.0169)	(0.0540)	(0.0667)	(0.0474)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2275	0.0332	2.8304	8.8238	0.0025	-9.7768	-0.0656				
			(9.7108)							
Machinery and transport equipment										
Electronic machinery										
ECT_{t-1}	ΔX_t	ΔPPi_{t-11}	ΔE_{t-3}	ΔE_{t-13}						
0.0007^{b}	-0.1793^{b}	0.4342^{c}	-0.1652^{b}	0.1649^{b}						
(0.0003)	(0.0780)	(0.2535)	(0.0726)	(0.0706)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2753	1.6228	76.5109^{a}	19.0737	0.0172	-5.3384	0.0481				
			(14.5302)							
Machinery and transport equipment										
ΔX_t	ΔX_{t-2}	ΔX_{t-5}	ΔX_{t-10}	ΔPPi_t	ΔPPi_{t-8}	ΔPPi_{t-10}	ΔPPi_{t-13}	ΔE_{t-5}	ΔE_{t-13}	
-0.1476^{a}	-0.0985^{b}	-0.1098^{b}	-0.0888^{c}	0.9010^{a}	-0.5859^{a}	0.5246^{b}	-0.3925^{b}	-0.1126^{c}	0.1617^{b}	
(0.0522)	(0.0482)	(0.0501)	(0.0500)	(0.1615)	(0.2256)	(0.2401)	(0.1985)	(0.0668)	(0.0756)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0133	1.0947	8.0191^{b}	19.9994	0.0109	-6.1720	0.1683				
			(35.0067)							
Machinery										
ΔX_t	ΔX_{t-5}	ΔPPi_t	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-11}	ΔE_{t-2}	ΔE_{t-13}			
-0.2033^{a}	-0.1189^{a}	0.5005^{b}	-0.3926^{b}	-0.4994^{b}	0.4821^{b}	-0.1493^{a}	0.1997^{a}			
(0.0417)	(0.0411)	(0.2243)	(0.1869)	(0.1951)	(0.1926)	(0.0518)	(0.0521)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1948	0.7943	1135.859^{a}	2.8416^{a}	0.0137	-5.9922	0.0486				
			(0.6433)							
Road vehicles										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-9}	ΔE_{t-1}	ΔE_{t-6}
-0.1131^{b}	-0.1209^{b}	-0.1292^{b}	-0.1407^{a}	0.1359^{a}	0.7816^{a}	0.3704^{b}	-0.3412^{b}	-0.2670^{c}	-0.0447^{c}	0.1215^{b}

Table 5.4 Cont'd

(0.0559)	(0.0530)	(0.0559)	(0.0539)	(0.0478)	(0.1068)	(0.1476)	(0.1585)	(0.1411)	(0.0230)	(0.0527)
ΔE_{t-7}	ΔE_{t-12}									
-0.2070[a]	0.1825[a]									
(0.0574)	(0.0613)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0271	0.1836	1069.452[a]	18.8777[a]	0.0133	-6.0059	0.2779				
			(6.4205)							
Miscellaneous										
Clothing										
ΔX_t	ΔX_{t-2}	ΔX_{t-4}	ΔPPi_{t-3}	ΔE_{t-3}	ΔE_{t-12}					
-0.3570[a]	-0.0832[b]	0.0711[c]	-0.3238[b]	-0.1346[b]	0.1871[a]					
(0.0398)	(0.0379)	(0.0379)	(0.1644)	(0.0525)	(0.0533)					
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2827	0.4855	11.011[a]	9.5869	0.0162	-6.1654	0.1293				
			(6.3107)							
Clothing and footwear										
ΔX_t	ΔX_{t-2}	ΔX_{t-6}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-11}	ΔE_{t-12}	ΔPPi_{t-12}			
-0.3553[a]	-0.1206[a]	0.0804[b]	-0.0888	-0.1212[b]	0.1034[b]	0.1692[a]	0.3101[b]			
(0.0376)	(0.0430)	(0.0318)	(0.0593)	(0.0546)	(0.0498)	(0.0549)	(0.1564)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1075	1.2716	2.8190	7.0666	0.0150	-6.2847	0.1731				
			(6.3266)							
Scientific and photographic										
ΔX_t	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-7}	ΔE_{t-3}	ΔPPi_{t-6}	ΔPPi_{t-8}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔPPi_{t-13}
-0.3305[a]	-0.0713	-0.1044[b]	0.1174[a]	0.0569[a]	0.0451[c]	0.0842[a]	0.0443[c]	0.0621[b]	0.0568[b]	0.0682[c]
(0.0360)	(0.0479)	(0.0408)	(0.0425)	(0.0220)	(0.0237)	(0.0230)	(0.0239)	(0.0298)	(0.0222)	(0.0353)
ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-10}	ΔE_{t-13}						
-0.1738[a]	-0.1130[c]	-0.1549[b]	0.0734	0.0799						
(0.0655)	(0.0666)	(0.0766)	(0.0581)	(0.0542)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3085	1.2147	74.891[a]	4.2475[b]	0.0109	-6.6368	-0.0442				
			(1.7834)							
Others										
Finished manufactures										
ECT_{t-1}	ΔX_t	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-8}	ΔPPi_{t-10}	ΔE_{t-6}	ΔE_{t-12}			

Table 5.4 Cont'd

0.0002	-0.1515[a]	0.1147[b]	0.9749[a]	-1.0007[a]	0.6771[b]	0.1438[a]	0.1088[b]
(0.0002)	(0.0393)	(0.0496)	(0.2240)	(0.2051)	(0.2631)	(0.0505)	(0.0510)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$	
0.0144	0.4331	32.3145[a]	19.9864	0.0110	-6.2737	0.1404	
			(16.2903)				

Finished manufactures less erratic

ΔX_t	ΔX_{t-5}	ΔPPi_t	ΔPPi_{t-8}			
-0.1513[a]	-0.0949[b]	1.1806[a]	-0.5173[b]			
(0.0389)	(0.0385)	(0.2232)	(0.2163)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.7889	1.6534	20.9235[a]	19.9237	0.0114	-6.2802	0.0745
			(24.9167)			

Standard errors are in parenthesis. [a], [b] and [c] indicate that the p-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. ARCH (2) is the modified LM statistic for autoregressive conditional heteroscedasticity in residuals at 2 lags. Q-stat(2) is the Ljung-Box Q-statistic for autocorrelation residuals at 2 lags. J-B is the Jarque-Bera test of the normality of the regression residuals. *t*-dist is the *t*-distribution. SER is the standard error of regression. AIC is the Akaike Information Criterion. $\overline{R^2}$ is the adjusted R squared.

More specifically, except in the case of Inorganic chemicals, the GJR estimations capture the ARCH effect in all the cases. Also, the Q-stat (2) indicates that there is no serial correlation in the residuals except in the case of Inorganic chemicals. Furthermore, the J-B normality test is significant in 18 cases under GJR while in 25 cases under the EGACH. Moreover, GJR models are *t*-distributed in 22 cases whereas EGARCH estimations have only 9 cases that follow *t*-distribution. Additionally, $\overline{R^2}$ values are much higher in all the GJR estimations, while SER and AIC are smaller in some GJR estimations than in those obtained by EGARCH.

The results for the mean equation are generally similar to those of the EGARCH estimation. As before, 13 out of 28 export sectors exhibit significant ECTs, although their signs and magnitudes vary among the different sectors. The speed of the adjustment to equilibrium might reflect the degree of international competitiveness for industries. To illustrate, the ECT is smaller in the more competitive export sectors. This can be explained as follows. Metal ores are basic materials with extensive usage that can be related to many other industries or people. Alternatively, Fuels is a kind of petroleum product, and can be substituted in many cases by coal, and/or gas. Hence, Metal ores' price elasticity of demand is more limited, and has higher competitiveness. In this case, the exporters (for Metal ores) are less concerned about the market share, and therefore PTM is not necessary to them. This leads to a lower speed of the equilibrium adjustment, causing a small value for the coefficient of ECT_{t-1} in absolute terms. In fact, the ECT for Metal ores is -0.0183 while Fuels' ECT is -0.0419. Notably, similar to the EGARCH, the significant ECT for Chemicals in GJR confirms that the co-integration tests give different results from ECM.

Again, the results show that the FX rate, PPIs and EPs have significant lag impacts on the EPs. Those coefficients are significant for up to 13 lags although the lags are intermittent. Notice also that the coefficients carry different signs. There is clear evidence that lags greater than one for the

FX rate are significant. This result suggests that lags beyond those that are specified for the PTM in Chapter 4 are required. Thus, more than just the contemporaneous FX rate, PPIs and EPs changes are required to explain the behaviour of EPs changes.

Thus, the explanatory variables have two effects on EPs. One effect occurs immediately in terms of the contemporaneous FX rate and PPIs change. In the short run, exporters react immediately to contemporaneous changes in FX rates and PPIs. However, the immediate adjustment might not be complete such that there is a delayed response that follows several periods later. Then there is long-run adjustment via the ECT which holds only for a significant minority of export sectors. Where the ECT is not significant, the equilibrium relation seems to break –down, destroying the long-run effect. It needs to be emphasised that a finding of co-integration does not necessarily imply the existence of a valid and significant ECTs in the ECM. Recall, that the ECM is a partial model of *co-integration* based only in terms of the variable of interest. Thus, the absence of a valid ECT in the ECM does not necessarily invalidate the co-integration results since the ECM is necessarily one-sided.

5.3.2.3 Variance Equation for ECM

The results for the variance equation for both the EGARCH and GJR estimates are also consider, and the results are shown in Table 5.5, which demonstrates a number of interesting features. Under the EGARCH model, the mean, ω is typically negative and significant in 93% of cases. However, ω is typically zero and significant in less than half the cases under the GJR model. For both models, the current news component κ is significant in about 50% of the cases. κ captures the effects of last period's shock in half of the cases.

Table 5.5 ECM Estimates of the EGARCH and GJR Variance Equation

	Panel A						Panel B				
	ω	κ	φ	θ	$D_{t,1987}*$		ω	κ	φ	θ	$D_{t,1987}*$
Food and live animals											
Cereals and animal feeding stuffs											
EGRACH	-9.8692[a]	2.6059[a]	-0.1350	0.1206		GJR	1.7E-06[b]	-0.0225[a]	-0.0081	1.0004[a]	
	(0.3161)	(0.3434)	(0.1808)	(0.0811)			(7.7E-07)	(0.0020)	(0.0110)	(0.0105)	
Food											
EGRACH	-8.0920[a]	-1.4702[a]	1.3618[a]	0.0303[a]		GJR	0.0000	0.0336	-0.0784	1.0105[a]	
	(0.8015)	(0.2505)	(0.1692)	(0.0836)			(0.0000)	(0.0611)	(0.0773)	(0.0498)	
Fruit and vegetables											
EGRACH	-9.8082[a]	2.6374[a]	-0.1167	-0.0072	1.2640	GJR	0.0000[a]	0.1048[a]	-0.2049[a]	0.9686[a]	0.0035[a]
	(0.7126)	(0.4095)	(0.1700)	(0.0944)	(2.7131)		(0.0000)	(0.0277)	(0.0483)	(0.0208)	(0.0013)
Meat											
EGRACH	-1.0200[b]	-0.0893	0.3070[a]	0.8425[a]	-1.8152	GJR	0.0005[c]	0.2324[c]	-0.3252[b]	0.4850[c]	-0.0012
	(0.4579)	(0.1039)	(0.0894)	(0.0660)	(1.3275)		(0.0003)	(0.1384)	(0.1477)	(0.2673)	(0.0041)
Beverages and tobacco											
Beverages and tobacco											
EGRACH	-8.3929[a]	0.8143[a]	0.0784	0.1216		GJR	0.0000	0.7347	-0.2380	0.6309[a]	
	(1.1980)	(0.2033)	(0.1379)	(0.1436)			(0.0000)	(0.7096)	(0.5151)	(0.1070)	
Basic materials											
Metal Ores											
EGRACH	-8.2059[a]	0.1049	-0.1361	-0.1601	-16.7916[a]	GJR	0.0000[c]	0.0133[c]	-0.0850[b]	0.9914[a]	0.0009[b]
	(4.2679)	(0.2264)	(0.1407)	(0.6081)	(2.0197)		(0.0000)	(0.0081)	(0.0367)	(0.0208)	(0.0004)
Textile fibres											
EGRACH	-8.1634[a]	0.3491	0.0127	0.0220	-8.7518[a]	GJR	0.0002	-0.0097	-0.0971	0.4683	-0.0004[a]
	(2.8427)	(0.2245)	(0.1341)	(0.3452)	(2.0639)		(0.0002)	(0.0916)	(0.1027)	(0.6089)	(0.0001)
Fuels											
Fuels											
EGRACH	-10.2846[a]	2.0569[a]	0.1154	-0.2622[b]		GJR	0.0003[a]	-0.1085[a]	0.3338[a]	0.7918[a]	
	(0.7956)	(0.4479)	(0.0842)	(0.1268)			(0.0001)	(0.0360)	(0.1176)	(0.0931)	
Chemicals											
Chemicals											
EGRACH	-7.9881	1.7916	-0.8598	-0.1500	-11.7396[a]	GJR	0.0000	-0.0346[a]	0.0343	0.9970[a]	0.0006[c]
	(10.5342)	(8.2720)	(3.9446)	(0.2275)	(2.0015)		(0.0000)	(0.0116)	(0.0524)	(0.0201)	(0.0003)
Organic chemicals											

Table 5.5 Cont'd

	Panel A						Panel B				
	ω	κ	φ	θ	$D_{t,1987*}$		ω	κ	φ	θ	$D_{t,1987*}$
EGRACH	-8.8873[a]	1.2257[a]	-0.2158	0.0238[a]	-22.6459[a]	GJR	0.0000	0.8905[a]	0.5795	0.3465[a]	-0.0004
	(1.1371)	(0.2600)	(0.1548)	(0.1541)	(3.7796)		(0.0000)	(0.2341)	(0.4455)	(0.0510)	(0.0008)
Inorganic chemicals											
EGRACH	-1.0491[a]	0.8642[a]	0.0359	0.9444[a]	-0.7667	GJR	0.0011	0.1510	0.0663	0.4772	-0.0022[a]
	(0.2418)	(0.1749)	(0.1043)	(0.0273)	(2.8574)		(0.0009)	(0.1843)	(0.2515)	(0.4069)	(0.0007)
Plastics											
EGRACH	-8.5433[c]	0.2473	0.1454	0.0136	-9.6932[a]	GJR	0.0002[a]	0.2774[c]	-0.2400	-0.3940[c]	0.0004
	(4.5561)	(0.2251)	(0.1703)	(0.5323)	(3.0636)		(0.0000)	(0.1450)	(0.1523)	(0.2247)	(0.0004)
Material manufactures											
Iron and steel											
EGRACH	-9.3744[a]	-1.8676[a]	-1.8732[a]	-0.1009[b]		GJR	0.0000	0.1981	-0.3008[b]	0.9225[a]	
	(0.5752)	(0.2286)	(0.1785)	(0.0509)			(0.0000)	(0.1409)	(0.1421)	(0.0883)	
Paper and paperboard											
EGRACH	-8.4161[a]	-1.1624[a]	1.8016[a]	-0.0690	3.9616[c]	GJR	0.0000	-0.0233	-0.0010	0.9982[a]	0.0016[c]
	(0.7257)	(0.1884)	(0.2237)	(0.0892)	(2.1484)		(0.0000)	(0.0285)	(0.0475)	(0.0275)	(0.0009)
Material manufactures											
EGRACH	-0.7128[a]	0.4668[a]	0.1478	0.9599[a]	1.7134	GJR	0.0000	0.8020[a]	0.1762	0.4679[a]	0.0000
	(0.2560)	(0.1292)	(0.0999)	(0.0256)	(1.1211)		(0.0000)	(0.2523)	(0.4071)	(0.0639)	(0.0006)
Mineral manufactures less precious stones											
EGRACH	-9.6734[a]	2.7445[a]	-0.2249	0.1880[c]		GJR	0.0000[a]	0.2687[a]	-0.4154[a]	0.8471[a]	
	(0.8004)	(0.4388)	(0.2116)	(0.1028)			(0.0000)	(0.0886)	(0.1177)	(0.0376)	
Miscellaneous metal manufactures											
EGRACH	-8.4594[a]	0.1459	0.3352[b]	0.0378	-10.213[a]	GJR	0.0000	0.1175	0.0045	0.8506[a]	0.0005
	(2.6924)	(0.1922)	(0.1452)	(0.3025)	(2.7933)		(0.0000)	(0.0732)	(0.1045)	(0.0650)	(0.0004)
Non-ferrous metals											
EGRACH	-12.8045[a]	0.1779	-0.4556[b]	-0.6486[a]	0.3821	GJR	1.9E-06[b]	-0.0873[a]	0.1299[a]	1.0109[a]	0.0007[c]
	(1.3878)	(0.1807)	(0.2101)	(0.1385)	(1.4263)		(9.3E-07)	(0.0053)	(0.0136)	(0.0009)	(0.0004)
Textiles											
EGRACH	-11.4501[a]	-1.9488[a]	2.4658[a]	0.0416		GJR	0.0000[b]	-0.0094	-0.0761	1.0002[a]	
	(0.6874)	(0.2373)	(0.1906)	(0.0491)			(0.0000)	(0.0250)	(0.0517)	(0.0333)	
Machinery and transport equipment											
Electronic machinery											
EGRACH	-7.8482[a]	0.4141	0.0302	0.0548	-7.8577[a]	GJR	0.0002[b]	0.3185	-0.2388	0.1554	-0.0002

Table 5.5 Cont'd

	Panel A						Panel B				
	ω	κ	φ	θ	$D_{t,1987}$ *		ω	κ	φ	θ	$D_{t,1987}$ *
	(2.5801)	(0.2667)	(0.1674)	(0.3177)	(2.0129)		(0.0001)	(0.2237)	(0.2502)	(0.3018)	(0.0003)
Machinery and transport equipment											
EGRACH	-8.2188[b]	-0.0100	0.1158	0.0917	-8.7921[a]	GJR	0.0001	0.0169	-0.0500	0.4704	-0.0001[a]
	(3.2433)	(0.2190)	(0.1513)	(0.3600)	(2.1336)		(0.0001)	(0.1003)	(0.1641)	(0.6041)	(0.0000)
Machinery											
EGRACH	-8.5420[a]	0.1798	0.0331	0.0042	-7.2212[a]	GJR	1.1E-05	0.0915	-0.1079	0.9030[a]	0.0014
	(2.4299)	(0.2174)	(0.1495)	(0.2845)	(2.2205)		(7.7E-06)	(0.0653)	(0.0942)	(0.0481)	(0.0014)
Road vehicles											
EGRACH	-9.6918[a]	1.9339[a]	-0.0002	0.1013	3.4003	GJR	0.0000	0.2538[b]	-0.2719[b]	0.8211[a]	0.0005
	(0.7322)	(0.2598)	(0.1337)	(0.0958)	(3.3785)		(0.0000)	(0.1208)	(0.1229)	(0.0790)	(0.0012)
Miscellaneous											
Clothing											
EGRACH	-8.4790[a]	0.7628[b]	-0.0801	0.0461	3.4521	GJR	0.0000	0.0351	0.0277	0.9169[a]	0.0017
	(1.4981)	(0.3277)	(0.1366)	(0.1885)	(59.5520)		(0.0000)	(0.0352)	(0.0733)	(0.0314)	(0.0012)
Clothing and footwear											
EGRACH	-8.0623[a]	1.2943	-0.5640	0.0435	-1.0406	GJR	0.0000	-0.0156	-0.0576	1.0103[a]	0.0009
	(1.8486)	(1.1847)	(0.5925)	(0.1596)	(137.5982)		(0.0000)	(0.0366)	(0.0558)	(0.0351)	(0.0006)
Scientific and photographic											
EGRACH	-9.4433[a]	-1.7968[a]	1.6341[a]	-0.0761		GJR	0.0000	0.3166	-0.1078	0.7028[a]	
	(0.7768)	(0.2502)	(0.2183)	(0.0836)			(0.0000)	(0.1941)	(0.2171)	(0.1150)	
Others											
Finished manufactures											
EGRACH	-5.0905[a]	0.0576	0.2300[c]	0.4453[b]	-19.3575[a]	GJR	0.0000[b]	0.2812[b]	-0.2274	0.4572[a]	-0.0001
	(1.7128)	(0.2133)	(0.1328)	(0.1820)	(1.9580)		(0.0000)	(0.1200)	(0.1423)	(0.1703)	(0.0002)
Finished manufactures less erratic											
EGRACH	-4.9577[a]	0.5260[a]	0.2380[a]	0.4978[a]	-10.9426[a]	GJR	0.0000[b]	0.3434[a]	-0.2434[c]	0.6865[a]	-0.0001[a]
	(0.9399)	(0.1515)	(0.0940)	(0.0959)	(2.0231)		(0.0000)	(0.1316)	(0.1443)	(0.1054)	(0.0000)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p*-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. * Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for those industries.

The θ coefficient is significant in 40% (93%) of the cases under the EGARCH (GJR) model. So, the data contains strong GARCH effects thereby validating the estimation approach taken in the study. Moreover, κ is much smaller than θ in 85% of the cases under the GJR; Under the EGARCH, κ is much smaller than θ in about 40% of the cases. The GJR results suggest that the effects of previous shocks, measured by θ have a more lasting effect than last period's shocks. This result means that the variables contain memory that is longer than one period and that the degree of volatility is more sensitive to its own lagged values than to recent shocks.

More importantly, the coefficient of asymmetry, φ is significant in 36% (32%) of the cases under the EGARCH (GJR) model. Whilst neither model provides strong evidence of asymmetry, the significant cases carry coefficients with opposite signs under each model. That is, the significant φ coefficients for EGARCH are always positive whilst those of the GJR model are negative, so both EGARCH and GJR results indicate that positive leverage effects exist in those cases, which is consistent with the result reported in Chapter 4. To explain, when exporters did not operate PTM to adjust the EPs to an optimal level, this produces a positive shock to EPs and then less competitive. This bad news makes exporters to adjust the EPs, and hence, positive shocks have more impact on the volatility of EPs. However, when the FX rate had larger effects on the EPs than other explanatory variables have, it means exporters used PTM and EPs decreased, so they do not need to adjust the EPs further and then the negative shock will have less impact on the EPs' volatility. Nevertheless, for the majority of the export sectors, $\varphi = 0$ which means that positive and negative shocks have similar effects on volatility. Furthermore, the dummy variable is significant in 62% (45%) under EGARCH (GJR) estimations.

Furthermore, as before, the Sign statistic was performed on the condition variance. The results are computed using the Newey West estimation method and presented in Table 5.6.

Table 5.6 Results for Sign Tests for the EGARCH and GJR estimates

	Sign test	Negative	Positive		Sign test	Negative	Positive
Food and Live Animals							
Cereals and Animal Feeding Stuffs							
EGARCH	-0.1877	8.3982	14.7719[b]	GJR	0.5190[c]	9.2156	1.7770
	(0.1788)	(5.6244)	(6.5201)		(0.2964)	(11.5008)	(10.2675)
Food							
EGARCH	0.5393	-51.6446[b]	-33.1565	GJR	-0.1157	9.2508	12.4840
	(0.3544)	(25.2871)	(26.8776)		(0.2537)	(16.2880)	(19.2733)
Fruit and Vegetable							
EGARCH	0.0018[a]	-0.0843[a]	-0.0117	GJR	0.0057	0.0031	-0.0630
	(0.0007)	(0.0171)	(0.0167)		(0.0043)	(0.1094)	(0.1130)
Meat							
EGARCH	0.0955	-10.2642[b]	-1.4767	GJR	-0.0307	0.3222	0.6727
	(0.1926)	(4.6564)	(4.5947)		(0.2065)	(4.9853)	(4.7913)
Beverages and Tobacco							
Beverages and Tobacco							
EGARCH	0.0494	2.6350	0.9969	GJR	0.4141	10.2028	-8.1433
	(0.4369)	(25.0154)	(22.1654)		(0.3189)	(16.9592)	(17.6052)
Basic Materials							
Metal Ores							
EGARCH	0.1259	4.4203	-2.0920	GJR	0.1430	-1.3340	-4.5867
	(0.2483)	(7.2119)	(6.6161)		(0.2213)	(6.3430)	(5.7769)
Textiles Fibres							
EGARCH	0.1766	-1.6281	-3.0117	GJR	0.2127	-11.7871	7.4830
	(0.2327)	(11.0038)	(11.1593)		(0.1994)	(9.5180)	(9.3064)
Fuels							
Fuels							
EGARCH	0.2003	-3.7803	-4.4244	GJR	0.0045	2.4473	-3.8484
	(0.1639)	(3.2201)	(3.2310)		(0.2556)	(4.6259)	(5.3871)
Chemicals							
Chemicals							
EGARCH	0.0000	0.3231	1.2327	GJR	0.0003	-0.2751[b]	0.0352
	(0.0334)	(2.5377)	(2.2119)		(0.0016)	(0.1146)	(0.1005)
Organic Chemical							
EGARCH	0.2227	0.5571	7.2919	GJR	-0.0742	7.2812	-11.2892[c]
	(0.2625)	(10.8203)	(9.7314)		(0.2199)	(8.0012)	(6.5754)
Inorganic Chemicals							
EGARCH	-0.0471	2.0903	4.2585	GJR	0.0087	0.0781	0.0675
	(0.2979)	(3.9667)	(6.8458)		(0.0053)	(0.1013)	(0.1143)
Plastics							
EGARCH	0.2170	-10.6312	-10.8232	GJR	0.2932	-8.1051	-6.6127
	(0.2568)	(16.2337)	(15.1756)		(0.3087)	(18.4695)	(18.9400)
Material Manufactures							
Iron and Steel							
EGARCH	-0.1033	5.6080	18.8709	GJR	0.0146	-13.8787	-7.2042
	(0.3025)	(15.8829)	(25.7127)		(0.2458)	(14.5598)	(17.6786)
Paper and Paperboard							

Table 5.6 Cont'd

	Sign test	Negative	Positive		Sign test	Negative	Positive
EGARCH	1.1485[b]	-85.4978[a]	-29.4303	GJR	-0.2714	15.4583[b]	17.8835[b]
	(0.5370)	(26.7395)	(24.8983)		(0.1795)	(7.6785)	(8.0441)
Material Manufactures							
EGARCH	-0.2006	5.0788	-8.6129	GJR	0.0263	13.8492	-17.0784[c]
	(0.3172)	(13.4573)	(14.1693)		(0.2304)	(9.8219)	(9.0147)
Mineral Manufactures Less Precious Stones							
EGARCH	0.1423	-1.8441	9.5958	GJR	0.3087	-13.1650	-11.5690
	(0.2118)	(12.5624)	(8.3284)		(0.3397)	(16.6509)	(13.3873)
Miscellaneous Metal Manufactures							
EGARCH	0.2657	-8.3397	-4.0413	GJR	-0.5656[b]	19.8309	23.0328[c]
	(0.2903)	(19.0941)	(17.2371)		(0.2333)	(14.3146)	(13.5736)
Non-ferrous Metals							
EGARCH	0.5305	-6.5177	-8.0553	GJR	0.0585	-14.4402	-20.8713
	(0.4517)	(16.4177)	(17.2659)		(0.5077)	(17.9564)	(17.9985)
Textiles							
EGARCH	1.3765[a]	-110.9451	-219.3704[c]	GJR	-0.0708	-77.1736	120.4789
	(0.3902)	(153.4156)	(124.3910)		(0.2904)	(124.8093)	(83.4503)
Machinery and Transport Equipment							
Electronic Machinery							
EGARCH	-0.1243	10.0226	3.9708	GJR	-0.0026	0.0222	0.1711
	(0.2735)	(12.4881)	(14.7043)		(0.0023)	(0.1095)	(0.1101)
Machinery and Transport Equipment							
EGARCH	0.0441	9.1264	-2.0052	GJR	0.0457	8.1512	5.3462
	(0.2316)	(21.5313)	(17.4646)		(0.1962)	(16.6260)	(14.9197)
Machinery							
EGARCH	0.2092	1.8586	-1.3134	GJR	0.3466	1.0111	-3.9811
	(0.2669)	(17.4018)	(15.7650)		(0.3827)	(27.4815)	(22.2919)
Miscellaneous							
Clothing							
EGARCH	-0.4461	-2.1929	7.4727	GJR	-0.0015	0.0028	0.0769
	(0.3504)	(17.7422)	(18.3355)		(0.0021)	(0.1242)	(0.0963)
Clothing and Footwear							
EGARCH	-0.3447	11.7049	6.2122	GJR	0.1376	-4.7645	-6.7404
	(0.2308)	(12.7854)	(13.4332)		(0.2070)	(11.9210)	(10.8008)
Scientific and Photographic							
EGARCH	0.9059	-51.7399	-19.0054	GJR	-0.0927	27.5187	4.0901
	(0.6881)	(65.6636)	(52.3862)		(0.3632)	(34.8715)	(24.3386)
Others							
Finished Manufactures							
EGARCH	-0.3464	13.7614	9.3214	GJR	-0.4672	21.4294	9.9462
	(0.3231)	(28.1322)	(22.4443)		(0.3030)	(26.8795)	(20.9595)
Finished Manufactures less Erratic							
EGARCH	-0.1455	1.4759	-4.6264	GJR	0.0762	16.3921	1.7694
	(0.2385)	(19.1893)	(15.5560)		(0.2574)	(20.7499)	(17.7928)

Standard errors are in parenthesis. [a], [b] and [c] denote statistical significance at a 1-, 5- or 10% level, respectively.

Not surprisingly, those results confirm the finding from the variance equation, that positive and negative innovations have no significant impact on the conditional variance. In particular, the test statistics are not typically significant. Under the EGARCH (GJR) model, the positive size-bias test is significant in 3(2) out of 28 cases. The remaining significant cases are at a much lower level. In general, it appears that the variance equations are not mis-specified as the square normalised residuals are not predictable. Thus the value of ε_{t-1} does not impact on volatility strongly. Specifically, both positive and negative shocks do not impact strongly on volatility, irrespective of their size.

5.3.3 Comparison for ECM and the Dynamic Model

In Chapter 4, it was concluded that the GJR dynamic estimation is the best one among the models employed. It was also found that the GJR estimation is better than the EAGARCH in ECM. Thus, it is now appropriate to assess those two estimations, so that the best one can be selected for our further investigation in the second stage analysis. It is well known that $\overline{R^2}$ measures how good the sample regression function fits the data. The higher the value of the $\overline{R^2}$, the better the model fit in the absence of spurious regressions. Compared with Table 5.4 and Table 4.6, there are 20 out of 28 cases (71%) that contain a higher $\overline{R^2}$ in ECM GJR estimation than that in the Dynamic GJR estimations. It implies that ECM estimations fit the data better than traditional GARCH-type estimations. Moreover, AIC is another criterion to consider when selecting a model. The lower value of AIC is more preferable. Again, Tables 5.4 and 4.6 indicated that ECM is better, since there are 21 out of 28 cases (75%) that have smaller AIC in ECM compared with the traditional GARCH-type model. Finally, there are only 7 cases (25%) in ECM that rejected the t-distribution assumption, while 14 cases (50%) are not t-distributed in the traditional GARCH-type estimations. Therefore, there is strong evidence in these empirical results that ECM GJR is the best estimation and that it is suitable for further use.

5.4 Does Pricing-To-Market Exist under Real Prices?

So far, the empirical work in this study has focused on the PTM implementation using nominal FX rates changes. However, many recent studies (see, e.g., Alexius, 2005, Sarno, *et al.*, 2004 and Beaudry and Devereux, 1995) have paid attention to the relationship between PPP (LOP) and real FX rates. More importantly, the real FX rates have been found not to be constant in the long term due to productivity shocks (see, e.g., Lee, *et al.*, 2002), whereas some argue that real FX rates tend toward to a long-term equilibrium (see, Sarno and Taylor, 2002; Chowdhury, 2004). Although some FX rate pass-through studies have considered real FX rates (see, e.g. Klitgaad, 1999 and Kanas, 1997), they have mixed other nominal value variables in their PTM models. It should be noted that the current study is the first one to employ all real value variables consistently in the PTM model.

Moreover, there are some studies (see, e.g., Domac and Mendoza, 2004; Bhattacharya and Thomakos, 2003) that claim that inflation is an important factor in financial arrangements. For example, Banerjee, *et al.*, (2006) find a negative relationship between inflation and mark-up on prices. If this is the case, the level of inflation can impact positively on PTM but negatively on FX rate pass-through, because an increase in inflation is likely to result in a fall in exporters' prices. However, Choudhri and Hahura (2006) argue that there is a positive and significant association between FX rate pass-through and inflation. That is, a negative relationship between PTM strategy and inflation.

Therefore, it is useful to take account of inflation in this study and to assess the PTM behaviour when the real FX rate fluctuates. In order to examine the PTM strategy after considering the inflation rate, the real value variables are applied to the ECM model in both EGARCH and GJR estimations. Before running the estimation, it is necessary to ensure that the series are co-integrated, so as previously, co-integration is tested for by using Johansen's (1988) tests. In this exercise, the Johansen (1988) tests still confirm co-integration[47] and the LR statistics are consistent with the earlier nominal results. These results are presented in Appendices 5 and 6, respectively.

5.4.1 Mean Equation for ECM-EGARCH (Real Values)

The results for the EGARCH mean equation and diagnostic tests are given in Table 5.7. From the residuals analysis, the ARCH(2) and Q-stat(2) demonstrate that the EGARCH model captures almost all the heteroscedasticity and auto-correlation properties. Nevertheless, the J-B normality test is significant in 21 out of 28 cases. Moreover, the *t*-distribution assumption is rejected in 16 out of 28 cases. The SER, AIC and $\overline{R^2}$ will be discussed later with GJR estimation.

The mean equation results also show that 13 out of 28 export sectors exhibit significant ECTs with different signs and magnitudes across sectors. Also, the lagged effects are significant in the model. These results are consistent with the study's earlier finding. More specifically, the tables show that the use of real values generates stronger evidence of PTM and the explanatory variables are significant at higher lags than for nominal values.

[47] Kanas (1997) also finds co-integration between real FX rate and nominal EPs in UK by using quarterly data.

Table 5.7 ECM Estimates of the EGARCH Regression Coefficients under the *t*-density (Real Values)

Food and live animals

Cereals and animal feeding stuffs

ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-10}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-4}
-0.0114[b]	-0.1860[a]	-0.2044[a]	-0.1862[a]	-0.1799[a]	-0.2905[a]	-0.1163[a]	0.7318[a]	-0.3982[a]	0.1415[b]	-0.1932[a]
(0.0574)	(0.0400)	(0.0555)	(0.0390)	(0.0304)	(0.0479)	(0.0451)	(0.0646)	(0.0427)	(0.0605)	(0.0499)
ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-11}	
-0.0835[b]	0.1767[a]	-0.2047[a]	0.0832[c]	-0.2310[a]	-0.2338[a]	-0.1138[b]	-0.0733[a]	-0.1090[a]	-0.1733[a]	
(0.0397)	(0.0602)	(0.0482)	(0.0510)	(0.0389)	(0.0361)	(0.0457)	(0.0189)	(0.0382)	(0.0337)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.0798	0.9960	1.4737	126.8445	0.0249	-5.3312	0.5587				
			(2624.548)							

Food

ECT_{t-1}	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-7}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-7}
0.0002	-0.1886[a]	0.0580[c]	0.1047[a]	-0.0771[c]	0.1105[a]	1.1618[a]	0.6152[a]	0.1334[a]	0.1492[a]	0.2346[a]
(0.0002)	(0.0457)	(0.0347)	(0.0290)	(0.0406)	(0.0332)	(0.0437)	(0.0978)	(0.0417)	(0.0331)	(0.0398)
ΔPPi_{t-10}	ΔPPi_{t-12}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-10}				
0.1788[a]	-0.2819[a]	-0.1519[a]	-0.3140[a]	0.0833[a]	-0.0486[b]	-0.1710[a]				
(0.0621)	(0.0639)	(0.0382)	(0.0629)	(0.0294)	(0.0235)	(0.0519)				
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
1.4449	3.2481	1.9178	20.3194	0.0119	-6.1601	0.8640				
			(51.7044)							

Fruit and vegetables

ECT_{t-1}	ΔX_{t-2}	ΔX_{t-7}	ΔX_{t-8}	ΔX_{t-9}	ΔX_{t-11}	ΔPPi_t	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-6}
-0.0001	-0.1634[a]	-0.1323[b]	-0.1632[b]	-0.1276[b]	-0.0791	0.9778[a]	-0.1463[a]	-0.1854[a]	-0.1059[b]	-0.1681[a]
(0.0005)	(0.0629)	(0.0655)	(0.0683)	(0.0563)	(0.0559)	(0.0697)	(0.0529)	(0.0453)	(0.0443)	(0.0447)
ΔE_{t-10}	ΔE_{t-13}									
-0.1587[a]	0.1710[a]									
(0.0414)	(0.0447)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
2.2688	1.9730	69.3265[a]	14.7086	0.0330	-4.0444	0.5414				
			(9.3720)							

Meat

ECT_{t-1}	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔPPi_{t-6}
-0.0001	-0.1809[b]	-0.2371[b]	-0.4243[a]	-0.3388[b]	0.2417[b]	-0.2011[b]	0.6431[a]	-0.2789[a]	-0.2061[b]	0.4889[a]
(0.0005)	(0.0900)	(0.0962)	(0.1353)	(0.1324)	(0.1273)	(0.0940)	(0.1162)	(0.1070)	(0.1050)	(0.1534)

Table 5.7 Cont'd

ΔPPi_{t-7}	ΔPPi_{t-9}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}	
0.3763[b]	-0.1980[b]	-0.4783[a]	-0.2825[a]	-0.0895	-0.1852[a]	-0.2524[a]	-0.1249[b]	-0.1247[c]	-0.1478[a]	
(0.1663)	(0.0844)	(0.1667)	(0.0600)	(0.0572)	(0.0588)	(0.0575)	(0.0579)	(0.0641)	(0.0513)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.8006	0.4039	18.7333[a]	5.8271	0.0365	-3.7874	0.4483				
			(3.6070)							

Beverages and tobacco

Beverages and tobacco

ΔX_t	ΔX_{t-3}	ΔX_{t-10}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-9}	ΔPPi_{t-11}	ΔPPi_{t-12}
-0.1728[a]	-0.1514[a]	-0.1391[a]	-0.1243[a]	1.0725[a]	0.1963[a]	0.1589[a]	0.1667[a]	-0.1107[a]	-0.1253[a]	-0.1636[a]
(0.0407)	(0.0299)	(0.0335)	(0.0290)	(0.0563)	(0.0499)	(0.0608)	(0.0319)	(0.0358)	(0.0393)	(0.0464)
ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-6}							
-0.0719[c]	-0.0672[c]	-0.1452[a]	-0.1280[b]							
(0.0425)	(0.0367)	(0.0490)	(0.0537)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.7148	1.2399	51.1527[a]	2.1639[a]	0.0162	-5.6850	0.7309				
			(0.5979)							

Basic materials

Metal Ores

α	ECT_{t-1}	ΔX_{t-5}	ΔX_{t-6}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-6}
-0.0874[c]	-0.0202[c]	-0.4219[a]	0.3142[b]	0.8081[a]	-0.3166[a]	-0.2883[b]	-0.2138[c]	-0.2065[c]	0.3325[b]	-0.5980[a]
(0.0508)	(0.0114)	(0.1245)	(0.1223)	(0.1047)	(0.1134)	(0.1204)	(0.1182)	(0.1194)	(0.1650)	(0.1684)
ΔPPi_{t-10}	ΔPPi_{t-11}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-10}					
-0.2060[b]	-0.1485[c]	0.2550[a]	0.1232[b]	0.1270[a]	0.1318[b]					
(0.0962)	(0.0849)	(0.0655)	(0.0528)	(0.0482)	(0.0662)					
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1387	0.0152	19.9590[a]	7.2117[c]	0.0306	-4.1323	0.5221				
			(3.9735)							

Textile fibres

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-9}
-0.1996[a]	-0.0436[a]	0.1510[a]	-0.1509[a]	-0.2352[a]	0.6152[a]	0.2885[a]	0.0844[b]	0.1313[a]	0.0744[b]	0.1504[a]
(0.0546)	(0.0118)	(0.0391)	(0.0488)	(0.0413)	(0.0423)	(0.0564)	(0.0386)	(0.0312)	(0.0334)	(0.0372)
ΔPPi_{t-11}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-9}	ΔE_{t-11}						
-0.1486[a]	0.0866[a]	-0.4207[a]	-0.1364[a]	0.1013[a]						
(0.0383)	(0.0332)	(0.0376)	(0.0334)	(0.0331)						

Table 5.7 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.7808	0.6157	0.2981	31.1613 (101.7989)	0.0200	-5.1188	0.6967

Fuels

Fuels

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-9}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}
-0.2339[a]	-0.0534[a]	-0.7740[a]	0.6071[a]	-0.5586[a]	-0.5554[a]	-0.4319[a]	-0.1663[a]	-0.2323[a]	1.8272[a]	-0.7110[a]
(0.0477)	(0.0105)	(0.0796)	(0.0977)	(0.0621)	(0.0493)	(0.0611)	(0.0385)	(0.0488)	(0.1178)	(0.0912)
ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-3}	ΔE_{t-5}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-12}
-0.1689[b]	-0.4004[a]	-0.2458[a]	-0.3668[a]	-0.4707[a]	0.2170[a]	0.0736[a]	0.1295[a]	0.1832[a]	0.1835[a]	0.1194[a]
(0.0699)	(0.0886)	(0.0797)	(0.0671)	(0.0827)	(0.0285)	(0.0230)	(0.0311)	(0.0365)	(0.0337)	(0.0360)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.9204	0.9346	1.8288	23.1572 (65.5424)	0.0475	-3.4427	0.4035				

Chemicals

Chemicals

ECT_{t-1}	ΔX_t	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-7}	ΔE_{t-1}	ΔE_{t-2}
0.0003[b]	-0.2380[a]	0.0492[b]	1.2273[a]	-0.1345[b]	0.0391[c]	-0.0721[a]	0.0996[c]
(0.0001)	(0.0343)	(0.0194)	(0.0419)	(0.0622)	(0.0231)	(0.0214)	(0.0563)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$	
0.0936	0.2544	15.2058[a]	7.5522[c] (4.3612)	0.0122	-6.3318	0.8687	

Organic chemicals

ΔX_t	ΔPPi_t	ΔE_{t-1}				
-0.4146[a]	1.3779[a]	-0.0887[a]				
(0.0465)	(0.0512)	(0.0246)				
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.2703	1.9184	18.9101[a]	6.0025[a] (2.8840)	0.0226	-5.3710	0.6885

Inorganic chemicals

ECT_{t-1}	ΔX_t	ΔX_{t-5}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-5}	ΔE_{t-1}	ΔE_{t-5}	ΔE_{t-9}
-0.0200[a]	-0.2576[a]	-0.0203[a]	1.2607[a]	0.1423[b]	0.1511[b]	-0.2153[a]	-0.1364[b]	-0.0639[b]
(0.0043)	(0.0668)	(0.0043)	(0.0737)	(0.0650)	(0.0630)	(0.0484)	(0.0553)	(0.0300)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$		
0.4445	1.9922	20.6005[a]	5.9428[a]	0.0438	-4.6903	0.2801		

Table 5.7 Cont'd

			(2.6773)							
Plastics										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-9}	
-0.0235	-0.0049	-0.1885[a]	-0.1836[a]	1.1690[a]	0.4106[a]	-0.0595[b]	-0.2757[a]	-0.0620[b]	-0.0499[b]	
(0.0192)	(0.0043)	(0.0509)	(0.0528)	(0.0623)	(0.0917)	(0.0302)	(0.0627)	(0.0254)	(0.0249)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0999	1.7807	51.5197[a]	8.4745[a]	0.0143	-5.7394	0.8282				
			(5.1310)							
Material manufactures										
Iron and steel										
α	ECT_{t-1}	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-8}	ΔX_{t-9}	ΔX_{t-11}
-0.0804[a]	-0.0181[a]	-0.1913[a]	-0.0852[a]	-0.1063[a]	0.1181[a]	-0.0827[a]	0.1227[a]	-0.0870[a]	-0.1474[a]	-0.0828[a]
(0.0276)	(0.0061)	(0.0392)	(0.0236)	(0.0231)	(0.0260)	(0.0241)	(0.0365)	(0.0316)	(0.0335)	(0.0354)
ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-6}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔPPi_{t-13}
0.1131[a]	-0.0807[a]	0.9800[a]	0.3205[a]	-0.2363[a]	0.1357[a]	0.2022[a]	0.1628[a]	0.0930[a]	-0.2741[a]	-0.2373[a]
(0.0399)	(0.0401)	(0.0335)	(0.0598)	(0.0560)	(0.0420)	(0.0646)	(0.0464)	(0.0438)	(0.0620)	(0.0670)
ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-12}	ΔE_{t-13}			
-0.1478[a]	-0.1968[a]	0.0777[a]	0.0719[a]	-0.0862[a]	-0.0991[a]	0.1143[a]	0.1671[a]			
(0.0412)	(0.0329)	(0.0382)	(0.0232)	(0.0388)	(0.0457)	(0.0356)	(0.0398)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
2.2585	1.6602	2.9021	29.0894	0.0146	-5.9229	0.8100				
			(146.9052)							
Paper and paperboard										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-8}	ΔPPi_t
-0.1430[a]	-0.0313[a]	-0.1830[a]	-0.1983[a]	-0.0757[c]	0.2730[a]	-0.0883[b]	-0.0992[b]	-0.1281[b]	0.0714[c]	0.9734[a]
(0.0528)	(0.0116)	(0.0584)	(0.0529)	(0.0458)	(0.0549)	(0.0437)	(0.0519)	(0.0547)	(0.0376)	(0.0589)
ΔPPi_{t-1}	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-11}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-6}	ΔE_{t-8}
0.2417[a]	-0.1821[a]	-0.5929[a]	0.1911[a]	0.2262[a]	-0.1608[a]	-0.3280[a]	-0.0988[b]	0.1577[a]	-0.0987[b]	-0.0646[c]
(0.0933)	(0.0468)	(0.0764)	(0.0693)	(0.0589)	(0.0374)	(0.0667)	(0.0387)	(0.0472)	(0.0451)	(0.0371)
ΔE_{t-9}	ΔE_{t-10}									
-0.1043[a]	-0.0643[c]									
(0.0368)	(0.0350)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2746	0.7012	82.5419[a]	3.9067[a]	0.0194	-5.2343	0.7222				
			(1.3565)							

Table 5.7 Cont'd

Material manufactures										
ΔX_t	ΔX_{t-4}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-9}	ΔE_{t-1}			
-0.4087[a]	0.0718[a]	0.1076[a]	1.4083[a]	0.2027[a]	0.0894[a]	-0.0845[c]	-0.1763[a]			
(0.0353)	(0.0162)	(0.0370)	(0.0432)	(0.0557)	(0.0219)	(0.0467)	(0.0527)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
2.6509[c]	1.7816	6.0757[b]	14.9809	0.0195	-5.7843	0.7269				
			(17.2948)							
Mineral manufactures less precious stones										
α	ECT_{t-1}	ΔX_t	ΔX_{t-4}	ΔX_{t-11}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-9}	ΔPPi_{t-12}
0.0276[a]	0.0006[a]	-0.3664[a]	-0.0851[a]	-0.1470[a]	1.3420[a]	0.0457[a]	0.2703[a]	-0.1588[a]	-0.1630[a]	-0.1019[a]
(0.0075)	(0.0000)	(0.0158)	(0.0145)	(0.0066)	(0.0211)	(0.0089)	(0.0360)	(0.0063)	(0.0109)	(0.0292)
ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-12}	ΔE_{t-13}				
-0.0338[c]	-0.1605[a]	-0.0928[a]	-0.1758[a]	-0.2710[a]	0.0731[b]	-0.0626[a]				
(0.0193)	(0.0373)	(0.0091)	(0.0084)	(0.0113)	(0.0289)	(0.0138)				
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.1752	1.0533	1056.106[a]	2.8897[a]	0.0214	-6.0491	0.6485				
			(0.5352)							
Miscellaneous metal manufactures										
ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-7}	ΔPPi_{t-9}
-0.1749[a]	-0.1203[a]	-0.1273[a]	0.1361[a]	0.1142[a]	1.1130[a]	0.5665[a]	0.2442[a]	-0.1376[b]	0.0757[a]	-0.1326[a]
(0.0436)	(0.0421)	(0.0373)	(0.0505)	(0.0374)	(0.0495)	(0.0889)	(0.0452)	(0.0593)	(0.0223)	(0.0446)
ΔPPi_{t-10}	ΔE_{t-1}	ΔE_{t-10}								
-0.1523[a]	-0.4050[a]	0.1579[a]								
(0.0435)	(0.0635)	(0.0462)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.5659	0.4335	16.4541[a]	7.5341	0.0137	-6.0239	0.8227				
			(5.4771)							
Non-ferrous metals										
α	ECT_{t-1}	ΔX_t	ΔX_{t-2}	ΔX_{t-5}	ΔX_{t-8}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-5}
-0.0669[a]	-0.0149[a]	-0.1781[a]	-0.0886[a]	-0.2534[a]	-0.1571[a]	0.0948[a]	0.8468[a]	-0.0557[a]	-0.1432[a]	0.2669[a]
(0.0185)	(0.0041)	(0.0211)	(0.0168)	(0.0281)	(0.0240)	(0.0280)	(0.0222)	(0.0162)	(0.0040)	(0.0401)
ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}
-0.1105[a]	0.0916[a]	-0.2794[a]	-0.1589[a]	0.0586[a]	-0.1090[a]	-0.1502[a]	-0.1154[a]	-0.1101[a]	0.0728[a]	0.0718[a]
(0.0246)	(0.0360)	(0.0257)	(0.0330)	(0.0184)	(0.0167)	(0.0167)	(0.0388)	(0.0129)	(0.0141)	(0.0256)

Table 5.7 Cont'd

ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-12}	ΔE_{t-13}							
-0.0883[a]	0.1191[a]	0.1542[a]	0.0585[a]							
(0.0150)	(0.0229)	(0.0151)	(0.0216)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.0975	4.7823[c]	2413.175[a]	2.6673[a]	0.0256	-5.2208	0.5351				
			(0.4509)							
Textiles										
ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-7}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-4}	ΔPPi_{t-7}	ΔPPi_{t-9}	ΔPPi_{t-10}
-0.1422[a]	-0.1730[a]	-0.1262[a]	-0.1432[a]	0.0792[c]	1.0076[a]	0.2956[a]	-0.2686[a]	-0.3061[a]	-0.0509[c]	-0.2347[a]
(0.0359)	(0.0384)	(0.0354)	(0.0399)	(0.0441)	(0.0421)	(0.0788)	(0.0597)	(0.0646	(0.0287)	(0.0572)
ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-11}		
-0.1489[a]	-0.2127[a]	-0.1574[a]	0.1446[a]	-0.1298[a]	0.1571[a]	-0.1172[a]	0.1479[a]	-0.0948[a]		
(0.0282)	(0.0746)	(0.0375)	(0.0549)	(0.0333)	(0.0482)	(0.0294)	(0.0564)	(0.0274)		
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.0965	0.8568	2.6571	157.2612	0.0125	-6.3207	0.8334				
			(3694.616)							
Machinery and transport equipment										
Electronic machinery										
α	ΔX_{t-1}	ΔX_{t-4}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-2}	ΔE_{t-3}	ΔE_{t-11}	ΔE_{t-13}	
-0.0030[a]	-0.0988[b]	-0.0605[b]	0.0720[b]	-0.0909[b]	0.9551[a]	-0.0887[b]	-0.0890[a]	-0.0531[b]	0.1261[a]	
(0.0009)	(0.0386)	(0.0295)	(0.0311)	(0.0376)	(0.0423)	(0.0391)	(0.0338)	(0.0266)	(0.0391)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.6753	0.7426	157.6576[a]	4.9299[a]	0.0178	-5.4176	0.7692				
			(1.4669)							
Machinery and transport equipment										
α	ΔX_t	ΔX_{t-5}	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-11}	ΔX_{t-6}		
-0.0027[a]	-0.1146[a]	-0.0854[b]	0.0595[a]	1.0809[a]	0.1632[a]	0.0915[a]	-0.0547[b]	0.1280[a]		
(0.0007)	(0.0382)	(0.0379)	(0.0229)	(0.0471)	(0.0463)	(0.0270)	(0.0259)	(0.0269)		
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.1032	1.3920	62.2085[a]	4.5998[a]	0.0114	-6.1977	0.8800				
			(1.6606)							
Machinery										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-5}
-0.0135	-0.0025	-0.1406[a]	-0.0687[b]	-0.0400	-0.0468[c]	-0.0904[b]	0.0305[c]	1.1258[a]	0.1248[b]	0.1720[a]
(0.0140)	(0.0032)	(0.0439)	(0.0305)	(0.0273)	(0.0256)	(0.0401)	(0.0182)	(0.0552)	(0.0531)	(0.0528)

Table 5.7 Cont'd

ΔPPi_{t-6}	ΔPPi_{t-11}	ΔPPi_{t-13}	ΔE_{t-2}	ΔE_{t-7}	ΔE_{t-11}	ΔE_{t-13}
0.0629[c]	-0.1816[a]	-0.2649[a]	-0.1520[a]	0.0801[a]	0.0891[b]	0.2700[a]
(0.0374)	(0.0532)	(0.0591)	(0.0454)	(0.0270)	(0.0446)	(0.0510)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$
2.2709	0.1832	281.1015[a]	2.8194[a]	0.0141	-5.9247	0.8308
			(0.7435)			

Road vehicles

ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-9}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-3}
-0.0803[c]	-0.1316[a]	-0.1757[a]	-0.1019[a]	-0.0450[c]	0.1430[a]	-0.0663[b]	1.0352[a]	0.2169[a]	0.2853[a]	-0.0655[b]
(0.0450)	(0.0479)	(0.0474)	(0.0251)	(0.0252)	(0.0402)	(0.0276)	(0.0543)	(0.0838)	(0.0670)	(0.0306)
ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-12}
-0.1343[b]	0.2187[a]	0.1083[b]	-0.1092[a]	-0.2959[a]	-0.1010[c]	-0.1580[a]	0.1489[a]	-0.1542[a]	-0.0770[c]	0.1209[b]
(0.0541)	(0.0519)	(0.0535)	(0.0260)	(0.0746)	(0.0594)	(0.0447)	(0.0461)	(0.0491)	(0.0460)	(0.0525)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.0505	0.8209	1225.386[a]	3.3806[a]	0.0133	-5.9995	0.8526				
			(0.7474)							

Miscellaneous

Clothing

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-8}	ΔX_{t-9}	ΔX_{t-10}
-0.0599[a]	-0.0130[a]	-0.2010[a]	-0.0627[b]	-0.2048[a]	0.1387[a]	-0.1022[a]	0.0653[a]	-0.0579[c]	0.0920[a]	-0.1073[a]
(0.0155)	(0.0034)	(0.0398)	(0.0287)	(0.0362)	(0.0299)	(0.0394)	(0.0250)	(0.0325)	(0.0264)	(0.0329)
ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-12}
1.2160[a]	0.1719[a]	0.1584[a]	-0.2698[a]	0.1227[b]	0.0731[a]	0.1139[a]	-0.1893[a]	0.2832[a]	-0.1472[a]	-0.2472[a]
(0.0524)	(0.0432)	(0.0423)	(0.0496)	(0.0503)	(0.0275)	(0.0505)	(0.0513)	(0.0599)	(0.0474)	(0.0404)
ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-12}	ΔE_{t-13}		
0.1560[a]	-0.2364[a]	0.1510[a]	-0.0644[b]	0.1210[a]	-0.1410[a]	0.1394[a]	0.2134[a]	-0.0880[a]		
(0.0298)	(0.0393)	(0.0356)	(0.0301)	(0.0399)	(0.0322)	(0.0396)	(0.0319)	(0.0176)		
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.8174	1.9477	4.1379	22.4607	0.0164	-5.9484	0.7675				
			(52.1861)							

Clothing and footwear

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-10}	ΔX_{t-12}	ΔPPi_t
-0.0903[a]	-0.0198[a]	-0.2057[a]	-0.1233[a]	-0.2078[a]	-0.1034[b]	0.0461[c]	-0.1116[a]	-0.1067[b]	-0.1109[a]	1.1535[a]
(0.0219)	(0.0049)	(0.0457)	(0.0336)	(0.0449)	(0.0426)	(0.0257)	(0.0372)	(0.0439)	(0.0333)	(0.0604)

Table 5.7 Cont'd

ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-5}	ΔE_{t-10}	ΔE_{t-11}
0.3790[a]	0.2907[a]	0.1646[a]	0.2580[a]	-0.1823[a]	-0.1276[a]	0.1436[a]	-0.1703[a]	-0.1500[a]	-0.1267[a]	0.1744[a]
(0.0647)	(0.0703)	(0.0467)	(0.0651)	(0.0539)	(0.0475)	(0.0391)	(0.0429)	(0.0450)	(0.0371)	(0.0461)
ΔE_{t-12}	ΔE_{t-13}									
0.1336[a]	0.1103[b]									
(0.0394)	(0.0435)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2834	0.2995	631.974[a]	2.9954[a]	0.0143	-5.8875	0.8125				
			(0.8249)							

Scientific and photographic

α	ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-8}	ΔX_{t-9}	ΔX_{t-10}	ΔX_{t-11}
-0.0017[b]	0.3435[a]	0.0761[b]	-0.0685[b]	-0.1674[a]	0.0681[a]	0.1272[a]	0.0626[a]	-0.1371[a]	0.0597[b]	0.1316[a]
(0.0007)	(0.0221)	(0.0346)	(0.0339)	(0.0326)	(0.0264)	(0.0224)	(0.0225)	(0.0248)	(0.0246)	(0.0303)
ΔPPi_t	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔPPi_{t-13}
0.3170[a]	0.0396[b]	0.2248[a]	0.1231[a]	0.1310[a]	0.1082[a]	0.0762[a]	0.1500[a]	0.0766[a]	0.1442[a]	0.0706[a]
(0.0171)	(0.0155)	(0.0220)	(0.0216)	(0.0173)	(0.0224)	(0.0283)	(0.0384)	(0.0227)	(0.0233)	(0.0163)
ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-11}	ΔE_{t-12}	ΔE_{t-13}	
-0.1752[a]	-0.0977[b]	0.0633[b]	-0.1234[a]	0.0743[c]	0.0698[b]	0.1605[a]	-0.1250[a]	0.0677[a]	0.0949[a]	
(0.0341)	(0.0462)	(0.0288)	(0.0353)	(0.0414)	(0.0356)	(0.0293)	(0.0285)	(0.0245)	(0.0283)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.5876	5.1015[c]	33.5717[a]	8.6564	0.0170	-5.8680	0.7038				
			(6.7268)							

Others

Finished manufactures

α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-4}	ΔX_{t-8}	ΔX_{t-11}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t
0.0116[c]	0.0029[b]	-0.1884[a]	-0.0354[c]	-0.1414[a]	-0.0532[c]	0.1314[a]	-0.0581[a]	0.0996[a]	-0.0515[a]	1.0590[a]
(0.0062)	(0.0013)	(0.0188)	(0.0197)	(0.0260)	(0.0307)	(0.0201)	(0.0119)	(0.0131)	(0.0165)	(0.0244)
ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-4}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-4}
0.1481[a]	0.1777[a]	-0.0604[a]	0.1344[a]	0.1329[a]	-0.1601[a]	0.0432[b]	-0.2296[a]	-0.1963[a]	-0.0987[a]	-0.0929[a]
(0.0407)	(0.0327)	(0.0220)	(0.0417)	(0.0295)	(0.0238)	(0.0185)	(0.0332)	(0.0278)	(0.0011)	(0.0229)
ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-12}	ΔE_{t-13}							
0.0481[a]	-0.1042[a]	0.1547[a]	0.0589[b]							
(0.0126)	(0.0296)	(0.0279)	(0.0243)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1527	4.5522	372.9608[a]	4.9254[b]	0.0121	-6.4364	0.8675				

Table 5.7 Cont'd

			(2.2651)							
Finished manufactures less erratic										
α	ΔX_t	ΔX_{t-4}	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔE_{t-2}
-0.0023[a]	-0.2084[a]	0.0483[b]	0.0552[b]	1.1986[a]	0.2556[a]	0.0677[a]	0.0749[a]	0.0957[a]	0.0495[b]	-0.2258[a]
(0.0006)	(0.0314)	(0.0203)	(0.0230)	(0.0379)	(0.0615)	(0.0235)	(0.0269)	(0.0257)	(0.0206)	(0.0585)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1047	0.5494	42.4337[a]	5.1729[b]	0.0117	-6.3603	0.8726				
			(2.2578)							

Standard errors are in parenthesis. [a], [b] and [c] indicate that the p-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. ARCH (2) is the modified LM statistic for autoregressive conditional heteroscedasticity in residuals at 2 lags. Q-stat(2) is the Ljung-Box Q-statistic for autocorrelation residuals at 2 lags. J-B is the Jarque-Bera test of the normality of the regression residuals. *t*-dist is the *t*-distribution. SER is the standard error of regression. AIC is the Akaike Information Criterion. $\overline{R^2}$ is the adjusted R squared.

For example, for the FX rate effect, compared with nominal values results, there are 17 out of 28 cases that have more or higher lags that reach the significant levels (p-value ≤ 0.1) in real value results in the EGARCH models.

5.4.2 Mean Equation for ECM-GJR (Real Values)

The diagnostic statistics for the GJR are shown in Table 5.8. Similar to the EAGRCH estimation, there is very weak evidence to show the ARCH effect and auto-correlation existing in the residuals, but about 60% of the cases are significant in the J-B normality tests. Moreover, less than 40% of the cases are significant in the *t*-distribution assumption, while about 60% of the cases are in the EGARCH. Also, the SER and AIC are generally smaller than in the EGARCH estimation. Moreover, the $\overline{R^2}$ values increased dramatically in many cases under the GJR. For example, in the case of Finished manufacturers, the $\overline{R^2}$ in the EGARCH increased from 0.8675 to 0.8919 in the GJR estimations (see, Table 5.7 and Table 5.8 respectively).

Table 5.8 also displays the coefficients for the mean equation. As before, there are 13 out of 28 cases that have significant ECTs with different signs and magnitudes in different sectors. Again, there is strong evidence to show that the impact of the explanatory variables is not contemporaneous. More specifically, from the GJR results in Table 5.8, in the industry sector Clothing, the real FX rate has a long-term impact on the EPs, including the current FX rate and with intermittent lags up to 13, while the nominal FX rate has a short-term effect on the EPs, only the current FX rate and with lag 2 and 4 (see Table 5.6). This is because real value cannot be observed by the agent directly, so exporters delay their response to the real FX rate fluctuation.

Table 5.8 ECM Estimates of the GJR Regression Coefficients under the *t*-density (Real Values)

Food and live animals										
Cereals and animal feeding stuffs										
ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-6}	ΔPPi_{t}	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}
-0.1624[a]	-0.1649[a]	-0.0954[c]	0.7468[a]	-0.1633[a]	-0.2097[a]	-0.1669[a]	0.1069[c]	-0.1133[b]	-0.1207[b]	-0.1083[a]
(0.0414)	(0.0509)	(0.0521)	(0.0354)	(0.0578)	(0.0545)	(0.0525)	(0.0658)	(0.0552)	(0.0499)	(0.0418)
ΔE_{t-12}	ΔE_{t-13}									
0.1346[a]	0.0966[c]									
(0.0405)	(0.0493)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.5355	0.0861	5.2523[c]	18.1032	0.0272	-5.2577	0.5338				
			(26.0475)							
Food										
ECT_{t-1}	ΔX_{t}	ΔX_{t-1}	ΔPPi_{t}	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-6}
0.0001	-0.1372[b]	-0.1566[b]	1.1947[a]	0.4787[a]	0.0694[b]	0.0834[a]	0.2290[a]	-0.1069[b]	-0.2785[a]	0.0469[c]
(0.0001)	(0.0572)	(0.0615)	(0.0703)	(0.1239)	(0.0303)	(0.0307)	(0.0720)	(0.0430)	(0.0777)	(0.0249)
ΔE_{t-7}	ΔE_{t-12}									
-0.1418[b]	-0.0990[a]									
(0.0668)	(0.0362)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
2.9671[c]	1.4299	3.5666	20.0841	0.0117	-6.2747	0.8669				
			(52.7947)							
Fruit and vegetables										
ΔX_{t-9}	ΔPPi_{t}	ΔPPi_{t-8}	ΔE_{t-10}	ΔE_{t-13}						
-0.1148[b]	0.9928[a]	-0.1770[a]	-0.0767[c]	0.1458[a]						
(0.0472)	(0.0567)	(0.0535)	(0.0409)	(0.0374)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
3.5012[b]	5.9066[c]	20.3779[a]	5.6798[b]	0.0349	-4.3698	0.4866				
			(2.7388)							
Meat										
ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_{t}	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-12}
-0.2696[a]	-0.3333[a]	-0.3510[a]	0.2424[b]	-0.2875[a]	0.7168[a]	-0.3375[a]	-0.2049[b]	0.3977[a]	0.3320[b]	-0.4979[a]
(0.0818)	(0.1255)	(0.1143)	(0.1044)	(0.0834)	(0.1156)	(0.0849)	(0.1022)	(0.1332)	(0.1375)	(0.1385)
ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-5}	ΔE_{t-6}							
-0.3746[a]	-0.1700[a]	-0.2675[a]	-0.1472[a]							
(0.0549)	(0.0615)	(0.0595)	(0.0559)							

Table 5.8 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.2659	0.3538	3.4554	16.1840	0.0380	-3.8529	0.4015
			(27.4634)			

Beverages and tobacco

Beverages and tobacco

α	ECT_{t-1}	ΔX_t	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-10}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}
-0.0588[b]	-0.0129[b]	-0.1577[a]	-0.1119[a]	-0.1105[a]	-0.1802[a]	-0.0439[c]	0.9744[a]	0.3955[a]	0.1496[a]	0.1172[a]
(0.0236)	(0.0052)	(0.0348)	(0.0231)	(0.0383)	(0.0254)	(0.0262)	(0.0387)	(0.0655)	(0.0443)	(0.0306)
ΔPPi_{t-9}	ΔPPi_{t-11}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-6}	ΔE_{t-10}	ΔE_{t-11}			
-0.1318[a]	-0.2081[a]	-0.1438[a]	-0.0621[c]	-0.2175[a]	-0.1408[a]	0.1253[a]	0.1122[b]			
(0.0303)	(0.0507)	(0.0342)	(0.0322)	(0.0453)	(0.0394)	(0.0294)	(0.0455)			
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0067	0.9253	79850.8[a]	2.0383[a]	0.0160	-5.8388	0.7388				
			(0.0560)							

Basic materials

Metal ores

α	ECT_{t-1}	ΔX_{t-5}	ΔX_{t-6}	ΔX_{t-11}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-7}
-0.0980[b]	-0.0222[b]	-0.2427[b]	0.2927[a]	-0.1473[a]	0.7844[a]	-0.2566[a]	-0.1925[b]	0.4036[a]	-0.3649[b]	0.2510[b]
(0.0433)	(0.0096)	(0.1080)	(0.1046)	(0.0536)	(0.0918)	(0.0905)	(0.0750)	(0.1463)	(0.1473)	(0.1108)
ΔPPi_{t-8}	ΔE_{t-6}	ΔE_{t-7}								
0.2594[a]	0.2631[a]	0.1169[c]								
(0.0803)	(0.0653)	(0.0645)								
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.7063	0.0390	0.7284	25.3065	0.0307	-4.2079	0.5173				
			(62.9462)							

Textile fibres

ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-10}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-10}
0.1219[b]	-0.2547[a]	-0.0933[c]	0.1461[b]	0.6609[a]	0.1383[c]	0.1966[b]	-0.0934[c]	-0.1131[b]	0.2022[a]	-0.1905[b]
(0.0556)	(0.0640)	(0.0525)	(0.0676)	(0.0625)	(0.0804)	(0.0777)	(0.0490)	(0.0533)	(0.0737)	(0.0799)
ΔPPi_{t-11}	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-6}	ΔE_{t-11}						
-0.2138[a]	-0.3664[a]	-0.1156[c]	-0.1452[b]	0.1070[c]						
(0.0704)	(0.0628)	(0.0644)	(0.0618)	(0.0608)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.5468	0.0779	2.8223	19.9940	0.0192	-4.9936	0.7195				
			(31.7517)							

Table 5.8 Cont'd

Fuels										
Fuels										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-5}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-6}	ΔPPi_{t-7}
-0.2000[b]	-0.0449[b]	-0.6554[a]	0.4970[a]	-0.5054[a]	-0.4340[a]	-0.3961[a]	1.8339[a]	-0.7203[a]	-0.4362[a]	-0.3031[b]
(0.0803)	(0.0178)	(0.1454)	(0.1295)	(0.0890)	(0.1259)	(0.0968)	(0.1572)	(0.1321)	(0.1079)	(0.1530)
ΔPPi_{t-11}	ΔE_{t-3}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-10}						
-0.2958[a]	0.1789[a]	0.1471[c]	0.1553[a]	0.1688[a]						
(0.1037)	(0.0464)	(0.0806)	(0.0465)	(0.0528)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.0153	2.4610	3.5071	103.3575	0.0458	-3.4208	0.4451				
			(1663.235)							
Chemicals										
Chemicals										
α	ECT_{t-1}	ΔX_t	ΔX_{t-5}	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}
0.0454[a]	0.0102[a]	-0.3098[a]	-0.0690[a]	0.0452[a]	1.2633[a]	-0.0892[a]	0.1417[b]	-0.0909[a]	-0.0667[a]	-0.0540[b]
(0.0006)	(0.0001)	(0.0349)	(0.0177)	(0.0161)	(0.0394)	(0.0252)	(0.0570)	(0.0261)	(0.0235)	(0.0246)
ΔE_{t-13}										
-0.1405[a]										
(0.0497)										
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0778	0.2688	2.2252	19.8059	0.0126	-6.2839	0.8620				
			(38.9534)							
Organic chemicals										
ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-6}	ΔX_{t-9}	ΔX_{t-10}	ΔPPi_t	ΔPPi_{t-1}
-0.0033[a]	-0.3933[a]	0.0804[c]	0.0752[b]	0.1364[a]	0.2087[a]	-0.1611[a]	0.0985[a]	0.1204[a]	1.4560[a]	0.2131[b]
(0.0005)	(0.0295)	(0.0480)	(0.0360)	(0.0305)	(0.0324)	(0.0404)	(0.0274)	(0.0288)	(0.0436)	(0.1068)
ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-5}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-6}
0.1725[a]	0.1539[a]	0.1115[a]	0.3558[a]	0.2102[a]	0.1227[b]	0.2011[a]	0.1134[a]	0.2270[a]	-0.1881[a]	-0.0974[b]
(0.0445)	(0.0373)	(0.0324)	(0.0776)	(0.0488)	(0.0510)	(0.0304)	(0.0314)	(0.0465)	(0.0605)	(0.0478)
ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-9}	ΔE_{t-10}	ΔE_{t-13}						
-0.0928[b]	-0.0846[b]	0.0544[b]	0.0513[b]	-0.1860[a]						
(0.0367)	(0.0359)	(0.0277)	(0.0249)	(0.0337)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0119	0.0472	152156.2[a]	2.3076[a]	0.0252	-5.4055	0.6180				
			(0.3746)							

Table 5.8 Cont'd

Inorganic chemicals										
α	ECT_{t-1}	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-5}	ΔX_{t-6}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-4}	ΔPPi_{t-5}	ΔE_{t-1}
-0.1053[a]	-0.0225[a]	-0.1615[a]	0.0690[c]	-0.1883[a]	-0.0609[c]	1.1298[a]	0.2225[a]	-0.1133[a]	0.2433[a]	-0.2796[a]
(0.0166)	(0.0036)	(0.0458)	(0.0362)	(0.0520)	(0.0325)	(0.0528)	(0.0682)	(0.0429)	(0.0823)	(0.0661)
ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-5}	ΔE_{t-7}	ΔE_{t-9}	ΔE_{t-10}					
-0.1534[a]	-0.1221[a]	-0.1355[a]	-0.0610[b]	-0.0310[c]	0.0720[a]					
(0.0418)	(0.0330)	(0.0430)	(0.0271)	(0.0175)	(0.0240)					
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.2396	2.0247	1066.529[a]	3.5236[a]	0.0475	-4.6210	0.1569				
			(0.9093)							
Plastics										
α	ECT_{t-1}	ΔX_{t-1}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔPPi_{t-9}	ΔE_{t-1}	ΔE_{t-4}	ΔE_{t-9}
-0.0261	-0.0055	-0.2757[a]	-0.0465	0.9609[a]	0.4643[a]	-0.0752[c]	0.1393	-0.2356[a]	-0.0635[b]	-0.1070[c]
(0.0254)	(0.0058)	(0.0661)	(0.0525)	(0.0438)	(0.1022)	(0.0408)	(0.0921)	(0.0712)	(0.0317)	(0.0560)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3387	1.5928	25.7543[a]	17.9137	0.0142	-5.6450	0.8297				
			(16.0754)							
Material manufactures										
Iron and steel										
ΔX_t	ΔX_{t-5}	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-6}	ΔPPi_{t-13}	ΔE_{t-3}	ΔE_{t-4}	ΔE_{t-9}
-0.1457[a]	-0.0906[b]	-0.0664[b]	0.9550[a]	0.1192[b]	-0.1120[a]	-0.0670[c]	-0.0859[c]	-0.1332[a]	-0.1068[a]	-0.0920[a]
(0.0548)	(0.0376)	(0.0300)	(0.0338)	(0.0588)	(0.0410)	(0.0405)	(0.0450)	(0.0429)	(0.0355)	(0.0340)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.4734	0.1796	5.6643[c]	13.6079	0.0135	-5.8395	0.8364				
			(14.2996)							
Paper and paperboard										
ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-4}	ΔPPi_t	ΔPPi_{t-3}	ΔPPi_{t-4}				
-0.0004[a]	-0.2583[a]	-0.0883[b]	0.1788[a]	1.1533[a]	-0.1033[a]	-0.2172[a]				
(0.0001)	(0.0564)	(0.0361)	(0.0599)	(0.0592)	(0.0377)	(0.0638)				
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0914	3.1064	0.3134	23.9937	0.0208	-5.3102	0.6718				
			(46.3727)							
Material manufactures										
ΔX_t	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-3}	ΔE_{t-1}					
-0.4106[a]	0.0370[c]	1.3728[a]	0.1432[b]	-0.0800[a]	-0.1842[a]					

Table 5.8 Cont'd

(0.0404)	(0.0222)	(0.0476)	(0.0604)	(0.0224)	(0.0557)					
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
1.0138	0.7084	115.9219[a]	8.7970[b]	0.0191	-5.7933	0.7389				
			(3.5750)							
Mineral manufactures less precious stones										
ECT_{t-1}	ΔX_t	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-7}	ΔX_{t-10}	ΔX_{t-11}	ΔPPi_t	ΔPPi_{t-4}	ΔPPi_{t-9}	ΔE_{t-1}
0.0005[a]	-0.2238[a]	-0.1340[a]	0.0835[b]	0.0716[a]	-0.0727[b]	-0.0660[a]	1.1728[a]	0.1962[a]	-0.0965[a]	-0.0727[b]
(0.0002)	(0.0445)	(0.0476)	(0.0336)	(0.0244)	(0.0367)	(0.0248)	(0.0489)	(0.0642)	(0.0350)	(0.0294)
ΔE_{t-10}										
-0.1014[b]										
(0.0428)										
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
2.7159[c]	2.6297	12.3238[a]	19.8904	0.0188	-5.8452	0.7224				
			(27.9706)							
Miscellaneous metal manufactures										
ΔX_t	ΔX_{t-2}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-7}	ΔE_{t-1}	ΔE_{t-6}	
-0.1900[a]	-0.1554[a]	1.1415[a]	0.3596[a]	0.2286[a]	-0.0522[b]	-0.1413[b]	0.0496[c]	-0.3395[a]	0.1402[b]	
(0.0422)	(0.0431)	(0.0457)	(0.0696)	(0.0466)	(0.0223)	(0.0586)	(0.0265)	(0.0668)	(0.0569)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.1927	0.2461	12.6165[a]	15.4242	0.0138	-6.0470	0.8186				
			(14.4613)							
Non-ferrous metals										
ECT_{t-1}	ΔX_t	ΔX_{t-5}	ΔX_{t-11}	ΔX_{t-12}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-5}	ΔPPi_{t-9}	ΔE_{t-1}
0.0001	-0.1027[b]	-0.1668[a]	-0.0784[b]	0.1369[a]	0.7836[a]	-0.0889[b]	-0.0900[a]	0.1006[c]	-0.1245[a]	-0.1132[a]
(0.0001)	(0.0492)	(0.0531)	(0.0332)	(0.0404)	(0.0499)	(0.0397)	(0.0346)	(0.0530)	(0.0317)	(0.0335)
ΔE_{t-4}	ΔE_{t-10}									
-0.1159[a]	-0.1015[a]									
(0.0337)	(0.0337)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R}^2$				
0.1088	1.7908	552.6006[a]	3.4533[a]	0.0241	-5.0777	0.5876				
			(0.9894)							
Textiles										
ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-11}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-4}	ΔPPi_{t-13}	ΔE_{t-2}	ΔE_{t-6}	
-0.1195[b]	-0.0934[b]	-0.0757[c]	-0.0671[b]	0.8933[a]	0.1378[b]	-0.1234[a]	0.1749[a]	-0.1129[b]	-0.0763[b]	
(0.0493)	(0.0412)	(0.0390)	(0.0289)	(0.0349)	(0.0598)	(0.0434)	(0.0347)	(0.0447)	(0.0365)	

Table 5.8 Cont'd

ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1226	0.3730	190.1533[a]	19.4899 (12.0214)	0.0114	-6.1729	0.8625				
Machinery and transport equipment										
Electronic machinery										
α	ΔX_{t-4}	ΔPPi_t	ΔE_{t-3}							
-0.0030[b] (0.0012)	-0.0928[a] (0.0355)	1.0371[a] (0.0403)	-0.0906[b] (0.0380)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1503	1.1794	61.9851[a]	19.9760 (15.2208)	0.0178	-5.3295	0.7640				
Machinery and transport equipment										
α	ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-5}	ΔX_{t-8}	ΔX_{t-10}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-5}	ΔPPi_{t-8}
-0.0020[b] (0.0008)	-0.1289[a] (0.0418)	-0.1074[b] (0.0466)	-0.0768[a] (0.0265)	-0.1339[a] (0.0444)	0.1174[b] (0.0515)	-0.0821[c] (0.0447)	1.1224[a] (0.0497)	0.2340[a] (0.0798)	0.1310[b] (0.0541)	-0.1407[b] (0.0594)
ΔPPi_{t-10}	ΔPPi_{t-13}	ΔE_{t-2}	ΔE_{t-4}	ΔE_{t-13}						
0.0892[c] (0.0525)	-0.2169[a] (0.0696)	-0.1422[a] (0.0548)	-0.0903[a] (0.0277)	0.1705[a] (0.0623)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
2.8359	0.8850	4.9311[c]	19.9958 (24.1331)	0.0111	-6.1527	0.8875				
Machinery										
α	ΔX_{t-1}	ΔX_{t-3}	ΔX_{t-6}	ΔX_{t-7}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-6}	ΔPPi_{t-13}	ΔE_{t-2}	ΔE_{t-4}
-0.0022[b] (0.0009)	-0.1271[a] (0.0403)	-0.1139[a] (0.0362)	-0.1399[c] (0.0714)	0.0626[b] (0.0282)	-0.1236[a] (0.0392)	0.9233[a] (0.0445)	0.2089[a] (0.0790)	-0.1363[a] (0.0442)	-0.0965[a] (0.0370)	-0.1105[a] (0.0322)
ΔE_{t-10}	ΔE_{t-13}									
-0.0807[a] (0.0305)	0.1158[a] (0.0415)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.3117	1.8221	92.1567[a]	19.9992 (13.0104)	0.0134	-5.8154	0.8467				
Road vehicles										
ΔX_t	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-9}	ΔX_{t-12}	ΔX_{t-13}	ΔPPi_t	ΔPPi_{t-2}	ΔPPi_{t-3}	ΔPPi_{t-6}
-0.1027[b] (0.0403)	-0.1497[a] (0.0405)	0.1210[a] (0.0393)	-0.0785[a] (0.0241)	-0.0606[b] (0.0288)	0.1135[a] (0.0425)	-0.0625[b] (0.0262)	1.0608[a] (0.0486)	0.1091[b] (0.0481)	-0.1798[a] (0.0522)	-0.0951[b] (0.0434)

Table 5.8 Cont'd

ΔPPi_{t-7}	ΔPPi_{t-8}	ΔPPi_{t-10}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔE_{t-6}	ΔE_{t-7}	ΔE_{t-8}	ΔE_{t-10}	ΔE_{t-12}	
0.2042[a]	0.0952[c]	0.1053[b]	-0.1090[a]	-0.2957[a]	0.0864[b]	-0.1830[a]	-0.0913[b]	-0.1292[a]	0.1193[b]	
(0.0454)	(0.0494)	(0.0532)	(0.0334)	(0.0785)	(0.0377)	(0.0407)	(0.0405)	(0.0483)	(0.0537)	
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0779	0.1394	3453.848[a]	5.6386[a]	0.0133	-6.1289	0.8511				
			(1.2410)							
Miscellaneous										
Clothing										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔX_{t-3}	ΔX_{t-4}	ΔX_{t-5}	ΔX_{t-9}	ΔX_{t-10}	ΔX_{t-13}
-0.3305[a]	-0.0122[a]	-0.3030[a]	-0.0938[a]	-0.0870[a]	-0.0484[b]	0.0770[a]	-0.0297[a]	0.1189[a]	-0.0266[a]	-0.0889[a]
(0.0360)	(0.0022)	(0.0246)	(0.0177)	(0.0160)	(0.0207)	(0.0254)	(0.0114)	(0.0256)	(0.0101)	(0.0220)
ΔPPi_t	ΔPPi_{t-4}	ΔPPi_{t-6}	ΔPPi_{t-8}	ΔPPi_{t-9}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔPPi_{t-13}	ΔE_{t-1}	ΔE_{t-3}	ΔE_{t-4}
1.2051[a]	-0.2029[a]	-0.0124[a]	0.1313[a]	-0.3033[a]	-0.0712[a]	-0.1366[a]	0.1648[a]	0.0783[a]	-0.0863[a]	0.1086[a]
(0.0355)	(0.0506)	(0.0021)	(0.0379)	(0.0496)	(0.0144)	(0.0333)	(0.0368)	(0.0242)	(0.0226)	(0.0341)
ΔE_{t-8}	ΔE_{t-9}	ΔE_{t-12}	ΔE_{t-13}							
-0.1243[a]	0.1802[a]	0.1665[a]	-0.1125[a]							
(0.0370)	(0.0306)	(0.0332)	(0.0214)							
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
1.1201	0.6324	0.7813	20.1995	0.0178	-6.1478	0.7275				
			(46.7787)							
Clothing and footwear										
α	ECT_{t-1}	ΔX_t	ΔX_{t-1}	ΔX_{t-2}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-2}	ΔPPi_{t-11}	ΔPPi_{t-12}	ΔPPi_{t-13}
-0.0530[a]	-0.0116[a]	-0.2786[a]	-0.0768[b]	-0.1019[a]	1.2016[a]	0.1088[c]	0.0960[b]	-0.1575[a]	-0.1492[b]	-0.0660[b]
(0.0150)	(0.0033)	(0.0382)	(0.0391)	(0.0391)	(0.0515)	(0.0569)	(0.0458)	(0.0500)	(0.0589)	(0.0333)
ΔE_{t-11}	ΔE_{t-12}									
0.1581[a]	0.1849[a]									
(0.0501)	(0.0537)									
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.0148	1.5681	26.4776[a]	5.6265[b]	0.0155	-6.1339	0.7800				
			(2.5117)							
Scientific and photographic										
α	ΔX_t	ΔX_{t-1}	ΔX_{t-4}	ΔX_{t-6}	ΔX_{t-9}	ΔPPi_t	ΔPPi_{t-1}	ΔPPi_{t-4}	ΔPPi_{t-12}	ΔE_{t-7}
-0.1924[a]	0.3249[a]	-0.2640[b]	-0.1110[a]	0.1198[a]	-0.1231[a]	0.2804[a]	0.1410[a]	0.1326[a]	0.1104[a]	0.1568[a]
(0.0557)	(0.0436)	(0.0457)	(0.0441)	(0.0416)	(0.0344)	(0.0361)	(0.0310)	(0.0297)	(0.0337)	(0.0404)
ΔE_{t-11}										

Table 5.8 Cont'd

-0.1172^{a}						
(0.0370)						
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.4998	1.7228	2.9721	19.9611	0.0140	-5.7040	0.8002
			(29.9857)			

Others

Finished manufactures

ECT_{t-1}	ΔX_t	ΔX_{t-8}	ΔPPi_t	ΔPPi_{t-5}	ΔPPi_{t-7}	ΔPPi_{t-10}	ΔPPi_{t-12}	ΔE_{t-6}	ΔE_{t-9}	ΔE_{t-12}
-0.0015^{b}	-0.1945^{a}	0.1032^{a}	1.2051^{a}	0.0654^{a}	0.1032^{a}	0.0652^{b}	-0.1339^{b}	0.0874^{a}	0.0717^{a}	0.1342^{b}
(0.0006)	(0.0349)	(0.0271)	(0.0491)	(0.0242)	(0.0301)	(0.0264)	(0.0680)	(0.0259)	(0.0278)	(0.0623)
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$				
0.1064	1.4867	47.8421^{a}	5.8425^{b}	0.0109	-6.3085	0.8919				
			(2.4352)							

Finished manufactures less erratic

ECT_{t-1}	ΔX_t	ΔPPi_t				
0.0003^{a}	-0.1815^{a}	1.1749^{a}				
(0.0001)	(0.0336)	(0.0395)				
ARCH(2)	Q-stat(2)	J-B	*t*-dist	SER	AIC	$\overline{R^2}$
0.2651	2.7454	55.5587^{a}	4.6033^{a}	0.0115	-6.3189	0.8765
			(1.7512)			

Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p*-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. ARCH (2) is the modified LM statistic for autoregressive conditional heteroscedasticity in residuals at 2 lags. Q-stat(2) is the Ljung-Box Q-statistic for autocorrelation residuals at 2 lags. J-B is the Jarque-Bera test of the normality of the regression residuals. *t*-dist is the *t*-distribution. SER is the standard error of regression. AIC is the Akaike Information Criterion. $\overline{R^2}$ is the adjusted R squared.

Therefore, the real value results confirm that UK exporters apply PTM strategy – a result consistent with the nominal estimation. Also, the real values impact lasts longer than the nominal one. Overall, the real value appears to generate stronger evidence of PTM.

5.4.3 Variance Equation for ECM (Real Values)

The results for the variance equation for both the EGARCH and GJR estimates are given in Table 5.9. First of all, the mean, ω is significant in more than half of the cases in both models. Moreover, the coefficient κ is significant in about 75% (54%) of the cases under the EGARCH (GJR) estimation, so κ again captures the effects of last period's shock in most of the cases. The θ coefficient is significant in 46% (82%) of the cases under the EGARCH (GJR) model, so the estimations are suitable for the data sets with strong GARCH effects. Moreover, κ is much smaller than θ in 90% of the cases under the GJR, while that is near to a half of the cases under the EGARCH. The GJR results suggest that the variables contain memory that is longer than one period and that the degree of volatility is more sensitive to own lagged values than to recent shocks. In terms of the coefficient of asymmetry, φ is significant in 40% (54%) of the cases under the EGARCH (GJR) model. As before, the results show that the impact of positive innovation is more powerful where the asymmetry exists. Compared with the nominal value results, the asymmetric effects are more significant in the real values. Finally, the dummy variable is significant in about half of the cases in both models.

Table 5.9 ECM Estimates of the EGARCH and GJR Variance Equation (Real Values)

	Panel A						Panel B				
	ω	κ	φ	θ	$D_{t,1987}*$		ω	κ	φ	θ	$D_{t,1987}*$
Food and live animals											
Cereals and animal feeding stuffs											
EGRACH	-8.5668[a]	2.0309[a]	0.2501	0.1805[c]		GJR	0.0000[a]	0.0359	-0.1098[b]	0.9765[a]	
	(0.6724)	(0.3631)	(0.1643)	(0.1002)			(0.0000)	(0.0587)	(0.0510)	(0.0378)	
Food											
EGRACH	-7.8457[a]	-0.8836[a]	0.7621[a]	0.0784		GJR	0.0000	0.0194	-0.0911[a]	1.0059[a]	
	(1.0281)	(0.2641)	(0.1988)	(0.1045)			(0.0000)	(0.0163)	(0.0119)	(0.0172)	
Fruit and vegetables											
EGRACH	-7.0643[a]	0.3775[b]	-0.2532[a]	0.0466	0.0182	GJR	0.0000	0.0378	-0.1065[b]	1.0059[a]	0.0025[a]
	(2.4138)	(0.1776)	(0.0940)	(0.3416)	(5.2695)		(0.0000)	(0.0268)	(0.0528)	(0.0052)	(0.0008)
Meat											
EGRACH	-6.6054[a]	0.2808	0.1463	0.0574	-7.2224[a]	GJR	0.0002[b]	0.2354[b]	-0.3837[a]	0.7505[a]	-0.0025[a]
	(2.0524)	(0.2412)	(0.1461)	(0.3065)	(2.3691)		(0.0001)	(0.1193)	(0.1361)	(0.1076)	(0.0009)
Beverages and tobacco											
Beverages and tobacco											
EGRACH	-5.0247[b]	1.7646	0.1258	0.3892[c]	0.0799[b]	GJR	0.0000	-0.1538	4.4344	0.8893[a]	
	(2.1260)	(2.9574)	(0.4149)	(0.2171)	(0.0350)		(0.0000)	(0.6029)	(6.0329)	(0.0317)	
Basic materials											
Metal Ores											
EGRACH	-7.2606	0.0484	0.0541	-0.0203	-11.9871[b]	GJR	0.0000[c]	0.0864	-0.1652[b]	0.9650[a]	0.0013
	(4.6657)	(0.2090)	(0.1422)	(0.6596)	(5.2796)		(0.0000)	(0.0587)	(0.0692)	(0.0319)	(0.0011)
Textile fibres											
EGRACH	-12.2083[a]	1.1891[a]	0.0070	-0.3817[a]	-6.3563[a]	GJR	0.0002	0.0963	-0.0476	0.4400	-0.0003
	(0.9947)	(0.2416)	(0.1087)	(0.1291)	(2.0120)		(0.0002)	(0.1496)	(0.1608)	(0.7615)	(0.0010)
Fuels											
Fuels											
EGRACH	-8.0778[a]	2.0967[a]	0.1345	0.0289		GJR	0.0029[a]	0.2660[a]	-0.1127[c]	-0.9784[a]	
	(0.7517)	(0.3470)	(0.2154)	(0.1318)			(0.0006)	(0.0772)	(0.0636)	(0.0373)	
Chemicals											
Chemicals											
EGRACH	-0.0441	-0.0668	0.0220	0.9912[a]	3.4099[a]	GJR	0.0000	0.0162[a]	-0.0626[a]	0.9920[a]	0.0006[a]
	(0.0793)	(0.0653)	(0.0528)	(0.0075)	(0.5013)		(0.0000)	(0.0025)	(0.0158)	(0.0040)	(0.0002)
Organic chemicals											
EGRACH	-0.3886[a]	0.2274[a]	0.0392	0.9757[a]	3.0207[b]	GJR	0.0000	0.5888	1.6143	0.6147[a]	0.0050

Table 5.9 Cont'd

	Panel A						Panel B				
	ω	κ	φ	θ	$D_{t,1987}*$		ω	κ	φ	θ	$D_{t,1987}*$
	(0.1429)	(0.0844)	(0.0667)	(0.0131)	(0.8420)		(0.0000)	(0.6785)	(1.7485)	(0.0663)	(0.0115)
Inorganic chemicals											
EGRACH	-0.0441	-0.0631	-0.0068	0.9917[a]	4.3134[a]	GJR	0.0000[b]	1.4100[b]	0.1085	0.2369[a]	0.0005
	(0.0729)	(0.0688)	(0.0432)	(0.0044)	(0.5164)		(0.0000)	(0.6010)	(0.6889)	(0.0769)	(0.0135)
Plastics											
EGRACH	-6.8124	0.4272[c]	0.0245	0.2335	0.4297	GJR	0.0001	0.1778	-0.0595	0.2573	-0.0001
	(4.3495)	(0.2383)	(0.1524)	(0.5133)	(27.7761)		(0.0001)	(0.1463)	(0.1809)	(0.4537)	(0.0002)
Material manufactures											
Iron and steel											
EGRACH	-10.3693[a]	2.1679[a]	0.1256	0.0619[a]		GJR	0.0000[c]	0.2559[b]	-0.3266[a]	0.7966[a]	
	(1.1805)	(0.4613)	(0.1950)	(0.1554)			(0.0000)	(0.1091)	(0.1191)	(0.0903)	
Paper and paperboard											
EGRACH	-6.5276[a]	0.8284[a]	0.3143[c]	0.2739	0.5338	GJR	0.0000	0.0770[a]	-0.1433[a]	0.9972[a]	0.0011[a]
	(1.6385)	(0.2593)	(0.1643)	(0.2002)	(14.9229)		(0.0000)	(0.0029)	(0.0140)	(0.0084)	(0.0002)
Material manufactures											
EGRACH	-0.9149[a]	0.6690[a]	0.2747[a]	0.9558[a]	2.5847[b]	GJR	0.0000	0.5068	-0.3726[b]	0.7095[c]	0.0010
	(0.2703)	(0.1346)	(0.0908)	(0.0290)	(1.0591)		(0.0000)	(0.2110)	(0.2177)	(0.0662)	(0.0009)
Mineral manufactures less precious stones											
EGRACH	-0.5599[a]	-0.2077[b]	0.8131[a]	0.9317[a]		GJR	0.0000[b]	0.2687[b]	-0.3444[a]	0.8588[a]	
	(0.1252)	(0.1041)	(0.1598)	(0.0156)			(0.0000)	(0.1045)	(0.1037)	(0.0455)	
Miscellaneous metal manufactures											
EGRACH	-7.1989[a]	1.0727[a]	0.1568	0.2931[b]	0.0603	GJR	0.0000[c]	0.3488[b]	-0.3246[b]	0.7581[a]	0.0008
	(1.2572)	(0.2194)	(0.1254)	(0.1472)	(36.5193)		(0.0000)	(0.1483)	(0.1494)	(0.0886)	(0.0007)
Non-ferrous metals											
EGRACH	-7.4901[a]	-2.0356[a]	-1.8979[a]	-0.1001	3.3260	GJR	0.0000	-0.0896[b]	0.1328[b]	1.0069[a]	0.0005
	(0.7422)	(0.5049)	(0.4692)	(0.1047)	(11.1525)		(0.0000)	(0.0392)	(0.0627)	(0.0187)	(0.0004)
Textiles											
EGRACH	-5.3851[a]	1.1790[a]	0.4541[a]	0.5306[a]		GJR	0.0000	0.0948	-0.1951	0.5858	
	(1.4169)	(0.2762)	(0.1479)	(0.1580)			(0.0000)	(0.1733)	(0.1903)	(0.3942)	
Machinery and transport equipment											
Electronic machinery											
EGRACH	-7.9419[a]	0.5735[a]	0.1800	0.1016	-7.6171[a]	GJR	0.0001[a]	0.3487[b]	-0.3182[c]	0.3535[c]	-0.0002
	(1.4894)	(0.1909)	(0.1177)	(0.1844)	(2.0158)		(0.0001)	(0.1765)	(0.1779)	(0.1957)	(0.0000)
Machinery and transport equipment											

Table 5.9 Cont'd

	Panel A						Panel B				
	ω	κ	φ	θ	$D_{t,1987}$*		ω	κ	φ	θ	$D_{t,1987}$*
EGRACH	-8.8886[b]	-0.0904	-0.0113	0.0055	-11.3264	GJR	0.0001[c]	0.1441	-0.1970	0.4133	-0.0001[a]
	(4.2677)	(0.2025)	(0.1435)	(0.4751)	(8.3036)		(0.0000)	(0.1528)	(0.1585)	(0.3459)	(0.0000)
Machinery											
EGRACH	-7.9993[a]	0.4430[c]	-0.4567[b]	0.0845	-9.2991	GJR	0.0001	0.1025	0.0090	0.5017[c]	-0.0001
	(2.0707)	(0.2623)	(0.2234)	(0.2233)	(17.1182)		(0.0000)	(0.1075)	(0.1378)	(0.2774)	(0.0003)
Road vehicles											
EGRACH	-5.2105	0.3002	0.2242	0.4337[a]	1.7124	GJR	0.0000[a]	0.0852	-0.0965[c]	0.9269	0.0005
	(3.9044)	(0.2136)	(0.1644)	(0.4382)	(6.7642)		(0.0000)	(0.0532)	(0.0518)	(0.0285)	(0.0005)
Miscellaneous											
Clothing											
EGRACH	-5.9537[a]	1.9873[a]	-0.2057	0.5202[a]	1.2317	GJR	0.0000	1.2533[a]	0.1890	0.2559[a]	0.0003
	(0.9147)	(0.2891)	(0.1725)	(0.1129)	(6.3330)		(0.0000)	(0.3172)	(0.5131)	(0.0577)	(0.0072)
Clothing and footwear											
EGRACH	-8.6039[a]	0.7471[b]	-0.2235	0.0503	-10.7762[a]	GJR	0.0000[a]	-0.0220[b]	-0.0066	0.9937[a]	0.0009[a]
	(2.0493)	(0.3320)	(0.1835)	(0.2517)	(8.5227)		(0.0000)	(0.0110)	(0.0191)	(0.0029)	(0.0002)
Scientific and photographic											
EGRACH	-8.0283[a]	-1.8888[a]	1.8644[a]	-0.0250		GJR	0.0001	-0.0619	-0.0777	0.5687	
	(1.0038)	(0.2908)	(0.2316)	(0.1184)			(0.0001)	(0.0624)	(0.0619)	(0.3938)	
Others											
Finished manufactures											
EGRACH	-6.8329[a]	-1.4099[a]	1.4489[a]	0.1666	-15.2824[a]	GJR	0.0000	0.1743[c]	-0.0753	0.8317[a]	0.0001
	(0.9352)	(0.2647)	(0.2153)	(0.1054)	(2.2904)		(0.0000)	(0.0893)	(0.1279)	(0.0761)	(0.0002)
Finished manufactures less erratic											
EGRACH	-0.8737[b]	0.3497[a]	0.1877[b]	0.9347[a]	-1.2053	GJR	0.0000	0.3321[b]	-0.2208	0.7666[a]	-0.0001[a]
	(0.3605)	(0.1293)	(0.0950)	(0.0367)	(0.8922)		(0.0000)	(0.1539)	(0.1845)	(0.0819)	(0.0001)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the p-value is statistically significant at a 1-, 5- or 10-percernt level, respectively. * Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for those industries.

5.4.4 Comparison for Real and Nominal Values

The results are further summarised based on a comparison for nominal and real values of the ECMs (see Table 5.10). The empirical results show that an inflation effect exists in the PTM strategy, since the real values have more and higher lags that affect the EPs significantly. Also, there are more significant ECTs in the real values than that in the nominal values.

Furthermore, it is hard to distinguish the real and nominal value estimations statistically. For example, in the EGARCH models, regarding the *t*–distribution, J-B normality, ARCH (2), Q-stat (2) tests, there are only one or two cases difference between nominal and real outcomes. In the GJR models, the nominal values model is more *t*-distributed than that of the real value models, as only 5 cases have significant *t*–distribution in the nominal estimation while 11 have this distribution in the real values models. In terms of the J-B normality, ARCH (2) and Q-stat (2), the results are similar in the both models.

It is worth noting that GJR models always perform better than EGARCH models in both nominal and real value estimations.

5.10 Comparison for Nominal and Real ECM estimations

	No. of sig. ECT		No. of sig. *t*-dist		No. of sig. J-B		No. of sig. ARCH (1)		No. of sig. Q-stat (2)	
	Nominal	*real*	Nominal	*real*	Nominal	*real*	Nominal	*real*	Nominal	*real*
EGARCH	13	*17*	19	*17*	25	*23*	4	2	3	3
GJR	13	*15*	5	*11*	18	*19*	1	3	1	*1*

t-dist is the *t*-distribution. J-B is the Jarque-Bera test of the normality of the regression residuals. ARCH (1) is the modified LM statistic for autoregressive conditional heteroscedasticity in residuals at 1 lags. Q-stat(2) is the Ljung-Box Q-statistic for autocorrelation residuals at 2 lags.

5.5 Conclusion

This chapter has provided results based on co-integration and error-correction modelling. It has also presented results based on real values. The findings indicate that the majority of these sets of series are co-integrated. However, the ECTs in the ECMs are significant for 13 out of 28 time series. This result holds for estimates based on both real and nominal values.

The results indicate that PPIs, FX rates and EPs have a long-term equilibrium relation, since exporters use PTM strategy to adjust their EPs according to the FX rate fluctuation as well as the PPIs movement, until the shocks disappear eventually. Alternatively, it implies that the FX rate has decreasing effects on foreign customers' local currency prices. This is a common phenomenon in many other countries, for example, Mihailov (2005) investigated the FX rate pass-through on aggregate prices in the US, Germany and Japan by using the VARs system. He found that pass-through on IPs has declined in the 1990s relative to the 1980s.

Finally, after various diagnostic tests, it is clear that GRJ estimations perform better than the EGARCH estimations.

CHAPTER 6

Cross-Sectional Regression for the Second-Stage Analysis

6.1 Introduction

Since significant PTM effects have been found in the first-stage time series analysis (see Chapters 4 and 5), the exposure coefficients are used to assess the determinants of PTM amongst exporters at this stage. With the exception of Yang (1998), most prior studies only estimate the exposure coefficients in PTM models. Thus, this study's findings in the second stage analysis provide an indication of some of the factors that can affect the PTM exposure coefficients. Those factors are related to theoretical work that emphasises marginal costs, and market share, amongst others (see Chapter 2). The cross-sectional model is introduced in section 6.2, and is followed by a description of data sets and various estimation methods in section 6.3. The findings are discussed in section 6.4, and finally, a conclusion is offered in section 6.5.

6.2 The Second-stage Model

Three explanatory variables are used in the cross-sectional regression, these being measures of product differentiation, market share and marginal cost. These variables were obtained from

Yang (1998), and are chosen for theoretical reasons (see below). The cross-sectional regression is similar to Yang's (1998). However, the model has been improved from a simple OLS regression to GMM regression and logit estimation.

The cross-sectional regression can be written as follows:

$$\beta_k = \alpha + \rho PD_k + \eta MC_k + \pi MR_k + D_{1987} * + \varepsilon_k \tag{6.1}$$

where

β_k represents any of the PTM exposure (elasticity) estimated at the first-stage analysis for industry *k*.
PD_k represents the variable measuring the degree of product differentiation for industry *k*.
MC_k represents measures of the variability of marginal cost for industry *k*.
MR_k represents measures of export share as the ratio of export to total domestic production in the UK market for industry *k*.
* D_{1987} is the dummy variable, which is only applied to the Logit model. Dummy=0 represents the period 1986M01 – 1995M12. Otherwise, 1.

It is worth noting that, the PTM coefficients β_k are typically negative from the first stage analysis, so the actual relationship (positive/negative) between β_k and the explanatory variables will give an opposite sign (negative/positive respectively) for the explanatory variables' coefficients. In particular, ρ is expected to have a negative relationship with β_k, so the sign for coefficient ρ should be positive. According to Knetter (1993), industry differences are important in understanding differences in PTM behaviour. Thus, exporters with a higher degree of product differentiation face less pressure to adjust their sterling prices when FX rates change. In this case, exporters will exhibit less PTM such that importers will experience FX rate pass-through. Moreover, as discussed in the literature review (see section 2.4.2.2), the higher the degree of substitutability, the higher the demand elasticity of the product. That is, when the product is more substitutable and product differentiation is not strong, demand is very sensitive to the price changes. Empirically, Yang (1996) claims that highly differentiated products are relatively insensitive to demand elasticity. So sellers have a greater ability to maintain their own currency prices and pass the FX rate shocks through to local currency prices in target markets. Nevertheless, the elasticity of marginal cost will affect the PTM positively, so the sign for coefficient η is expected to be negative. If there are large variations in marginal costs because of production changes, exporters are more likely to adjust their sterling prices to keep sales and production relatively stable. Finally, the sign for π is predicted to be positive, because market share should have a negative relationship with PTM strategy. Theoretically, higher export shares represent more competitive advantage, so exporters with high market share are less likely to adjust their sterling prices for their products. Thus, importers will absorb a larger portion of FX rates' effects.

6.2.1 Product Differentiation

Piana (2003) indicates that product differentiation allows a substantial amount of price discrimination. Furthermore, intra-industry trade (IIT) is a useful measure of product differentiation (see e.g., Grubel and Lloyd, 1975; Greenaway and Milner, 1983) since IIT allows the trading of related specialist products. Ruffin (1999) emphasises that intra-industry trade is different from inter-industry trade[48], and intra-industry trade is more beneficial than inter-industry trade because it stimulates innovation and exploits economies of scale. He illustrates this using an example of the US importation of Japanese cars and trucks that led to improvements/innovations in US car and truck manufactures. Also, better exploitation of economies of scale can be seen in a limited number of products within the car industry.

[48] Intra-industry trade occurs when a country exports and imports goods in the same industry, while inter-industry trade happens when countries export and import the product of different industries (Ruffin, 1999).

Originally, IIT was proposed by Grubel and Lloyd (1975). To generate that IIT measure, we estimate:

$$B_j = \left[1 - \frac{|X_j - M_j|}{(X_j + M_j)}\right] \times 100 \qquad (6.2)$$

where

j represents the *j*th of *n* industries at a given level of statistical aggregation and

$$0 \leq B_j \leq 100 \qquad (6.3)$$

Grubel and Lloyd (1975) form the B_j by using third digit data of the SITC. Since IIT developed on the basis of the SITC data, it is appropriate to apply IIT to the SITC data that were employed in this study.

The measure can be simplified to (see Yang, 1998)

$$IIT_k = 1 - |X_k - M_k| / (X_k + M_k) \qquad (6.4)$$

where

X_k and M_k represents the values of exports and imports in industry *k* respectively.

Thus, the index is expected to be between 0 and 1. A higher value of the index implies a higher degree of product differentiation. Furthermore, products with high differentiation should have small demand elasticity of price, both because of higher production cost and greater satisfaction for clients, which would be partly reflected in a higher profit margin. As a consequence, products with high differentiation can be *insensitive* to the FX rate fluctuation and the exporters are less likely to PTM.

6.2.2 Marginal Cost

According to Yang (1997), the capital-to-labour (CTL) ratio can be a proxy for the variability of marginal cost. The CTL[49] can be written as:

$$CTL_k = A_k / WJ_k \tag{6.5}$$

where

A_k represents fixed asset[50] for industry k.
WJ_k represents workforce jobs[51] for industry k.

Basically, CTL ratio indicates output per labour, which could also represent a measure of productivity. On average, more output produced by an individual worker means the factory realises higher productivity, which also implies that labour is used more intensively, requiring a rise in the wages and hence, a rise in unit cost of production. Moreover, Yang (1997) suggests that manufacturers with higher CTL have more difficulties in adjusting their production in the short run, than those manufacturers with a lower CTL requirement. Hence, the marginal cost is more variable in industries with higher CTL requirements.

[49] Yang (1998) defines CTL as total asset divided by total number of employees. However, in UK, those variables are not available, so the closest variables were chosen.
[50] This is exclusive of expenditure on land and existing buildings (Monthly Digest, 2005).
[51] Workforce jobs measure the number of jobs (Monthly Digest, 2005).

Theoretically, firms with higher variability of marginal cost are more likely to operate PTM, so as to control production and limit the CTL requirement (see Chapter 2). This is because, in microeconomic theory, after the short term decreases at the beginning, the marginal cost increases with increases in production. That means every extra item produced by a factory will cause its marginal cost to increase. Under this circumstance, in order to maximise profits, firms should produce when the marginal cost is less than, or equal to, the marginal revenue, and should stop production just prior to the marginal cost equating the marginal revenue. Therefore, firms have to ensure that the product is profitable, requiring the mark-up to be more than the cost. Consequently, if firms have high marginal costs (or CTL), they need to pay more to produce an extra unit product, so they will need to PTM when the product's mark-up cannot cover the marginal cost. This relationship would be more pronounced in the case where the currency's depreciation leads to an increase in export demand, thus requiring a greater output. Hence, exporters will PTM by increasing their product price in order to control the production (demand). However, since the UK is a small-open economy, exporters would prefer to increase market share rather than control production.

6.2.3 Market Share

The more products exporters sell abroad, the more competitive they will behave in international markets. Hence, they are less likely to adjust their prices when FX rates change. The export market share is computed as:

$$MR_k = EO_k / TDP_k \tag{6.6}$$

where

EO_k represents export output for industry k.

TDP_k represents total domestic production for industry k.

6.3 Data Sets and Estimation Methods

The data for the explanatory variables are taken from DataStream. All the data are at monthly frequency except for the data used to compute CTL, which are at quarterly frequency since they can only be obtained at this frequency. The dependent variable is the PTM coefficients from the ECM-GJR[52] [53] at the first-stage, because this estimation has been found to be the best estimate from the previous experiments in this study. Here, in the second-stage analysis, two sets of PTM coefficients are required, since the data will be analysed in two ways, these being in one continuous run of 20 years, and as two separate data sets of 10 years each. Firstly, the ECM-GJR results (see Table 5.4) show the FX rates' effect for the full 20 years. Since there are lags in the contemporaneous and lagged PTM coefficients, these are summed for each export sector in order to construct the dependent variable. Secondly, the cross-sectional regression is also estimated by splitting the 20 years of data into two and then re-estimating the exposure coefficients over both sub-periods. The ECM-GJR estimation is re-run to obtain the new PTM coefficients from 1986M01 to 1995M12 and from 1996M01 to 2005M03. In order to ensure the possibility of comparison, the same lag structure as the 20-year ECM structure is retained. The benefit of splitting the 20-year period is that this doubles the sample size to 56 observations. The explanatory variables are estimated in a similar manner where the data is split into two to produce two 10-year periods[54].

[52] For the GJR estimates (see Table 5.4), industry inorganic chemicals does not has any coefficients for the PTM elasticity, so one (two) missing value(s) for the dependent variable is obtained in the 20 (10) years estimation.

[53] Nominal value is used in the second-stage analysis, since it is observable.

[54] 1986M01 – 1995M12 and 1996M01 – 2005M03.

The cross-sectional regression is estimated using OLS, GMM and Logit regression. The estimation method chosen must ensure estimation consistency, unbiasedness, and efficiency, and hence, must be free of heteroscedasticity and residual serial correlation. This cannot be guaranteed under the OLS approach since the variables may be highly correlated. Alternatively, GMM is free from these restrictions. It allows the residuals to be both conditionally heteroscedastic and serially correlated (see, e.g., Hansen, 1982). Also, Wooldridge (2001) states that GMM can be more efficient than the fixed effects estimator, when either serial correlation or heteroscedasticity exists in the residuals. Furthermore, Arellano and Bond (1991) indicate that a two-stage GMM generates reliable coefficient estimates. More importantly, the GMM provides an opportunity to capture the omitted variables. For example, the marginal cost measure may be correlated with unobserved elements that can also affect PTM, such as productivity (see chapter 2 for more detail). Here, according to the data availability in UK, output per hour and output per job are identified to measure the productivity (marginal cost). Thus, a two-stage GMM procedure is employed, in which the first differences of each variable in Eq. (6.1) are estimated, and then the level-explanatory variables[55] are used as instruments together with output per hour and output per job. Differencing is a common method to eliminate the unobserved effect[56] (Wooldridge, 2001).

The logit model is estimated since the dependent variable of the PTM coefficient can have either a positive or negative sign. To estimate the logistic model, PTM coefficients with positive values are allocated in group 1, while PTM coefficients with negative values are allocated in group 0. The unequal rates of the two groups will cause the results to be less accurate (Maddala, 2001).

[55] Some studies (see, Laeven, 2003) used lagged values in the instrument variables to sort out the serial correlation problems, but in this study, OLS results show that the residuals are not serially correlated (see Table 6.1). Additionally, Wooldridge (2001) emphasizes the lagged values in the application of time series and panel data, but not in cross-sectional data. Further, since limited number of observations, the dependent variable is not included in the instruments, so to avoid reducing the degree of freedom for *J*-statistic by large number of instruments (Imrohoroglu, 1994).

[56] The OLS results show that heteroscedasticity is present in the residuals (see Table 6.1).

Some studies (see e.g., Joseph, 2000) denote that a minimum of 20% for either of the groups is reasonable. For this study, the data amounts to 56[57] PTM observations, which include 46 observations in group 0 and 8 observations in group 1. Finally, a dummy variable is included to examine whether PTM behaves differently in those two intervals for the case of the logit model.

6.4 Empirical Results

6.4.1 Results For the Full 20-Year Period

Firstly, the diagnostic statistic are shown in Table 6.1, it seems that the $\overline{R^2}$ (0.3996 vs. -0.1828) and SER (0.1928 vs. 0.2730) perform better in OLS than that in GMM. Also, the F-statistic in OLS can reject the null hypothesis that all of the slope coefficients (excluding the constant) in a regression are zero. Further, the $Q^2(2)$ and LM(2) statistics demonstrate that the residuals in the OLS are not serial correlated. J-B statistic indicate that the OLS residuals are normal distributed. However, the ARCH-LM (2) is significant, so there is ARCH effect in the OLS residuals. Nevertheless, ARCH effects are eliminated in the GMM estimation. More importantly, the Hansen's J test of over-identifying restrictions, which measures whether some variable used as an instrument should really be an explanatory variable (Hansen, 1982), is used. The J-stat is not significant, thereby indicating that good instrument variables have been included, so the GMM has captured the omitted information.

Panel A in Table 6.1 shows the results for the OLS and GMM models. Particularly, the results for OLS estimation display significant positive coefficients for PD, which demonstrate the strong negative relationship between PTM and PD. This result is consistent with this study's prediction

[57] The 56 observations include the two missing variables for the industry Inorganic chemicals.

as well as with that of other studies (see, Yang, 1998). So, the results reveal that UK exporters with highly differentiated products use this advantage to absorb more profit from FX rate fluctuation.

Table 6.1 Second-Stage Results Based on 20-Year Average Data

Panel A: Estimates of the OLS Regression Coefficients

α	PD	MC	MR	$\overline{R}^2$	SER
-0.5371	2.4988[a]	-0.0004	-2.3485[b]	0.3996	0.1928
(1.1092)	(0.7659)	(0.0138)	(0.8643)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	F-Stat
-0.3183	4.0515	0.0361	2.7173[c]	1.5580	6.7686[a]

Panel B: Estimates of the GMM Regression Coefficients

α	PD	MC	MR	$\overline{R}^2$	SER
-0.4089[a]	2.7132[a]	-0.0229	-3.2988[a]	-0.1828	0.2730
(0.046)	(0.5965)	(0.0160)	(1.1401)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	J-Stat
N/A	0.4104	0.4735	0.7956	0.8870	0.0442

Notes: Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-% level, respectively. $\overline{R}^2$ is the adjusted Goodness-of-fit. SER is the standard error of regression. AIC is the Akaike info criterion. Q (2) is the Q-statistic tests for residuals in lag 2. LM (2) is the auto-correlation LM tests for residuals in lag 2. ARCH-LM (2) is the ARCH effect tests for residuals in lag 2. J-B is the normality test for residuals. F-stat is for the joint test in OLS, while the J-stat is for the Hansen's test to over-identify restrictions in GMM.

Nevertheless, the CTL ratio is not significant at conventional levels. An insignificant coefficient has also been found in previous studies (see, e.g., Yang, 1996 and 1998), the possible reason being that marginal cost is correlated with much other information, which hopefully can be sorted out by the GMM approach. Additionally, UK exporters would prefer to increase the market share and are not keen on increasing the EPs by taking into account marginal cost. Furthermore, the CTL for some industries can be very similar or low, so the movement is not significant. Moreover, it could be because the CTL is not a good proxy for marginal cost, and therefore fails to capture the relationship between PTM and marginal cost. In fact, Yang (1998) also comments that the prediction that exporters tend to PTM more in industries with higher CTL ratios may be too arbitrary, and that further theoretical justification for this finding may be needed. Nor is it possible to use price indices to measure marginal cost. Indeed, Bowe and Saltvedt (2004) claim that price indices are not pure cost data, so they are bad proxies for marginal cost. Therefore, the impact of CTL (or marginal cost) may need to be further modified.

In addition, according to Dornbusch (1987), market share has been an important element in modelling FX rate pass-through in the literature. When exporters set their prices, they have already taken account of the demand of both home and foreign markets. More importantly, as discussed in Chapter 2, market share effects on exporters' PTM could be two-fold. Firstly, when firms obtain larger market shares, they have greater market power, and face lower price elasticity of demand. This means that their importers' demand will be little affected by their price changes. Hence, they are more competitive to maintain their local currency price when FX rates change. Thus, the relationship between market share and PTM is negative. In this case, they can gain more profit, but this could be the compensation for a higher risk of losing some market share. Secondly, exporters' attitudes to market share and international competitiveness could affect PTM differently. Some exporters are more interested in market share rather than taking advantage of it to absorb profit. When they have a larger market share, they might not be willing to lose this advantage in the competitive target market, and hence, prefer to keep the same prices to their loyal customers. Thus, the relationship between market share and PTM should be positive, and especially when the exporters' currency is appreciated, they will reduce their local currency price in order to protect their market shares. The net effect of these two cases depends on the exporters' attitudes in the country and competitiveness in the target market. In terms of the UK, the National Balance of Payment account[58] shows that most industries have a negative value due to the industries' export values being less than import values. So, exporters should recognise that a lack of exports is a cause of the national account's decline. Moreover, the UK faces much pressure to export to its target market, which is the US. UK exporters would PTM to the target

[58] From Monthly Review of External Trade Statistics February 2005.

market, in order to gain some competitive advantages. In 2003, the UK exported 15.3% of its total exports to the US[59]. It is likely that UK exporters would have to PTM their goods to remain competitive in the US market. Empirically, the results from this study support the contention that market share is positively associated with PTM in the UK. This is exactly the situation in the UK.

The GMM results are presented in Panel B in Table 6.1, which confirm the OLS estimates. Notice that the constant is now significant under this approach. The GMM results indicate that the coefficients are consistently estimated.

6.4.2 Results for the Two 10-year Periods

A first look at the diagnostic statistic in Table 6.2, as before, the $\overline{R^2}$ (0.0217 vs. -0.1542) perform better in OLS than that in GMM, but SER (0.4348 vs. 0.3792) is lower in the GMM. Although the results show that there is not ARCH effects existing in the OLS residuals, but the $Q^2(2)$ and LM(2) are significant as well as the J-B normality tests. The F-statistic cannot reject the null hypothesis. However, the auto-correlation problems are solved and the $Q^2(2)$ and LM(2) are not significant in GMM. Again, the *J*-stat is not significant, thereby implying that good instrument variables are identified. Compared with the OLS diagnostic results, the logit model produces smaller SER and AIC. Additionally, this model solves the serial correlation problem in $Q^2(2)$. In addition, the percentage gain is 10.88, which indicates that the logit model has improved 10.88% in comparison with the default model. Moreover, the goodness-of-fit is not significant, which means there is no significant difference between the actual and predicted values.

[59] In 2003, the UK's top 10 export markets were US, Germany, France, Netherlands, Irish Rep, Belgium-Lux, Spain, Italy, Sweden and Japan with 15.3, 11.0, 10.0, 7.2, 6.5, 6.0, 4.7, 4.6, 2.0 and 2.0% of total UK exports respectively (see UK national Balance of Payment account). Since most of those countries are in the single currency under the same FX rate influence, my description of the US-UK situation should be interpreted with some caution.

This section presents the results for the situation where the 20-year sample is divided into two 10-year periods. In Panel A in Table 6.2, the OLS results show that MR affects PTM significantly, but the PD and CTL seem not to matter to PTM. The only difference from the OLS results in Table 6.1 is that PD now becomes insignificant in the analysis of the shorter time periods analysis. This implies that UK exporters absorbed the profits from FX rate fluctuation incrementally rather than dramatically, but the negative relation between PD and EPs can be recognised in the long term (e.g., the 20-year period). Actually, this is a very good strategy, because they reduced the risk of losing their market share. However, some problems have emerged in the diagnostic statistics for the OLS estimations, since the J-B test reveals that the residuals are not normally-distributed, and the $Q^2(2)$ and LM(2) express that the residuals are auto-correlated.

Table 6.2 Second-Stage Results Based on 10 Years Average Data

Panel A: Estimates of the OLS Regression Coefficients

α	PD	MC	MR	$\overline{R^2}$	SER
0.3888	1.0405	-0.0057	-1.7074[c]	0.0217	0.4348
(1.4609)	(1.2054)	(0.0211)	(0.9292)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	F-Stat
1.2434	5.1860[c]	2.8891[b]	1.0589	159.2703[a]	1.3920

Panel B: Estimates of the GMM Regression Coefficients

α	PD	MC	MR	$\overline{R^2}$	SER
-0.2889[a]	1.8619	0.0354	-1.3685[b]	-0.1542	0.3792
(0.0535)	(1.5332)	(0.0306)	(0.6036)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	J-Stat
N/A	0.6072	0.3795	0.0869	8.2409[b]	0.0693

Panel C: Estimates of the Logit Regression Coefficients

α	PD	MC	MR	D_{1987}	$\overline{R^2}$
-5.8838	3.0534	0.0539	1.9421	-2.3887[b]	N/A
(11.0114)	(9.8479)	(0.1442)	(6.2983)	(1.2153)	
SER	AIC	$Q^2(2)$	Percent Gain	Goodness-of-fit	J-B
0.3515	0.9094	2.3783	10.88	6.5052	27.9075[a]

Notes: Standard errors are in parenthesis. [a], [b] and [c] indicate that the *P-value* is statistically significant at a 1-, 5- or 10% level, respectively. N_1 indicates the number of negative PTM coefficients while N_2 indicates the number of positive PTM coefficients. SER is the standard error of regression. AIC is the Akaike info criterion. Q (2) is Q-statistic tests for residuals in lag 2. LM (2) is the auto-correlation LM tests for residuals in lag 2. ARCH-LM (2) is the ARCH effect tests for residuals in lag 2. J-B is the normality test for residuals. Percent Grain is the percent of incorrect (default) prediction corrected by equation. Goodness-of-Fit is Pearson χ^2-type test (Hosmer-Lemeshow, 1989) while $\overline{R^2}$ here is Mcfadden R-square. F-stat is for joint test in OLS, while the J-stat is for the Hansen's over-identifying restrictions in GMM.

The GMM results presented in Panel B in Table 6.2, confirm the findings obtained from OLS, but the constant has become significant.

Furthermore, Panel C in Table 6.2 reveals the result for the Logit estimation, showing that the coefficients are not significant, with the exception of the dummy variable. This finding can only indicate that PTM behaved dramatically differently between the two specified periods. This seems to match the UK's situation. To illustrate, Fig. 6.1, shows that sterling depreciated dramatically from 1986M01 to 1995M12 and increased significantly from 1996M01 – 2005M03. This result also suggests that UK exporters tend to use different PTM strategy when their currency goes in different directions. As mentioned earlier, the US is the UK's biggest export market, so when sterling becomes more expensive, UK exporters reduce their EPs to the same degree that sterling appreciates. In contrast, if sterling depreciates, they raise their prices to a lesser extent or even reduce them.

Figure 6.1 Plot of Sterling Index

6.4.3 Sensitivity of Intra-Industry Trade for UK

Since empirical results from previous sections show that PD is an important element for PTM, it is necessary to undertake further research in this area. As can be seen from Eq.(6.4), the absolute value shows the difference between export and import values in the country, but it seems that the IIT ignores the sign. Therefore, it is necessary to take off the absolute term and see how this changes the results. It was mentioned in section 6.3.1, that the UK's export values are less than its import values, so this is a very good example to test the sensitivity of IIT. Thus, this new measure accounts for the sign of the variable, as follows:

$$IIT_k' = 1 - (X_k - M_k)/(X_k + M_k) \tag{6.7}$$

Using this new IIT to run the OLS, GMM and Logit model again, the results in Tables 6.3 and 6.4 are obtained. In general, these are similar to those in Tables 6.1 and 6.2, except for the signs of PD. Focusing on the coefficient of the PD, Tables 6.3 and 6.4 indicate that the relationship between PD and the firm's pricing behaviour is positive, because they are carrying negative signs. This finding contrasts with my prediction that firms with highly differentiated production are less likely to adjust their price. This might be because the absolute term gives a more comprehensive definition to IIT that the difference within industries can be presented either by the export values being more than import values, or the import values being more than export values. However, if the absolute term has been taken off, the IIT is true only when export values are more than import values. In this case, when the UK's export values are less than the import values, the IIT cannot be a good proxy to PD and the results are biased.

Table 6.3 Second-Stage Results Based on 20 Years Average Data Without Absolute Terms

Panel A: Estimates of the OLS Regression Coefficients

α	PD	MC	MR	$\overline{R^2}$	SER
4.4479[a]	-2.2718[a]	0.0013	-2.6071[b]	0.4104	0.1911
(1.1346)	(0.677)	(0.0136)	(0.8598)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	F-Stat
-0.3365	1.9805	0.0679	1.0763	1.5874	7.0331[a]

Panel B: Estimates of the GMM Regression Coefficients

α	PD	MC	MR	$\overline{R^2}$	SER
-0.4127[a]	-2.3982[a]	0.034[b]	-3.1871[a]	-0.2315	0.2786
(0.046)	(0.0164)	(0.0160)	(1.1425)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	J-Stat
N/A	0.5681	0.3	0.8315	0.5324	0.0483

Notes: Standard errors are in parenthesis. [a], [b] and [c] indicate that the *P-value* is statistically significant at a 1-, 5- or 10% level, respectively. $\overline{R^2}$ is the adjusted Goodness-of-fit. SER is the standard error of regression. AIC is the Akaike info criterion. Q (2) is the Q-statistic tests for residuals in lag 2. LM (2) is the auto-correlation LM tests for residuals in lag 2. ARCH-LM (2) is the ARCH effect tests for residuals in lag 2. J-B is the normality test for residuals. F-stat is for the joint test in OLS, while the J-stat is for the Hansen's over-identifying restrictions in GMM.

Table 6.4 Second-Stage Results Based on 10 Years Average Data Without Absolute Terms

Panel A: Estimates of the OLS Regression Coefficients

α	PD	MC	MR	$\overline{R^2}$	SER
5.2634[c]	-1.32	-0.1998	-3.9467[c]	0.1034	0.5533
(1.4609)	(1.5426)	(0.1459)	(1.9589)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	F-Stat
1.7949	3.172	2.0222	0.3842	34.6005[a]	1.961

Panel B: Estimates of the GMM Regression Coefficients

α	PD	MC	MR	$\overline{R^2}$	SER
-0.3196[a]	-1.2793	-0.1466	-1.4787	-0.2039	0.4855
(0.0855)	(1.1351)	(0.1072)	(1.1652)		
AIC	$Q^2(2)$	LM(2)	ARCH-LM(2)	J-B	J-Stat
N/A	0.355	0.1183	0.7353	1.1365	0.1761

Panel C: Estimates of the Logit Regression Coefficients

α	PD	MC	MR	D_{1987}	$\overline{R^2}$
12.7909	-3.7931	-0.1686	-9.9852	-1.1204	N/A
(15.4309)	(8.0425)	(0.6980)	(11.3718)	(1.3943)	
SER	AIC	$Q^2(2)$	Percent Grain	Goodness-of-fit	J-B
0.4087	1.2338	0.1159	13.19	7.236	6.3245[b]

Notes: Standard errors are in parenthesis. [a], [b] and [c] indicate that the *P-value* is statistically significant at a 1-, 5- or 10% level, respectively. N_1 indicates the number of negative PTM coefficients while N_2 indicates the number of positive PTM coefficients. SER is the standard error of regression. AIC is the Akaike info criterion. Q (2) is the Q-statistic tests for residuals in lag 2. LM (2) is the auto-correlation LM tests for residuals in lag 2. ARCH-LM (2) is the ARCH effect tests for residuals in lag 2. J-B is the normality test for residuals. Percent Grain is the percentage of incorrect (default) prediction corrected by equation. Goodness-of-Fit is Pearson χ^2 -type test (Hosmer-Lemeshow, 1989) while $\overline{R^2}$ here is Mcfadden R-square. F-stat is for the joint test in OLS, while the J-stat is for the Hansen's over-identifying restrictions in GMM.

6.5 Conclusion

Most previous studies on PTM only estimate PTM elasticity, and have not valuated the determinants of the PTM decision, although the determinants are strongly supported by theory. In the second-stage analysis, this study employed various approaches to establish that PD is related to PTM negatively while MR is associated with PTM positively. The empirical results suggest that UK exporters are ambitious in expanding their market share in the world market, especially in those industries that have a small market share or are just entering the market. The results also demonstrate that exporters attempt to operate PTM more intensively and provide a lower price to foreign customers. The investigation for CTL also highlights the fact that UK exporters are keen on market share and will not control production by considering marginal cost. Nevertheless, industries with a highly differentiated product, could be seen to reduce their prices less, in order to absorb more profit when FX rate changes.

Thus, UK exporters do not excessively PTM. Rather, they seek to protect their profit margins by considering their market proposition. This helps to limit the FX rate pass-through, while still allowing them to remain competitive.

CHAPTER 7

Conclusion and Further Research

This empirical study has investigated the extent of PTM strategy in the UK export sector, and empirically estimated the relationship between EPs, FX rates and PPIs. It is noteworthy that no such prior study exists for UK data and that several novel approaches have been applied to model the data. Specifically, the findings can be summarised below together with their empirical and theoretical implications:

i) The preliminary data results indicate that there is very little evidence of seasonal unit root in the data. Previous studies tend to automatically adjust seasonal data without specifically testing for seasonal unit root. This approach is likely to affect the parameter estimates of PTM models when this transformation is not required. Consequently, the results from this study would appear to be more informative about the PTM strategies adopted by UK exporters.

ii) Two particular models of PTM were estimated. The first was a standard dynamic model which is probably mis-specified. The second was a dynamic model devised by the researcher in which EGARCH and GJR estimation methods are employed to take account of the relationship between import and export prices, which whilst being supported in theoretical work, is entirely ignored in empirical work. The dynamic model indicates that there is a useful relation between import and export prices which can be a reflection of international competition amongst similar industries. The PTM effect is strong. The most noteworthy feature is that FX rates are found to have more of an effect on the PTM than PPIs. There is a tendency for the GJR to better capture the data generating process of the data. However, there is still a great deal of non-linearity in the residuals – a finding consistent with empirical work in other areas of economics.

iii) The preferred model is an ECM. This modelling approach followed from the finding of co-integration based on Johansen. Again, although prior work has estimated an ECM using standard OLS, such studies have not tested for co-integration. It is useful to note that the restriction imposed on the co-integrating vectors has not supported the assumption of proportionality in the relation between EP and FX rate. However, this might be due to the weakness of the LR statistic.

iv) The ECMs were estimated using both EGARCH and GJR, and this is the only known study to adopt this approach. Furthermore, the results suggest that the GJR is a better specification than the EGARCH in terms of the AIC and the coefficient for *t*-distribution. Both ECMs provide strong evidence for PTM although the GJR provided a stronger case. In general, the results indicate that EPs are negatively associated with FX rate changes. However, the magnitude of the PTM coefficients varies across export sectors, being more pronounced in Beverage and tobacco, Fuels and Chemicals sectors, and not apparent at all in other industries such as Food and live animals and Basic materials. The GARCH approach provides useful insights into the leverage effect of PTM. When there is a leverage effect, positive shocks tend to have larger impact on the volatility of PTM than negative shocks. It is worth noting that the same finding was obtained in the preliminary data analysis. The variance equation indicates strong GARCH effects but asymmetry is relatively weak. This result is similar for the dynamic model. The Engle and Ng (1993) tests indicate that positive and negative shocks do not have a strong impact on the volatility of the PTM. It is also worth noting that prior studies use alternative approaches to test for asymmetric exposure in FX rate changes. These approaches have also generated weak results (see, e.g., Knetter, 1994). This study's results for nominal values on the extent of asymmetry captured by the variance equations partly explain why earlier approaches have been relatively unsuccessful. In terms of those results, it would appear that exporters tend to adjust export prices in a relatively smooth manner in line with FX rate changes. Despite the weak results for asymmetry, the approach to testing for asymmetry in the EPs in relation to the FX rate changes seems more consistent with the PTM strategies of UK exporters as it is the EPs that they adjust (not the FX rates) when they observe variation in FX rates.

v) PTM is also tested for by using real prices of the data, and similar effects are found, but the estimates based on real values require more lags then the nominal case. This suggests that there is more information in real values despite such values not being observable by agents. Further, the additional lags in real values suggest that the system takes more time to adjust, which in an error-correction framework, is econometrically important. The GARCH effect is also strong. Interestingly, the extent of asymmetry in the data is stronger for real values of the data, and the study finds almost twice as much significant coefficient for asymmetry. Thus, real values give better support for the asymmetric effect. In this context, it would be useful for future studies to apply the Engle and Ng (1993) test to specifically investigate the impacts of negative and positive shocks as this would indicate which type of shock dominates for real values.

vi) Since significant PTM has been found in the first-stage time series analysis, the determinants of PTM in the second stage are also examined, using a set of cross-sectional regressions. The determinants of PTM are economically important in the attempt to capture the environment in which PTM decisions are made. For example, foreign market share can impact on the extent of PTM undertaken by UK exporters. The cross-sectional relationship is estimated using a logit model, two-stage GMM estimation and standard OLS. The two-stage GMM estimation method is the preferred approach as it ensures estimation consistency. Again, only Yang (1998) has used a cross-sectional analysis but this was for US data, and his model was estimated using standard OLS which can result in estimation problems. This study's results are generally consistent with economic theory. The two-stage GMM generated the best diagnostic results. The coefficient for marginal is not significant. However, the coefficients for product differentiation and market share are significant and of the predicted sign. Overall, the results suggest that even if UK exporters PTM, the extent of this varies and certain factors can explain the amount of PTM undertaken. The logit model performed very poorly. Only the dummy variable for structural break is significant. The weak results might be a refection of the disproportionate occurrence of positive PTM coefficients in the transformation of the dummy dependent variable. It would be useful for future research to explore the determinants of PTM exposure using real values as this might show variation in the determinants of PTM.

There are of course other specific limitations of the study that deserve some mention. As indicated in section 3.4, due to the limitation of the data, it was not always possible to match specific EPs and PPIs on a one-to-one basis in terms of a given industry sector. This is a restriction imposed by data availability. To the best of the researcher's knowledge, better data is not available for the UK but it might be useful to adopt this study's approach for another country if better data is available. It would, of course, be useful to estimate PTM using alternative GARCH models. Although Engle and Ng (1993) suggest that the EGARCH and GJR models perform best in capturing asymmetry, there is generally some variation in the extent to which GARCH models as a whole, capture the non-linearity in time series data. Similarly, from the variance equation, the sum of the coefficient of the lagged residuals and variance (GARCH effect) is equal to one, suggesting that an IGARCH model might be appropriate for estimating the PTM model in this thesis. Furthermore, it might be useful to combine the asymmetry in the FX rate exposure into the variance equation to determine whether in fact, the direction of the FX rate change matters. The volatility of interest rates can also have an effect and this can also be modelled in the variance equation. Further, there is a recent study by (Barhoumi, 2006), he applied panel data into various non-stationary panel estimation techniques. However, he used low frequency annual data. Also, similar to prior studies, his research is a cross-country analysis. Thus, it would be interesting that apply monthly panel data to UK for a cross-industry analysis. It would be useful to further estimate the second stage regression using better measures of marginal cost. However, despite those problems there is a consistency in this study's results and this promotes confidence in the estimates produced.

Finally, there are other practical implications that need to be mentioned. Firstly, PTM is popular in UK export sector. UK exporters use PTM to help them limit the FX rate pass-through effect, and keep their foreign local currency price relative stable via adjusting their mark-up, so that they can maintain their market share and profit. However, PTM implementation is based on sufficient mark-up. Zero or negative mark-up does not allow firms to PTM. Moreover, the degree of PTM is associated with industries competitiveness, and the empirical results demonstrate that PTM behaves differently across industries in UK export sectors. Further, unanticipated FX rate fluctuation can cause firms' bankruptcy, in turn leads to high unemployment. Consequently, PTM plays an important role on UK domestic welfare, e.g., employment, income, because PTM enhances consumption, demand and then production, so firms need to hire more employees or provide higher salaries to them. Moreover, PTM helps to solve the international trade imbalance problem and improve the domestic current account deficit. Nevertheless, although UK exporters are ambitious in expending market share, they still absorb some FX rate effects into their profit with highly differentiated products. Thus, UK exporters do not abuse PTM. They use PTM to limit the FX rate pass-through, but still maintain their profit margin in an optimal level.

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Appendix 1 Estimates of the EGARCH Regression Coefficients under the *t*-density

			Food and live animals							
	UK sterling trade-weighted rate		Cereals and animal feeding stuffs		Food		Fruit and vegetables♦		Meat	
$\mu_{0,i}$	0.0011	(0.0012)	0.0003	(0.0013)	0.0002	(0.0007)	0.0023	(0.0014)	0.0006	(0.0022)
$\xi_{i,t-1}$	0.1811[a]	(0.0684)	-0.1063[c]	(0.0640)	-0.1117[c]	(0.0666)	-0.1323[b]	(0.0604)	-0.1824[b]	(0.0791)
$\xi_{i,t-2}$	-0.1028[b]	(0.0511)	0.0609	(0.0602)	0.0198	(0.0639)	-0.0409	(0.0563)	0.0027	(0.0721)
$\xi_{i,t-3}$	-0.0087	(0.0537)	-0.0839	(0.0609)	0.0515	(0.0620)	-0.0653	(0.0632)	-0.0241	(0.0662)
$\xi_{i,t-4}$	0.1190[a]	(0.0446)	0.0230	(0.0618)			-0.0211	(0.0543)	-0.0777	(0.0680)
$\xi_{i,t-5}$	-0.0090	(0.0548)	0.1119[c]	(0.0592)			0.0708	(0.0585)	-0.1876[a]	(0.0646)
$\xi_{i,t-6}$	-0.0111	(0.0607)	-0.0202	(0.0619)			0.0146	(0.0517)	-0.0693	(0.0684)
$\xi_{i,t-7}$	0.0798[a]	(0.0298)	-0.0186	(0.0617)			0.0061	(0.0582)	-0.0525	(0.0667)
$\xi_{i,t-8}$	0.0550	(0.0608)	-0.0721	(0.0594)			-0.0263	(0.0557)	-0.0890	(0.0585)
$\xi_{i,t-9}$	-0.0214	(0.0544)	0.0139	(0.0588)			0.0161	(0.0568)	0.0677	(0.0565)
$\xi_{i,t-10}$			-0.0124	(0.0560)			-0.1162[b]	(0.0555)	0.0150	(0.0637)
$\xi_{i,t-11}$			0.0208	(0.0528)			-0.0140	(0.0569)	0.0918	(0.0650)
$\xi_{i,t-12}$			0.2311[a]	(0.0554)			0.0481	(0.0552)	0.2362[a]	(0.0613)
$\xi_{i,t-13}$			0.1072[b]	(0.0529)			0.1822[a]	(0.0509)	0.1083[c]	(0.0612)
$\overline{R}^2$	-0.0150		0.0593		-0.0418		0.0387		0.1026	
AIC	0.0154		-4.6053		-5.7178		-4.2653		-3.6888	
ω_i	-9.7240[a]	(2.5647)	-0.2565[a]	(0.1091)	0.0089	(0.0943)	-0.0565	(0.0532)	-1.1648	(0.7333)
κ_i	0.6623[a]	(0.1946)	0.2362[b]	(0.1094)	-0.0077	(0.0799)	-0.0602	(0.0684)	0.2049	(0.1350)
φ_i	-0.0655	(0.1297)	-0.0463	(0.0656)	0.0343	(0.0372)	0.1079[c]	(0.0583)	0.2122[b]	(0.0920)
θ_i	-0.0801	(0.3020)	0.9904[a]	(0.0105)	1.0022[a]	(0.0063)	0.9872[a]	(0.0105)	0.8504[a]	(0.1037)
$D_{t,1987}$*	-18.7465[a]	(3.3966)	2.0336[b]	(0.8075)	2.4183[a]	(0.4271)	1.6289[a]	(0.5187)	-0.9093	(1.7196)
t-dist	7.7541	(4.8391)	3.6699[a]	(1.1793)	13.0449	(9.4992)	3.6165	(1.2626)	21.4224	(40.0385)

Appendix 1 Cont'd

	Beverages and Tobacco		Basic materials				Fuels		Chemicals	
	Beverages and Tobacco		Metal Ores		Textile fibres		Fuels		Chemicals	
$\mu_{0,i}$	0.0027[a]	(0.0007)	0.0026	(0.0021)	0.0007	(0.0008)	0.0009	(0.0042)	-0.0003	(0.0008)
$\xi_{i,t-1}$	-0.1630[a]	(0.0469)	0.0452	(0.0634)	-0.3564[a]	(0.0329)	0.1861[b]	(0.0778)	-0.0643	(0.0817)
$\xi_{i,t-2}$	-0.0199	(0.0516)					-0.0516	(0.0629)	0.1216[b]	(0.0631)
$\xi_{i,t-3}$	0.1001[c]	(0.0544)					0.0564	(0.0605)		
$\xi_{i,t-4}$							-0.1400[b]	(0.0674)		
$\xi_{i,t-5}$							-0.0183	(0.0614)		
$\xi_{i,t-6}$							-0.0224	(0.0681)		
$\xi_{i,t-7}$							-0.0006	(0.0684)		
$\xi_{i,t-8}$							0.0213	(0.0716)		
$\xi_{i,t-9}$							-0.0296	(0.0643)		
$\xi_{i,t-10}$							0.2116[a]	(0.0606)		
$\xi_{i,t-11}$							0.0212	(0.0737)		
$\xi_{i,t-12}$							0.0031	(0.0641)		
$\xi_{i,t-13}$							-0.1600[a]	(0.0595)		
$\bar{R}^2$	0.0086		-0.0306		0.0691		0.1026		-0.0202	
AIC	-5.5317		-4.0306		-5.1087		-3.6888		-5.9877	
ω_i	-7.1133[a]	(2.5547)	-6.8876[c]	(3.9294)	-7.0797	(4.6362)	-7.0272[a]	(2.0230)	-3.2988[a]	(1.2337)
κ_i	0.3403	(0.2079)	0.0725	(0.1814)	0.2624	(0.1955)	0.2722	(0.1747)	0.5421[a]	(0.1544)
φ_i	0.2879[b]	(0.1455)	0.0385	(0.1222)	0.0467	(0.1234)	0.2512[b]	(0.1068)	-0.1530[c]	(0.0875)
θ_i	0.1514	(0.3191)	0.0116	(0.5694)	0.1284	(0.5794)	-0.1768	(0.3523)	0.6741[a]	(0.1343)
$D_{t,1987}$ *	-17.3042	(52.3516)	-1.2247	(55.2750)	-18.4774[a]	(3.2959)	-7.8877[a]	(2.0113)	0.3408	(10.5689)
t-dist	3.4931[a]	(1.1917)	7.6918[b]	(3.9409)	8.6921	(5.5351)	15.8905	(18.0033)	22.0703	(51.5724)

Appendix 1 Cont'd

	Chemicals						Material Manufactures			
	Organic chemicals		Inorganic chemicals		Plastics		Iron and steel[#]		Paper and paperboard[#]	
$\mu_{0,i}$	0.0006	(0.0011)	-0.0004	(0.0008)	-0.0003	(0.0008)	0.0011	(0.0010)	0.0001	(0.0009)
$\xi_{i,t-1}$	-0.0356	(0.0659)	-0.2277[a]	(0.0547)	-0.1376[b]	(0.0576)	0.0507	(0.0769)	-0.2763[a]	(0.0661)
$\xi_{i,t-2}$	0.1065	(0.0696)	0.0092	(0.0593)					-0.0068	(0.0586)
$\xi_{i,t-3}$			-0.0110	(0.0524)						
$\xi_{i,t-4}$			0.0229	(0.0584)						
$\xi_{i,t-5}$			-0.1497[b]	(0.0594)						
$\xi_{i,t-6}$										
$\xi_{i,t-7}$										
$\xi_{i,t-8}$										
$\xi_{i,t-9}$										
$\xi_{i,t-10}$										
$\xi_{i,t-11}$										
$\xi_{i,t-12}$										
$\xi_{i,t-13}$										
$\overline{R^2}$	-0.0195		-0.0147		0.0018		-0.0358		0.1079	
AIC	-5.0107		-4.6361		-5.6723		-5.5296		-5.1985	
ω_i	-0.4302[b]	(0.1794)	-0.0275	(0.0937)	-0.0244	(0.0176)	-0.7686	(0.4829)	-7.8138[a]	(1.5286)
κ_i	0.2055[b]	(0.0890)	-0.0478	(0.0579)	-0.0818[a]	(0.0025)	0.1600	(0.0979)	0.5756[a]	(0.1931)
φ_i	0.0264	(0.0551)	0.0361	(0.0476)	-0.0101	(0.0285)	0.0827	(0.0640)	0.0602	(0.1228)
θ_i	0.9661[a]	(0.0186)	0.9949[a]	(0.0073)	0.9911[a]	(0.0024)	0.9232[a]	(0.0509)	0.0928	(0.1922)
$D_{i,1987}^{*}$	3.1657[a]	(0.7709)	4.2302[a]	(0.4164)	1.4720[b]	(0.5871)	1.5205[b]	(0.7723)	-2.4728	(3.4705)
t-dist	5.2960[c]	(2.7874)	7.5863[b]	(3.8016)	6.6923[b]	(3.1376)	20.0708	(34.6634)	17.8635	(16.3818)

Appendix 1 Cont'd

	Material manufactures									
	Material manufactures		Mineral manufactures less precious stones		Miscellaneous metal manufactures		Non-ferrous metals		Textiles	
$\mu_{0,i}$	-0.0007	(0.0009)	-0.0011[c]	(0.0006)	0.0004	(0.0003)	-0.0005	(0.0013)	0.0002	(0.0006)
$\xi_{i,t-1}$	-0.1901[a]	(0.0668)	-0.3002[a]	(0.0743)	-0.4048[a]	(0.0537)	0.1052[c]	(0.0576)	-0.0481	(0.0592)
$\xi_{i,t-2}$	0.0026	(0.0704)	-0.1176[c]	(0.0659)	-0.0509	(0.0392)			0.0595	(0.0655)
$\xi_{i,t-3}$	0.0352	(0.0765)								
$\xi_{i,t-4}$	0.0831	(0.0671)								
$\xi_{i,t-5}$	0.0253	(0.0693)								
$\xi_{i,t-6}$	0.0273	(0.0684)								
$\xi_{i,t-7}$	0.0441	(0.0669)								
$\xi_{i,t-8}$										
$\xi_{i,t-9}$										
$\xi_{i,t-10}$										
$\xi_{i,t-11}$										
$\xi_{i,t-12}$										
$\xi_{i,t-13}$										
$\overline{R}^2$	0.0649		0.0707		0.0240		-0.0646		-0.0243	
AIC	-5.3689		-5.2752		-5.7422		-5.0917		-6.0112	
ω_i	-0.6177	(0.2821)	-0.3187[b]	(0.1286)	-0.6177	(0.2821)	-0.3187[b]	(0.1286)	-0.1730	(0.1072)
κ_i	0.3352[a]	(0.1036)	0.2461[b]	(0.0972)	0.3352[a]	(0.1036)	0.2461[b]	(0.0972)	-0.0896	(0.0835)
φ_i	0.0512	(0.0828)	0.0014	(0.0715)	0.0512	(0.0828)	0.0014	(0.0715)	0.0800	(0.0569)
θ_i	0.9568[a]	(0.0288)	0.9847[a]	(0.0128)	0.9568[a]	(0.0288)	0.9847[a]	(0.0128)	0.9743[a]	(0.0134)
$D_{t,1987}$ *	1.5976[a]	(0.8001)	0.7562	(0.7240)	1.5976[a]	(0.8001)	0.7562	(0.7240)	1.4770[a]	(0.5558)
t-dist	8.1560[a]	(4.1940)	6.7168	(4.4016)	8.1560[a]	(4.1940)	6.7168	(4.4016)	25.1351	(32.4040)

Appendix 1 Cont'd

	Machinery & transport equipment								Miscellaneous	
	Electronic machinery		Machinery and transport equipment		Machinery		Road vehicles		Clothing	
$\mu_{0,i}$	-0.0001	(0.0004)	0.0001	(0.0006)	0.0000	(0.0008)	0.0005	(0.0005)	0.0003	(0.0012)
$\xi_{i,t-1}$	-0.0163	(0.0620)	0.0818	(0.0608)	0.0845	(0.0621)	0.0056	(0.0067)	0.0683	(0.0667)
$\xi_{i,t-2}$			-0.0657	(0.0553)			0.0052	(0.0043)	0.0017	(0.0673)
$\xi_{i,t-3}$			0.0273	(0.0558)			0.0055	(0.0044)	-0.1058	(0.0668)
$\xi_{i,t-4}$							0.0056	(0.0043)	-0.0228	(0.0689)
$\xi_{i,t-5}$							0.0084[c]	(0.0044)	0.0402	(0.0703)
$\xi_{i,t-6}$							0.0056	(0.0043)	0.0493	(0.0742)
$\xi_{i,t-7}$							0.0054	(0.0045)	-0.0521	(0.0756)
$\xi_{i,t-8}$							-0.0150[a]	(0.0043)	0.0267	(0.0704)
$\xi_{i,t-9}$							0.0054	(0.0044)	0.0217	(0.0676)
$\xi_{i,t-10}$							0.0063	(0.0053)	0.0097	(0.0719)
$\xi_{i,t-11}$							0.1549[a]	(0.0049)	0.0827	(0.0595)
$\xi_{i,t-12}$							0.0065	(0.0046)	0.2076[a]	(0.0552)
$\xi_{i,t-13}$							0.0001	(0.0286)		
$\overline{R}^2$	-0.0397		-0.0264		-0.0220		-0.0906		0.1108	
AIC	-5.4430		-6.1362		-5.8360		-6.6676		-5.8235	
ω_i	-7.7293[a]	(2.9862)	-5.7335[a]	(1.6390)	-7.7293[a]	(2.9862)	-5.7335[a]	(1.6390)	-0.2238[b]	(0.1134)
κ_i	0.3667[c]	(0.2102)	-0.0018	(0.1722)	0.3667[c]	(0.2102)	-0.0018	(0.1722)	-0.0516	(0.0686)
φ_i	0.1108	(0.1415)	0.1742	(0.1170)	0.1108	(0.1415)	0.1742	(0.1170)	0.0862[b]	(0.0435)
θ_i	0.0682	(0.3748)	0.3551[b]	(0.1789)	0.0682	(0.3748)	0.3551[b]	(0.1789)	0.9721[a]	(0.0096)
$D_{t,1987}^{*}$	-19.4865[a]	(7.4749)	-14.4107[a]	(4.3585)	-19.4865[a]	(7.4749)	-14.4107[a]	(4.3585)	3.0692[a]	(0.6498)
t-dist	3.6771[a]	(1.1158)	5.6885[b]	(2.5915)	3.6771[a]	(1.1158)	5.6885[b]	(2.5915)	340.8386	(7625.8540)

Appendix 1 Cont'd

	Miscellaneous				Others			
	Clothing and footwear		Scientific and photographic		Finished manufactures		Finished manufactures less erratic	
$\mu_{0,i}$	0.0003	(0.0008)	0.0010[b]	(0.0005)	0.0000	(0.0001)	-0.0003	(0.0003)
$\xi_{i,t-1}$	0.0855	(0.0588)	-0.1051	(0.0816)	-0.0112	(0.0722)	0.0303	(0.0515)
$\xi_{i,t-2}$	-0.0485	(0.0626)	-0.0155	(0.0715)				
$\xi_{i,t-3}$	-0.1022[c]	(0.0611)	-0.0490	(0.0803)				
$\xi_{i,t-4}$	0.0046	(0.0626)	0.0844	(0.0629)				
$\xi_{i,t-5}$	-0.0320	(0.0634)	0.1365[b]	(0.0661)				
$\xi_{i,t-6}$	-0.0027	(0.0554)	-0.0902	(0.0621)				
$\xi_{i,t-7}$	0.0596	(0.0607)	-0.0891	(0.0684)				
$\xi_{i,t-8}$	-0.0430	(0.0559)						
$\xi_{i,t-9}$	0.1231[b]	(0.0487)						
$\xi_{i,t-10}$	-0.0438	(0.0673)						
$\xi_{i,t-11}$	0.0944[c]	(0.0536)						
$\xi_{i,t-12}$	0.2086[a]	(0.0561)						
$\xi_{i,t-13}$	-0.0542	(0.0518)						
$\overline{R}^2$	0.1465		0.0241		-0.0392		-0.0349	
AIC	-5.8990		-5.8688		-6.2075		-6.1896	
ω_i	-0.1231	(0.0826)	-1.1631[a]	(0.4418)	-5.4575[a]	(1.3766)	-5.2143[a]	(1.8677)
κ_i	-0.1283[a]	(0.0185)	0.4884[a]	(0.1348)	0.1603	(0.1978)	0.1707	(0.2007)
φ_i	0.0795	(0.0530)	-0.0029	(0.0882)	0.1143	(0.1191)	0.1665	(0.1173)
θ_i	0.9771[a]	(0.0111)	0.9122[a]	(0.0410)	0.4046[a]	(0.1496)	0.4300[b]	(0.2065)
$D_{t,1987}^{*}$	2.0330[a]	(0.2471)	1.8052	(1.4238)	-15.7428[a]	(2.0381)	-15.1911[a]	(2.0555)
t-dist	9.0398	(6.0893)	18.5658	(26.9943)	7.4431[b]	(3.0251)	5.8235[b]	(2.5781)

Appendix 1 Cont'd

	Producer Prices Indices									
	Meat and poultry meat product		Man-made fibres		Fabricated metal products, exc. machinery and equipment		Other basic organic chemicals		Rubber and plastic products	
$\mu_{0,i}$	0.0016[a]	(0.0004)	0.0007[c]	(0.0004)	0.0009[b]	(0.0004)	0.0010	(0.0018)	0.0008[a]	(0.0003)
$\xi_{i,t-1}$	0.0859	(0.0693)	0.0017	(0.0472)	0.1335[b]	(0.0520)	0.2461[a]	(0.0462)	0.2346[a]	(0.0565)
$\xi_{i,t-2}$					0.1588[a]	(0.0350)	0.1209[a]	(0.0324)	0.2068[a]	(0.0469)
$\xi_{i,t-3}$					0.1099[a]	(0.0333)	0.1061[b]	(0.0466)	0.1754[a]	(0.0302)
$\xi_{i,t-4}$					0.0493	(0.0341)	-0.0843[b]	(0.0369)	-0.0311	(0.0493)
$\xi_{i,t-5}$					-0.0709[c]	(0.0402)	0.0714[c]	(0.0395)		
$\xi_{i,t-6}$					0.1066[a]	(0.0364)	0.1348[a]	(0.0419)		
$\xi_{i,t-7}$					-0.0001	(0.0417)	-0.0038	(0.0335)		
$\xi_{i,t-8}$					-0.0206	(0.0361)	-0.0860[a]	(0.0323)		
$\xi_{i,t-9}$					0.0575	(0.0361)	0.0970[a]	(0.0322)		
$\xi_{i,t-10}$					-0.0251	(0.0387)	-0.0431	(0.0346)		
$\xi_{i,t-11}$					0.0072	(0.0416)				
$\xi_{i,t-12}$					0.1333[a]	(0.0410)				
$\xi_{i,t-13}$										
$\bar{R}^2$	-0.0130		-0.0319		0.1834		0.0678		0.2986	
AIC	-7.0956		-6.4624		-9.0308		-5.3039		-9.1710	
ω_i	-6.1446[a]	(2.4071)	-11.9560[b]	(5.2637)	-11.1165	(8.2130)	-7.4315[b]	(3.7143)	-12.0543[a]	(3.6239)
κ_i	0.3300	(0.2022)	1.0617	(1.6753)	0.3331	(0.3556)	2.9861	(3.5444)	0.7537	(0.7606)
φ_i	0.3026[b]	(0.1442)	-0.0963	(0.2846)	-0.0257	(0.2548)	-0.4592	(0.8391)	-0.0091	(0.2960)
θ_i	0.3878	(0.2445)	-0.6532[a]	(0.1293)	0.0110	(0.7230)	-0.7610[a]	(0.0790)	-0.0864	(0.3041)
$D_{i,1987}$ *	-0.7070	(89.6660)	-0.4282	(2.1347)	-7.9320[a]	(2.4028)	3.7545[c]	(1.9388)	-17.6434	(14.8421)
t-dist	3.1916[a]	(0.9920)	2.0682[a]	(0.2127)	2.3278[a]	(0.4040)	2.0101[a]	(0.0208)	2.2449[a]	(0.4763)

Appendix 1 Cont'd

	Producer Prices Indices									
	Manufactured products exc. food, beverages, tobacco and petroleum		Paper and paperboard		Manufacture of basic precious and non-ferrous metal, aluminum prod.		Electronic machinery and apparatus		Wearing apparel	
$\mu_{0,i}$	0.0015[b]	(0.0008)	-0.0001	(0.0008)	0.0002	(0.0017)	0.0004	(0.0008)	0.0001	(0.0004)
$\xi_{i,t-1}$	0.2668[a]	(0.0508)	0.1628[a]	(0.0563)	0.1177[c]	(0.0626)	-0.0203	(0.0621)	0.0297	(0.0378)
$\xi_{i,t-2}$	0.1493[a]	(0.0408)	0.0711[c]	(0.0402)	0.1074	(0.0679)	0.0273	(0.0556)	0.0432	(0.0329)
$\xi_{i,t-3}$	0.0844[c]	(0.0446)	0.2326[a]	(0.0375)	0.1977[a]	(0.0703)	0.1200[a]	(0.0394)	0.0421	(0.0298)
$\xi_{i,t-4}$	0.0226	(0.0391)	0.1087[a]	(0.0433)	0.2022[a]	(0.0610)	0.0808	(0.0570)	0.0520	(0.0322)
$\xi_{i,t-5}$	-0.0024	(0.0436)			0.0415	(0.0605)	0.0233	(0.0612)	-0.0079	(0.0347)
$\xi_{i,t-6}$	0.1272[a]	(0.0396)					0.0790	(0.0547)	0.0701[c]	(0.0360)
$\xi_{i,t-7}$	-0.0180	(0.0501)					0.0711	(0.0445)	-0.0241	(0.0327)
$\xi_{i,t-8}$	0.0498	(0.0456)					0.0929[c]	(0.0549)	0.0259	(0.0364)
$\xi_{i,t-9}$	0.0299	(0.0306)					0.0706	(0.0443)	0.0103	(0.0286)
$\xi_{i,t-10}$	-0.0559	(0.0495)					-0.0105	(0.0491)	0.0710[b]	(0.0305)
$\xi_{i,t-11}$	-0.0260	(0.0373)					0.0556	(0.0365)	0.0162	(0.0469)
$\xi_{i,t-12}$	0.2621[a]	(0.0461)					0.1052[b]	(0.0485)	0.1694[a]	(0.0385)
$\xi_{i,t-13}$	-0.0170	(0.0422)							0.0875[b]	(0.0371)
$\bar{R}^2$	0.3214		0.1737		0.1866		0.1015		0.1138	
AIC	-9.6338		-7.2708		-6.0988		-8.6775		-9.1869	
ω_i	-13.0957[b]	(5.8913)	-9.5994	(6.4980)	0.1218[a]	(0.0056)	-8.5122[a]	(3.1655)	-10.8228[b]	(5.0880)
κ_i	0.4748	(0.5813)	0.2485	(0.2937)	0.0885[b]	(0.0409)	0.4537[c]	(0.2425)	-0.1305	(0.3778)
φ_i	-0.1345	(0.3153)	-0.1139	(0.2124)	-0.0288	(0.0382)	-0.3137[c]	(0.1674)	-0.2640	(0.3977)
θ_i	-0.1433	(0.4842)	-0.0095	(0.6934)	1.0231[a]	(0.0047)	0.2769	(0.2764)	-0.0126	(0.4573)
$D_{t,1987}^{*}$	-17.5917[b]	(7.1436)	-14.4581	(19.5482)	0.8993[c]	(0.4837)	-11.9507	(63.3068)	-8.8238[a]	(3.3876)
t-dist	2.2356[a]	(0.4867)	2.4937[a]	(0.5285)	29.5748	(69.3458)	3.6498[a]	(1.0400)	2.1848[a]	(0.3735)

Appendix 1 Cont'd

	Producer Prices Indices									
	Footwear		Chemicals, chemical prod. and manmade fibres		Fruit and vegetable juices		Processed and preserved fruit and vegetables		Motor vehicles	
$\mu_{0,i}$	0.0006[b]	(0.0003)	0.0006	(0.0007)	0.0001	(0.0001)	0.0011[a]	(0.0003)	0.0014[a]	(0.0002)
$\xi_{i,t-1}$	-0.0003	(0.0443)	0.3291[a]	(0.0604)	0.0003	(0.0238)	0.0292	(0.0330)	0.1199[a]	(0.0279)
$\xi_{i,t-2}$	0.0509	(0.0330)	0.2018[a]	(0.0574)	-0.0015	(0.0076)	0.0976[a]	(0.0215)	-0.0288	(0.0310)
$\xi_{i,t-3}$	-0.0213	(0.0358)	0.1154[c]	(0.0610)			0.0112	(0.0331)	0.0062	(0.0253)
$\xi_{i,t-4}$	-0.0056	(0.0315)	-0.1402[b]	(0.0634)			0.0383	(0.0249)	0.0094	(0.0322)
$\xi_{i,t-5}$	0.0569[c]	(0.0308)	-0.0197	(0.0580)			-0.0148	(0.0296)	0.0074	(0.0233)
$\xi_{i,t-6}$	0.1487[a]	(0.0361)	0.0780	(0.0582)			-0.0485[b]	(0.0201)	0.0245	(0.0242)
$\xi_{i,t-7}$	-0.0320	(0.0351)	-0.0274	(0.0689)			0.0400[c]	(0.0221)	0.0661[b]	(0.0313)
$\xi_{i,t-8}$	0.0880[a]	(0.0321)	0.0254	(0.0571)			0.0164	(0.0231)	0.0228	(0.0305)
$\xi_{i,t-9}$	0.0329	(0.0326)	0.1563[a]	(0.0520)			0.0188	(0.0261)	-0.0350	(0.0244)
$\xi_{i,t-10}$	0.1007[a]	(0.0315)	-0.0066	(0.0564)			-0.0077	(0.0229)	-0.0192	(0.0220)
$\xi_{i,t-11}$	0.0297	(0.0378)	-0.0482	(0.0511)			-0.0149	(0.0334)	-0.0095	(0.0297)
$\xi_{i,t-12}$							0.0965[a]	(0.0273)	0.1268[a]	(0.0257)
$\xi_{i,t-13}$							-0.0057	(0.0270)	0.0365	(0.0291)
$\overline{R}^2$	0.0137		0.2402		-0.0374		-0.0591		0.0618	
AIC	-8.9328		-8.1877		-7.7828		-7.7046		-8.3652	
ω_i	-10.1175	(6.8701)	-6.9789	(5.0743)	-4.5408	(4.0623)	-0.7659[a]	(0.0497)	-12.8986[a]	(2.0325)
κ_i	0.5443	(1.7912)	0.0955	(0.2308)	20.6907	(27.5445)	-0.3980[a]	(0.0968)	3.8570[c]	(2.2982)
φ_i	-0.3943	(1.2816)	-0.1355	(0.1563)	10.3430	(14.1525)	-0.1500[a]	(0.0512)	-0.8583	(0.6719)
θ_i	-0.0544	(0.2678)	0.3615	(0.4663)	-0.5365[a]	(0.0686)	0.8993[a]	(0.0001)	-0.8595[a]	(0.0273)
$D_{t,1987}^{*}$	-7.8155[a]	(2.6734)	1.6194	(10.4947)	-5.0200[c]	(2.9115)	1.7183[b]	(0.8184)	-1.2681	(0.9749)
t-dist	2.0496[a]	(0.3207)	3.0535[a]	(0.9467)	2.0001[a]	(0.0002)	2.6464[a]	(0.4842)	2.0055[a]	(0.0061)

Appendix 1 Cont'd

	Producer Prices Indices									
	Machinery and equipment		Transport equipment		Food product less beverages		Prepared animal feed for farm animals		Beverages	
$\mu_{0,i}$	0.0007	(0.0005)	0.0012[a]	(0.0003)	0.0011[a]	(0.0003)	0.0017	(0.0011)	0.0015[a]	(0.0003)
$\xi_{i,t-1}$	0.0946[b]	(0.0477)	0.1306[a]	(0.0503)	0.3740[a]	(0.0826)	0.3788[a]	(0.0814)	0.0940[a]	(0.0237)
$\xi_{i,t-2}$	0.0453	(0.0470)	-0.0635	(0.0508)	0.1232	(0.0786)	0.1906[a]	(0.0662)	-0.1250[a]	(0.0252)
$\xi_{i,t-3}$	0.1195[a]	(0.0378)	-0.0191	(0.0390)	-0.0518	(0.0744)	-0.1015	(0.0731)	-0.0126	(0.0354)
$\xi_{i,t-4}$	-0.0187	(0.0378)	0.0491	(0.0376)	0.1917[b]	(0.0928)			0.0159	(0.0427)
$\xi_{i,t-5}$	0.0004	(0.0362)	0.0123	(0.0387)	-0.2157[a]	(0.0832)			-0.0724	(0.0452)
$\xi_{i,t-6}$	0.0103	(0.0435)	0.0501	(0.0402)					-0.1304[a]	(0.0413)
$\xi_{i,t-7}$	-0.0017	(0.0347)	0.0517	(0.0392)					-0.0496[a]	(0.0179)
$\xi_{i,t-8}$	0.0321	(0.0402)	0.1198[a]	(0.0389)					-0.0829[a]	(0.0281)
$\xi_{i,t-9}$	0.1025[a]	(0.0369)	0.0411	(0.0443)					0.1187[a]	(0.0295)
$\xi_{i,t-10}$	0.0047	(0.0410)	-0.0154	(0.0409)					-0.0025	(0.0375)
$\xi_{i,t-11}$	0.0086	(0.0404)	0.0179	(0.0441)					0.2405[a]	(0.0447)
$\xi_{i,t-12}$	0.2167[a]	(0.0536)	0.1521[a]	(0.0419)					0.0426	(0.0325)
$\xi_{i,t-13}$	0.0441	(0.0558)							0.0307	(0.0384)
$\overline{R}^2$	0.2193		0.1825		0.2137		0.1672		-0.0104	
AIC	-9.2876		-8.9557		-8.8011		-6.5707		-7.7211	
ω_i	-10.0398[b]	(4.7975)	-10.9788[b]	(5.4293)	0.0811	(0.1486)	-8.7663	(8.1305)	-6.1179[a]	(1.6914)
κ_i	-0.1429	(0.4966)	0.1214	(0.2735)	-0.0270	(0.1015)	0.2237	(0.2363)	-1.8878	(2.0269)
φ_i	0.2759	(0.5108)	0.0379	(0.2126)	0.0546[a]	(0.0301)	-0.1062	(0.1682)	-2.1302	(2.2732)
θ_i	0.0724	(0.4094)	-0.0083	(0.4907)	1.0060[a]	(0.0093)	0.0687	(0.8873)	0.2593[a]	(0.0650)
$D_{t,1987}$ *	-7.7409[b]	(3.3265)	-8.0480[a]	(2.1079)						
t-dist	2.1952[a]	(0.4428)	2.2604[a]	(0.4151)	19.7272	(35.1373)	3.3771[a]	(1.1058)	2.1986[a]	(0.4795)

Appendix 1 Cont'd

	Producer Prices Indices									
	Motor spirit		Fuel oil		Gas oil and derivatives		Textiles fabrics		Other non metallic mineral prod.	
$\mu_{0,i}$	0.0026[b]	(0.0013)	0.0070[a]	(0.0018)	0.0042[a]	(0.0004)	0.0003	(0.0003)	0.0018[a]	(0.0005)
$\xi_{i,t-1}$	0.3036[a]	(0.0689)	0.2816[a]	(0.0545)	0.3982[a]	(0.0394)	0.0243	(0.0796)	-0.0229	(0.0688)
$\xi_{i,t-2}$	-0.2632[a]	(0.0652)	-0.2788[a]	(0.0550)	-0.1810[a]	(0.0401)			0.0927	(0.0630)
$\xi_{i,t-3}$	-0.0167	(0.0613)			-0.0032	(0.0521)			-0.0074	(0.0709)
$\xi_{i,t-4}$	-0.0559	(0.0600)			-0.1301[a]	(0.0499)			0.0032	(0.0808)
$\xi_{i,t-5}$	-0.0129	(0.0587)			0.0348	(0.0389)			-0.1251[c]	(0.0739)
$\xi_{i,t-6}$	0.0657	(0.0630)			-0.0649	(0.0479)			-0.0271	(0.0727)
$\xi_{i,t-7}$	-0.0725	(0.0680)			0.0926[c]	(0.0500)			0.0023	(0.0674)
$\xi_{i,t-8}$	0.1557[a]	(0.0582)			-0.0577	(0.0475)			-0.0244	(0.0730)
$\xi_{i,t-9}$	-0.1925[a]	(0.0632)			0.0843[b]	(0.0407)			-0.0247	(0.0735)
$\xi_{i,t-10}$	0.0573	(0.0636)							-0.0641	(0.0763)
$\xi_{i,t-11}$	0.1567[a]	(0.0526)							0.0309	(0.0650)
$\xi_{i,t-12}$									0.4791[a]	(0.0564)
$\xi_{i,t-13}$									0.0798	(0.0685)
$\overline{R^2}$	0.0989		0.1107		0.0020		-0.0399		0.2545	
AIC	-5.3069		-3.4636		-4.9042		-7.6998		-8.3724	
ω_i	-11.8453[a]	(2.0424)	-0.3695[a]	(0.0968)	-1.2497[a]	(0.1319)	-2.1248[b]	(1.0522)	-12.4427	(8.0206)
κ_i	0.7206[c]	(0.4056)	-0.2152[a]	(0.0009)	-0.5617[a]	(0.0685)	0.5446[c]	(0.2913)	-0.4987[c]	(0.2649)
φ_i	-0.6008[c]	(0.3305)	0.1270[a]	(0.0363)	0.2993[a]	(0.0741)	-0.0454	(0.1378)	0.2025	(0.1870)
θ_i	-0.4528[c]	(0.2329)	0.9156[a]	(0.0151)	0.7875[a]	(0.0114)	0.8205[a]	(0.1018)	-0.1202	(0.7078)
t-dist	2.8765[a]	(0.9181)	13.0092	(12.8063)	9.0417	(7.4441)	2.7877[a]	(0.9191)	11.6406	(16.6644)

Appendix 1 Cont'd

	Producer Prices Indices					
	Base metals		Photographic chemical materials		Basic pharmaceutical prod.	
$\mu_{0,i}$	0.0006	(0.0005)	0.0000	(0.0001)	0.0004[c]	(0.0003)
$\xi_{i,t-1}$	0.2635[a]	(0.0622)	0.0087	(0.0405)	-0.0006	(0.0561)
$\xi_{i,t-2}$	-0.0471	(0.0551)	-0.0020	(0.0341)	-0.0441	(0.0517)
$\xi_{i,t-3}$	0.3878[a]	(0.0623)			0.0229	(0.0566)
$\xi_{i,t-4}$	-0.1930[a]	(0.0562)			0.0683	(0.0436)
$\xi_{i,t-5}$	-0.0115	(0.0662)			-0.0230	(0.0438)
$\xi_{i,t-6}$	0.2581[a]	(0.0636)			-0.0692	(0.0424)
$\xi_{i,t-7}$					-0.0096	(0.0460)
$\xi_{i,t-8}$					-0.0273	(0.0393)
$\xi_{i,t-9}$					0.0124	(0.0401)
$\xi_{i,t-10}$						
$\xi_{i,t-11}$						
$\xi_{i,t-12}$						
$\xi_{i,t-13}$						
$\overline{R^2}$	0.3767		-0.0476		-0.0534	
AIC	-7.2672		-7.1709		-7.4443	
ω_i	-19.2984[a]	(0.4673)	-0.8295[a]	(0.1662)	-1.2492[b]	(0.6270)
κ_i	0.5549[a]	(0.1562)	3.0845	(2.3659)	1.3113	(1.3750)
φ_i	-0.0401	(0.0478)	-2.5139	(1.9311)	0.2935	(0.3859)
θ_i	-0.8762[a]	(0.0383)	0.9095[a]	(0.0191)	0.8589[a]	(0.0879)
t-dist	4.6079[b]	(2.1779)	2.0054[a]	(0.0082)	2.0201[a]	(0.0385)

Standard errors are in parenthesis. [a], [b] and [c] indicate that the *p-value* is statistically significant at a 1-, 5- or 10-percent level, respectively. [#]The lag structure of this series has been adjusted, since the optimal lag chosen by AIC cannot reject the null hypothesis of ARCH LM test in either 2 or 4 lags. ♦This series cannot reject the null hypothesis of ARCH LM test in neither 2 nor 4 lags. * Some PPIs series starts from 1991 M1, so dummy variable ($D_{t,1987}$) is not valid for some industries. $\overline{R^2}$, AIC and *t*-dist denote the adjusted R squared, Akaike Information Criterion and *t*-distribution, respectively

Appendix 2 BDS Tests of Nonlinearity: Standardised Residuals EGARCH(1,1)

		Food and live animals			
m	UK sterling trade-weighted rate	Cereals and animal feeding stuffs	Food	Fruit and vegetables	Meat
			l=0.25		
2	-0.3967	-0.4779	-0.4293	0.0503	-0.1916
3	0.0449	-0.5961	0.5005	1.6566[c]	-0.8091
4	-0.2277	-0.7640	-1.3230	1.6689[c]	-0.8016
5	0.3180	-1.4498	0.7753	1.9023[c]	0.1540
6	0.3817	-1.2412	1.6829[c]	1.7369[c]	2.7006[a]
7	5.4871[a]	0.4416	12.8500[a*]	1.3112	1.5969
8	17.6667[a]	3.5109[a]	32.4924[a#]	1.6158	-2.4011[b]
9	31.7713[a#]	-2.2662[b]	55.4786[a#]	-0.7600	-1.8369[c]
10	-2.4303[b]	-1.7900[c]	-2.0414[b]	-0.5774	-1.4566[#]
			l=0.5		
2	-0.3652	0.0339	1.6742[c]	0.6657	-0.3016
3	-0.2701	-0.3198	1.2344	1.6213	-0.2778
4	-0.2151	-0.4304	0.0697	2.0478[b#]	-0.4137
5	-0.0268	-0.0028	0.2014	3.1268[a+]	0.1219
6	0.7259	-0.0634	0.5425	4.5728[a+]	0.6685
7	1.0572	-0.0573	1.4169	6.2051[a+]	0.7995
8	1.0812	0.0743	1.1451	7.9284[a+]	0.5197
9	1.0033	-0.2666	1.4521	9.7922[a+]	0.2921
10	0.9477	-0.5494	1.9759[b]	11.9637[a+]	0.2747
			l=0.75		
2	-0.0984	0.4958	1.4504	0.6443	-0.1060
3	-0.3026	-0.0792	1.3504	1.1450	0.2434
4	-0.4119	-0.2173	0.7041	1.3460	0.1833
5	-0.1757	0.3263	0.7118	1.9108[c*]	0.5126
6	0.6062	0.1562	0.9083	2.4889[b#]	0.7956
7	1.0956	0.0475	1.0500	3.2658[a+]	0.9001
8	1.2431	0.3285	0.7309	3.9398[a+]	0.8242
9	1.6596[c]	0.5140	0.6446	4.4614[a+]	0.8162
10	1.9204[c*]	0.6511	0.4539	4.9378[a+]	0.9068

Appendix 2 Cont'd

	Beverages and Tobacco	**Basic Materials**		**Fuels**	**Chemicals**
m	Beverages and Tobacco	Metal Ores	Textile fibres	Fuels	Chemicals
			l=0.25		
2	0.5599	-0.5372	-0.0580	-0.5087	1.0654
3	1.9746[b]	0.3240	0.4974	-1.3426	0.9391
4	2.9551[a*]	1.7016[c]	0.6163	-1.5845	0.7936
5	4.1255[a#]	2.5980[a]	1.1238	-0.1266	0.6437
6	3.5264[a]	3.5848[a]	-0.0558	0.1975	-0.8535
7	0.6836	5.3857[a]	0.6231	0.2395	-2.6034[a]
8	-1.5438	4.1931[a]	2.4734[b]	-2.4368[b]	-2.0966[b]
9	-1.2126	-2.0401[b]	-1.2382	-2.1354[b]	-1.5964
10	-0.9091	-1.5964	-0.9235	-1.7169[c]	-1.3073
			l=0.5		
2	1.2930	0.2772	0.8190	-1.1439	1.2565
3	2.6435[a#]	0.9748	2.0404[b*]	-0.9867	2.1825[b#]
4	4.0211[a+]	0.8135	1.8896[c*]	-0.1267	3.0676[a+]
5	5.2547[a+]	0.7076	2.3026[b*]	0.6568	3.2981[a+]
6	6.8273[a+]	1.0185	2.5429[b#]	0.8830	3.5139[a+]
7	8.2925[a+]	1.2228	2.7138[a#]	1.1237	3.5055[a#]
8	9.6581[a+]	1.2702	2.3080[b*]	1.5152	3.5203[a3]
9	10.9616[a+]	1.3016	1.9105[c]	1.3406	3.5559[a#]
10	12.4774[a+]	1.9573[b]	1.1198	1.4508	3.0946[a#]
			l=0.75		
2	0.8662	-0.0467	0.5503	-0.9699	1.2434
3	2.6347[a#]	0.8445	1.3496	-0.5454	2.6120[a#]
4	3.7216[a+]	1.0507	1.2158	0.0105	3.1344[a+]
5	4.5619[a+]	0.8888	1.6707[c]	0.3365	3.7077[a+]
6	5.3420[a+]	1.1376	1.7932[c]	-0.0692	4.0591[a+]
7	6.0364[a+]	1.3137	1.9145[c*]	0.3441	4.2332[a+]
8	6.5995[a+]	1.4542	1.9041[c*]	0.7201	4.3105[a+]
9	7.1706[a+]	1.3964	1.9787[b*]	0.6572	4.5958[a+]
10	7.9529[a+]	1.8096[c*]	2.2822[b#]	0.8431	4.7313[a+]

Appendix 2 Cont'd

m	Organic chemicals	Inorganic chemicals	Plastics	Iron and steel	Paper and paperboard
	Chemicals			**Material Manufactures**	
			l=0.25		
2	0.2885	1.1323	-0.3938	-0.0379	2.0784^{b*}
3	1.2983	0.2703	-0.8859	-0.2625	4.0406^{a+}
4	2.5733$^{b\#}$	0.7086	-0.3266	0.6206	4.1665$^{a\#}$
5	2.8827^{a*}	1.3050	-0.4275	3.5271^{a}	5.9934^{a+}
6	2.5503^{b}	-0.8492	-1.5223	7.2470^{a}	8.8387^{a+}
7	1.6424	-1.5920	-3.2069^{a}	10.2454^{a}	11.4491^{a3}
8	-1.2584	-2.6309^{a}	-2.5954^{a}	11.6615^{a}	14.3502$^{a\#}$
9	-0.9939	-2.0677^{b}	-2.1009^{b}	-2.4416^{b}	15.7035^{a*}
10	-0.7847	-1.6027	-1.6380	-1.9585^{c}	-1.1571
			l=0.5		
2	1.4705	2.1467$^{b\#}$	0.8671	-0.4283	2.5567$^{b\#}$
3	3.2583^{a+}	1.3189	1.3145	-0.2131	4.9455^{a+}
4	4.8732^{a+}	1.4460	0.9607	-0.2226	6.2704^{a+}
5	6.0342^{a+}	1.7329^{c}	0.8173	-0.3736	7.4968^{a+}
6	7.7124^{a+}	2.0323^{b*}	0.6517	-0.3510	8.2172^{a+}
7	9.3156^{a+}	2.4205^{b*}	0.2375	-0.3003	8.7485^{a+}
8	11.0711^{a+}	2.4387^{b*}	0.0148	-0.1927	8.8584^{a+}
9	12.8572^{a+}	2.6338^{a*}	-0.2435	-0.2523	9.2032^{a+}
10	14.3443^{a+}	2.6834^{a*}	-0.4087	-0.4507	10.0621^{a+}
			l=0.75		
2	0.7167	1.7128^{c}	0.6354	0.0297	0.0084
3	2.7454$^{a\#}$	0.7788	0.9795	0.2960	1.8773^{c*}
4	3.9480^{a+}	0.8949	0.8472	0.2967	2.9938$^{a\#}$
5	5.0946^{a+}	1.4979	0.5699	0.3296	4.2936^{a+}
6	6.0233^{a+}	1.6823^{c}	0.2488	0.2890	5.4139^{a+}
7	6.7776^{a+}	1.8790^{c*}	-0.0202	0.1428	6.2973^{a+}
8	7.4779^{a+}	1.9609^{b*}	-0.3186	-0.0905	7.0834^{a+}
9	8.0758^{a+}	2.1027^{b*}	-0.2832	-0.5420	7.8771^{a+}
10	8.7564^{a+}	2.1570^{b*}	-0.2086	-0.5212	8.6716^{a+}

Appendix 2 Cont'd

m	Material manufactures	Mineral manufactures less precious stones	Miscellaneous metal manufactures	Non-ferrous metals	Textiles
	Material manufactures				
			l=0.25		
2	1.6958[c]	2.2694[b*]	3.8927[a#]	0.7859	-1.1712
3	3.3142[a+]	4.1199[a+]	3.6051[a#]	1.3542	-0.9236
4	4.2019[a+]	5.8194[a+]	1.8629[c]	2.8581[a*]	0.3524
5	5.4981[a+]	5.1798[a#]	-0.4271	3.6011[a*]	0.4322
6	5.3391[a#]	5.0109[a#]	-2.1488[b]	5.9209[a#]	-1.5532
7	0.5375	4.8652[a*]	-3.9487[a]	10.7127[a#]	-2.8518[a]
8	-1.7659[c]	-1.0626	-2.9814[a]	21.7043[a#]	-2.1716[b]
9	-1.3334	-0.7510	-2.3075[b]	17.4070[a*]	-1.8120[c]
10	-1.0079	-0.5416[*]	-1.7894[c]	-1.1700[*]	-1.3984
			l=0.5		
2	2.3341[b#]	0.9568	3.3256[a+]	0.9417	-0.8831
3	4.9490[a+]	2.7529[a#]	2.8646[a#]	1.3667	-1.2616
4	7.0452[a+]	3.9915[a+]	1.9430[c*]	1.9752[b*]	-0.9694
5	8.6368[a+]	4.7496[a+]	1.7204[c]	2.4496[b#]	-0.4879
6	10.6137[a+]	5.3230[a+]	1.3301	2.6223[a#]	-0.4388
7	12.7906[a+]	5.5764[a+]	1.4281	2.6239[a#]	-0.6171
8	15.2077[a+]	6.2842[a+]	0.9786	2.6659[a*]	-0.6229
9	17.8158[a+]	6.8303[a+]	1.0040	2.4296[b*]	-0.9550
10	21.3471[a+]	7.6022[a+]	0.9658	3.0407[a*]	-1.3257
			l=0.75		
2	0.8480	0.5698	3.6766[a+]	0.9184	0.0368
3	3.3987[a+]	2.9726[a+]	3.2173[a+]	1.5169	-0.2313
4	5.0252[a+]	4.3445[a+]	2.4965[b#]	2.0105[b*]	0.0013
5	6.6989[a+]	5.1788[a+]	2.1359[b*]	2.2629[b#]	0.2770
6	8.0396[a+]	6.2345[a+]	1.7060[c]	2.5840[a#]	0.3324
7	9.2557[a+]	7.0052[a+]	1.6736[c]	2.9497[a#]	0.3307
8	10.4708[a+]	7.5849[a+]	1.7241[c*]	3.3417[a+]	0.5406
9	11.7253[a+]	8.3012[a+]	1.6351	3.6109[a+]	0.3329
10	13.0332[a+]	9.0215[a+]	1.5284	4.0231[a+]	0.4018

Appendix 2 Cont'd

	Machinery & transport equipment				**Miscellaneous**
m	Electronic machinery	Machinery and transport equipment	Machinery	Road vehicles	Clothing
			l=0.25		
2	1.0949	-0.1114	0.2791	3.1929[a+]	0.0524
3	0.6396	0.6087	1.0699	4.3000[a#]	0.7831
4	0.4850	1.3369	1.4807	7.5138[a#]	1.4490
5	0.0964	1.0940	2.4593[b]	12.0436[a*]	1.3416
6	-1.5247	-0.4354	2.8979[a]	21.6578[a*]	1.2748
7	-1.0313	0.4162	2.1911[b]	40.1897[a*]	0.9136
8	-2.2979[b]	2.2541[b]	-1.7449[c]	65.4893[a*]	-2.7900[a]
9	-1.7390[c]	-1.3653	-1.3037	82.6963[a*]	-2.3177[b]
10	-1.3266	-1.0336	-1.0410	101.6043[a*]	-2.0031[b]
			l=0.5		
2	0.5848	0.1248	0.2380	1.5543[*]	-0.0875
3	0.6201	0.7576	1.5849	1.9108[b#]	-0.5160
4	0.3571	1.3426	2.0133[b#]	2.6151[a#]	-0.4928
5	-0.0693	1.7168[c]	2.4404[b#]	2.8241[a#]	-0.1730
6	-0.6030	2.0017[b*]	2.9150[a#]	2.8204[a#]	0.2372
7	-0.5474	2.7347[a#]	3.1164[a#]	3.3986[a*]	0.5704
8	-0.7574	3.2877[a#]	3.4623[a#]	3.6266[a*]	0.7010
9	-0.1856	4.0378[a#]	4.0026[a#]	3.8242[a]	0.7351
10	-0.0390	4.6728[a#]	4.8376[a#]	4.1736[a]	0.5334
			l=0.75		
2	0.4960	-0.4330	0.1067	1.0044	0.1771
3	0.1569	0.2011	1.2647	1.7337[c#]	0.4931
4	-0.2153	0.6777	1.7461[c*]	2.5523[b#]	1.0201
5	-0.4179	0.9978	2.2852[b#]	2.8357[a+]	1.5772
6	-0.5393	1.5962	2.9174[a+]	2.9936[a+]	1.9087[c*]
7	-0.2762	2.2329[b#]	3.5127[a+]	3.3086[a+]	1.9987[b*]
8	-0.5223	2.4764[b#]	3.7951[a+]	3.2037[a+]	2.0661[b*]
9	-0.2948	2.8614[a#]	4.2393[a+]	3.4046[a#]	2.0170[b*]
10	-0.2115	3.1173[a#]	4.7101[a+]	3.7326[a#]	1.7999[c*]

Appendix 2 Cont'd

	Miscellaneous		**Others**	
m	Clothing and footwear	Scientific and photographic	Finished manufactures	Finished manufactures less erratic
		l=0.25		
2	0.3098	-1.8035[c]	0.5600	-1.0746
3	-0.2980	-1.8143[c]	1.6390	0.2323
4	-0.2327	-2.1048[b]	0.9239	0.3666
5	0.1609	-1.5262	-0.0716	0.6976
6	2.1244[b]	-3.8753[a#]	-0.5730	0.6185
7	2.3804[b]	-2.9444[a]	-2.8619[a]	0.9341
8	3.2264[a]	-2.2876[b]	-2.1558[b]	-1.6397
9	-1.8015[c]	-1.9569[c]	-1.7013[c]	-1.2642
10	-1.5421	-1.5169	-1.3300	-0.9646
		l=0.5		
2	1.1227	-1.1043	0.4337	-0.6927
3	0.3074	-1.2159	0.4320	0.4869
4	0.5102	-1.4750	0.3689	1.0711
5	0.9924	-0.8782	0.1716	1.7698[c]
6	1.5434	-0.6143	-0.0373	2.2670[b*]
7	1.6671[c]	-0.0490	0.1176	2.5481[b#]
8	2.1197[b]	0.1391	0.1557	2.9511[a#]
9	2.1682[b]	0.0305	-0.0309	3.2952[a#]
10	2.0747[b]	0.1865	-0.1632	3.6555[a#]
		l=0.75		
2	1.5196	-0.7238	0.7537	-0.8449
3	0.7361	-0.7102	0.6954	-0.2544
4	0.5777	-1.5613	0.6099	0.0261
5	0.5860	-0.9138	0.6377	0.5248
6	0.7656	-0.7729	0.4734	1.1131
7	0.6652	-0.0905	0.8632	1.7092[c]
8	0.8086	0.3089	1.0521	2.2296[b#]
9	0.6867	0.4887	0.9819	2.5785[a#]
10	0.5406	0.8240	0.9023	2.8286[a#]

Appendix 2 Cont'd

Producer Prices Indices

m	Meat and poultry meat products	Man-made fibres	Fabricated metal products, except machinery and equipment	Basic organic chemicals	Rubber and plastic products
			l=0.25		
2	-0.5780	-0.3786	-0.7345	-0.1109	0.6904
3	0.2966	-1.0120	0.1636	-0.5852	1.6928[c]
4	-0.2958	-0.1356	0.1233	0.1395	1.5607
5	-0.6632	1.2328	-0.0690	1.8290[c]	0.0830
6	-0.5869	-1.1427	0.6458	5.2452[a#]	0.8107
7	-0.6833	-2.1884[b]	0.3275	10.5664[a+]	0.0463
8	-1.5297	-1.6346	2.6344[a]	11.2713[a#]	2.1165[b]
9	-1.1295	-1.2150	-1.9285[c#]	12.1304[a*]	-1.6815[c#]
10	-0.8979	-0.9151	-1.7377[c+]	-0.8910	-1.3132[*]
			l=0.5		
2	0.6238	-1.2995	0.0574	-0.7084	0.6170
3	1.1719	-0.8274	0.5515	-0.6944	1.7198[c*]
4	1.1589	0.0168	0.7592	0.2903	2.0253[b*]
5	1.0342	0.3290	0.9439	0.2580	1.9805[b*]
6	1.2198	0.3744	1.1256	0.3148	1.6622[c]
7	1.2913	0.5018	1.0058	0.7720	0.7900
8	1.7015[c]	0.6030	0.8373	0.7419	0.3502
9	2.3409[b*]	0.3084	0.8381	0.8246	0.3002
10	3.1332[a*]	0.0736	0.6210	1.1823	0.1345
			l=0.75		
2	0.4165	-0.7176	0.1816	-0.7836	-0.4469
3	0.9006	-0.1404	0.3024	-0.7009	1.0674
4	1.0097	0.3606	-0.2661	0.1590	1.7274[c*]
5	1.0598	0.6803	-0.2745	0.2713	1.4506
6	1.2511	0.8533	-0.3094	0.5422	1.6042
7	1.3160	1.0823	-0.4066	0.9110	1.4417
8	1.3567	1.1439	-0.5274	1.0605	1.5234
9	1.4242	1.1241	-0.5133	1.1751	1.4648
10	1.4748	1.0164	-0.7869	1.3408	1.4729

Appendix 2 Cont'd

m	Manufactured products excluding food, beverages, tobacco and petroleum	Paper and paperboard	Manufacture of basic precious and non-ferrous metal, aluminum product	Electronic machinery and apparatus	Wearing apparel
	Producer Prices Indices				
			l=0.25		
2	1.9430^{c*}	0.4251	1.1853	0.7192	-1.1306
3	$2.5826^{a\#}$	1.4278	-0.7916	0.5255	-1.3593
4	2.7160^{a*}	1.8522^{c}	-2.4885^{b}	0.2489	-0.5021
5	2.4771^{b}	1.2488	-2.9063^{a}	0.0300	-0.4135
6	2.7912^{a}	1.6540^{c}	-2.6117^{a}	-0.3054	0.2579
7	1.7973^{c}	2.2719^{b}	-3.9097^{a}	-2.2755^{b}	1.6425
8	2.5003^{b}	2.8772^{a}	-3.1146^{a}	-1.8444^{c}	2.0916^{b}
9	-1.9630^{b+}	-1.1187	-2.6413^{a}	-1.3915	-1.2238
10	-1.7925^{c+}	-0.8411	-2.0973^{b}	-1.1397	-0.9445
			l=0.5		
2	1.6145	0.4337	1.1716	0.5999	0.3457
3	$2.6414^{a\#}$	1.7455^{c*}	0.4889	0.4199	0.5826
4	$2.6156^{a\#}$	$2.0772^{b\#}$	-0.0383	0.4592	0.7550
5	2.1759^{b*}	$2.7202^{a\#}$	0.0417	0.6047	1.0347
6	1.9027^{c*}	$3.4701^{a\#}$	0.1784	0.6707	1.1524
7	1.5493	$4.0149^{a\#}$	-0.5284	0.5472	1.0816
8	1.5356	$4.5707^{a\#}$	-0.4446	0.5277	0.6611
9	0.9760	$5.0102^{a\#}$	-0.3027	0.4736	-0.1625
10	0.9251	$5.2134^{a\#}$	0.1136	0.8400	-0.5037
			l=0.75		
2	-0.2801	-0.1322	0.9268	-0.4419	-1.0736
3	-0.3822	0.1910	0.5710	-0.3947	-0.4512
4	-0.4645	0.3520	-0.0260	-0.0943	-0.4732
5	-0.5379	1.0788	0.1142	0.2092	-0.2391
6	-0.6060	1.7384^{c*}	0.2619	0.3238	-0.0347
7	-19.4811^{a}	$2.1090^{b\#}$	0.2934	0.2985	-0.0114
8	-15.9932^{a}	$2.4069^{b\#}$	0.5312	-0.2189	-0.1829
9	-13.5119^{a}	$2.6448^{a\#}$	0.3937	-0.2031	-0.4945
10	-27.9707^{a}	$2.7287^{a\#}$	0.5112	-0.1111	-0.5333

Appendix 2 Cont'd

	Producer Prices Indices				
m	Footwear	Chemicals, chemical products and manmade fibres	Fruit and vegetable juices	Processed and preserved fruit and vegetables	Motor vehicles
			l=0.25		
2	0.4746	2.2064[b*]	2.9154[a+]	1.0498	0.8349
3	0.2959	2.5557[a#]	1.6250	0.6668	0.2113
4	-0.9262	2.3170[b*]	0.8486	-0.1734	0.4800
5	-1.2432	1.8637[c]	0.7629	0.1256	0.6190
6	-0.6678	0.8868	0.4850	-1.1069	0.9890
7	0.7650	1.0113	1.3448	-2.0441[b]	0.8088
8	-1.2932	-2.0644[b]	2.2448[b]	-1.4832	-0.7925
9	-0.9416	-1.6186	2.2323[b]	-1.1318	-0.5740
10	-0.7192	-1.2729	-0.2503	-0.8765	-0.4545
			l=0.5		
2	0.1266	1.0578	3.2502[a+]	1.0359	1.7800[c*]
3	0.1281	0.6363	2.6550[a+]	0.8030	1.7207[c*]
4	-0.2343	0.8889	1.6909[c#]	0.1986	2.1107[b#]
5	0.1738	0.9121	0.7022	0.0375	2.5909[a#]
6	0.4694	1.0069	0.3189	-0.0404	3.0034[a#]
7	0.9886	1.3038	-0.3006	-0.1739	3.3411[a#]
8	1.1674	1.4165	-0.5702	0.1009	3.5742[a#]
9	1.3989	1.6463[c]	-0.5504	0.0833	3.9937[a#]
10	1.1543	2.3409[b]	-0.6495	0.2397	3.9287[a#]
			l=0.75		
2	-0.7851	0.8555	2.0624[b*]	1.0681	0.3028
3	-1.2327	0.8338	1.9647[b*]	1.1787	0.2959
4	-1.0310	0.9544	1.5260	0.8772	0.1837
5	-0.4764	1.0095	0.6735	0.7073	0.4747
6	-0.2152	1.0492	0.5178	0.6602	0.7456
7	0.3998	0.9092	0.3301	0.3430	0.8686
8	0.5756	0.8987	0.1304	0.4471	1.1406
9	1.0080	0.7814	-0.1354	0.5868	1.4791
10	1.3322	1.0972	-0.2338	0.6843	1.6395

Appendix 2 Cont'd

m	Machinery and equipment	Transport equipment	Food product less beverages	Prepared animal feed for farm animals	Beverages
			Producer Prices Indices		
			l=0.25		
2	0.5846	0.7881	-0.2941	0.4065	1.8161[c*]
3	0.2622	-0.9869	0.0085	0.2138	1.6940[c]
4	-0.0143	-1.9387[c*]	2.4172[b]	-0.6277	0.5161
5	0.8459	-1.7493[c]	3.7801[a]	-0.3072	0.0464
6	2.4206[b]	-2.5085[b#]	0.0159	-0.2985	-0.7442
7	1.9491[c]	-1.8568[c]	-3.4274[a]	-1.9374[c]	-1.4595
8	-2.4489[b+]	-1.4757	-2.5211[b]	-1.3936	-1.1436
9	-2.1470[b+]	-1.1144	-2.1794[b]	-1.1912	-1.0021
10	-1.7140[c+]	-0.9023	-1.7368[c]	-1.0184	-0.8817
			l=0.5		
2	0.3850	0.9859	-1.1412	-0.0429	1.1394
3	-0.0050	-0.1527	-0.8654	-0.2369	1.0139
4	-0.0885	-0.9195	-1.0586	-0.7158	-0.1947
5	-0.0722	-0.2660	-1.1792	-0.8640	-0.4533
6	-0.5000	0.1265	-1.8827	-0.8564	-0.6318
7	-0.9702	0.7984	-1.4834	-0.8466	-0.6095
8	-1.3697	1.4504	-0.9438	-0.4810	-0.4229
9	-1.5054	2.1267[b*]	-0.2365	-0.3585	-0.5647
10	-1.3578	2.2345[b*]	1.4149	-0.2079	-0.8837
			l=0.75		
2	0.8532	0.3963	-1.1972	-0.9215	0.7749
3	0.7625	-0.3683	-0.5737	-0.8002	0.8139
4	0.7209	-0.7851	-0.1081	-1.0587	-0.4474
5	0.8473	0.0927	0.1468	-1.2033	-0.3388
6	0.1993	0.6438	0.2907	-1.2229	-0.1566
7	-0.5294	1.0012	0.2685	-1.0775	0.1377
8	-0.8188	1.4459	0.1490	-1.0699	0.4538
9	-1.3091	1.8341[c*]	-0.2229	-1.4970	-0.0450
10	-1.1982	2.0382[b*]	-0.0061	-1.4441	-0.1646

Appendix 2 Cont'd

			Producer Prices Indices		
m	Motor spirit	Fuel oil	Gas oil and derivatives	Textiles fabrics	Non metallic mineral products
			l=0.25		
2	-0.9052	0.1584	1.2727	1.2031	-0.4735
3	-0.7629	-1.8559[c]	2.3194[b]	0.3847	-1.0049
4	-0.4590	-0.6402	1.4138	1.3878	-1.2265
5	-1.1091	-2.3355[b]	1.7846[c]	1.9552[c]	0.8683
6	-2.3765[b]	-5.4451[a#]	-0.1342	0.8025	0.2248
7	-2.7080[a*]	-4.2147[a]	0.6660	2.0476[b]	-3.2009[a]
8	-2.0042[b]	-3.2498[a]	-2.5232[b]	-1.2792	-2.4107[b]
9	-1.6283	-2.5576[b]	-2.1025[b]	-0.9275	-1.8274[c]
10	-1.3733	-2.2216[b]	-1.9273[c]	-0.6803	-1.4951
			l=0.5		
2	0.2449	-0.2791	0.4750	0.0687	-0.0916
3	-0.0430	-0.4443	0.5921	-0.1769	-0.1035
4	-0.3151	-0.4307	0.4978	0.2081	-1.0460
5	-0.6558	-0.8686	0.4316	0.0355	-0.5408
6	-0.8126	-0.7014	-0.0254	-0.3228	-0.4659
7	-1.0345	-0.8461	0.1023	-0.4099	-0.3841
8	-0.8452	-0.2291	0.2030	-0.5796	-0.4007
9	-0.7871	0.0377	0.5112	-0.6683	-0.5195
10	-0.6148	-0.4654	0.7993	-0.7714	-0.7604
			l=0.75		
2	-0.3692	-1.0813	-0.1147	0.5636	-0.0135
3	-0.4827	-0.6809	0.0495	0.9241	0.1790
4	-0.5889	-0.5242	0.1251	0.9865	-1.0145
5	-1.0174	-0.9023	-0.1240	0.6019	-0.4702
6	-1.0967	-0.7277	-0.2964	0.2710	-0.3082
7	-1.3771	-0.9913	-0.6409	0.1666	-0.2308
8	-1.2990	-0.8138	-0.7151	0.1795	-0.2573
9	-1.1869	-0.5787	-0.8758	0.1043	-0.3561
10	-1.2714	-0.5040	-1.2591	0.0047	-0.6604

Appendix 2 Cont'd

		Producer Prices Indices	
m	Base metals	Photographic chemical materials	Basic pharmaceutical products
		l=0.25	
2	-1.0467	1.6355[*]	1.4133
3	-1.0224	0.7064	2.7664[a#]
4	-0.7446	0.7085	2.9833[a#]
5	-1.2796	1.0991	3.3689[a#]
6	-2.0373[b]	1.6907[c]	5.0711[a#]
7	-2.2902[b]	1.4656	6.4261[a#]
8	-1.6477[c]	1.5432	6.6744[a*]
9	-1.2052	-0.2165	-0.4884
10	-1.0753	-0.1384	-0.3611
		l=0.5	
2	-0.5162	3.3263[a+]	0.6926
3	-0.3742	3.1042[a+]	1.4675
4	0.1324	2.5418[b#]	2.1699[b#]
5	0.5012	2.4331[b#]	2.8519[a#]
6	0.8194	2.5159[b#]	4.0416[a+]
7	1.2513	2.0784[b*]	4.9921[a+]
8	1.4795	1.6822[c]	5.7029[a+]
9	1.3093	1.0722	6.4335[a+]
10	0.6890	0.6734	6.7606[a+]
		l=0.75	
2	-0.0758	1.8504[c]	-1.3248
3	-0.0240	1.3892	-0.6960
4	0.4000	1.2369	-0.9455
5	0.5663	1.4776	-0.5397
6	0.6315	1.5563	-0.1646
7	0.6290	1.3386	0.0253
8	0.7484	1.4021	0.2068
9	0.7210	1.3484	0.3160
10	0.1040	1.1949	0.3244

Notes: The BDS statistic for *l*=0.25, 0.5 and 0.75 standard deviations and *m*-dimensions 2 to 10. At *l*=1 (m=2, 3, 4…10), the BDS statistics was typically zero and therefore is not shown. In terms of normal distribution, significantly different from zero at 1% (a), 5% (b) and 10% (c) level, while bootstrap at 1% (+), 5% (#) and 10% (*) level respectively.

Appendix 3. Results for Johansen's Maximum Likelihood Co-integration Tests (EPs-IPs)

	Panel A: λ_{max}		Panel B: Trace		
	$r=0$	$r\leq 1$	$r=0$	$r\leq 1$	m
Food and live animals					
Cereals & animal feeding stuffs	17.8888[b]	1.9485	19.8372[b]	1.9485	1
Food	27.4426[a]	4.0743[b]	31.5169[a]	4.0743[b]	1
Fruit & vegetables	40.8726[a]	6.5038[b]	47.3764[a]	6.5038[b]	1
Meat	25.3666[a]	5.3521[b]	30.7187[a]	5.3521[b]	2
Beverages and tobacco					
Beverages & tobacco	19.4157[b]	8.9746[a]	10.4411	8.9746[a]	1
Basic Materials					
Metal Ores	10.1815	0.0360	10.2175	0.0359	13
Textile fibres	13.9110[c]	1.7458	15.6568[b]	1.7458	13
Fuels					
Fuels	29.0441[a]	0.5712	29.6153[a]	0.5712	1
Chemicals					
Chemicals	7.5418	4.0630[b]	11.6047	4.0630[b]	5
Organic chemicals	19.6246[a]	1.1776	20.0822[a]	1.1776	1
Inorganic chemicals	11.6998	0.0626	11.7625	0.0626	4
Plastics	21.0234[a]	2.6283	23.6516[a]	2.6283	11
Material Manufactures					
Iron & steel	4.4359	0.5252	4.9611	0.5252	2
Paper & paperboard	11.2943	0.4979	11.7922	0.4979	8
Material manufactures	24.5906[a]	4.9510[b]	29.5416[a]	4.9510[b]	13
Mineral manufactures less precious stones	13.2530[c]	5.1181[b]	18.3710[b]	5.1181[b]	1
Miscellaneous metal manufactures	1.5444	12.2514	13.7958[c]	1.5444	13
Non-ferrous metals	20.9514[a]	5.6184[b]	26.5698[a]	5.6154[b]	12
Textiles	8.1355	4.6158[b]	12.7513	4.6158[b]	8
Machinery & transport equipment					
Electronic machinery	9.3832	2.5842	11.9674	2.5842	1
Machinery & transport equipment	11.7665	3.6019[c]	15.3684[c]	3.6019[c]	13
Machinery	10.5914	0.3270	10.9184	0.3269	13
Road vehicle	31.0579[a]	9.5778[a]	40.6357[a]	9.5778[a]	1
Miscellaneous					
Clothing	10.0029	4.3296[b]	14.3325[c]	4.3296[b]	6
Clothing & footwear	8.0380	6.3785[b]	14.4165[c]	6.3785[b]	9
Scientific & photographic	18.5394[a]	9.4631[a]	28.0024[a]	9.4631[a]	13
Others					
Finished manufactures	12.3657[c]	5.0690[b]	17.4347[b]	5.0690[b]	13
Finished manufactures less erratic	7.0971	3.5447[c]	10.6419	3.5447[c]	1

[a] and [b, c] respectively indicates that the test statistic is significant at 1-percent level, 5-percent level or 10-percent level. r is the number of cointegrating vectors and m is the lag length for the VAR. The critical values are those provided by Pesaran, Shin & Smith (1996). The periods covered by the above results are similar to those shown in Table 3.1

Appendix 4 - Results for OCSB Tests in Univariate Series (IPs)

	Seas. R^2	Lags	τ_1	τ_2	$F_{1,2}$
Food and live animals					
Cereals & animal feeding stuffs	0.0330	0	0.0557	-12.2883[a]	75.5018[a]
Food	0.0285	0	-0.3650	-13.0146[a]	84.8956[a]
Fruit & vegetables	0.0444	1-2	0.2596	-12.6573[a]	80.1229[a]
Meat	0.1517	0	-0.8038	-14.2072[a]	100.9705[a]
Beverages and tobacco					
Beverages & tobacco	0.0358	1	-1.2789	-13.1726[a]	86.9194[a]
Basic Materials					
Metal Ores	0.0316	1-13	-0.9371	-10.7186[a]	58.1005[a]
Textile fibres	0.0313	1	1.1498	-12.6084[a]	79.5128[a]
Fuels					
Fuels	0.0508	1-6	1.0219	-14.5134[a]	105.3712[a]
Chemicals					
Chemicals	0.0412	0	-0.8279	-15.8139[a]	125.1008[a]
Organic chemicals	0.0689	0	-1.4131	-16.8371[a]	142.5805[a]
Inorganic chemicals	0.0275	1-14	1.5934	-10.0056[a]	50.0576[a]
Plastics	0.0275	1-2	0.2611	-14.2274[a]	101.2624[a]
Material Manufactures					
Iron & steel	0.0850	1-2	-0.1491	-14.1737[a]	100.4497[a]
Paper & paperboard	0.0433	0	-0.9900	-16.4897[a]	136.0920[a]
Material manufactures	0.0558	1	0.5063	-12.4368[a]	77.3513[a]
Mineral manufactures less precious stones	0.0335	1-13	0.9897	-10.4816[a]	55.3473[a]
Miscellaneous metal manufactures	0.0942	1-6	1.0268	-12.6786[a]	83.4343[a]
Non-ferrous metals	0.0401	1	-0.2845	-13.1039[a]	85.9703[a]
Textiles	0.0862	0	1.5109	-12.5573[a]	78.9494[a]
Machinery & transport equipment					
Electronic machinery	0.0489	0	0.3295	-13.3021[a]	88.6133[a]
Machinery & transport equipment	0.0576	0	0.8414	-12.7112[a]	80.7942[a]
Machinery	0.0468	0	-0.0384	-11.9158[a]	71.0030[a]
Road vehicles	0.0322	1-6	-0.0564	-13.1775[a]	89.7899[a]
Miscellaneous					
Clothing	0.1501	0	-0.4238	-11.8283[a]	69.9562[a]
Clothing & footwear	0.1450	1	-0.1605	-11.2479[a]	63.2770[a]
Scientific & photographic	0.0604	1-14	-1.6996[c]	-10.0879[a]	50.9045[a]
Others					
Finished manufactures	0.0695	0	0.3923	-12.7830[a]	81.7202[a]
Finished manufactures less erratic	0.0798	0	0.0318	-12.6455[a]	79.9855[a]

Note: Seasonality R^2 values obtained for regressions of the first difference series against twelve monthly dummy variables. The higher value of Seas. R^2 indicates stronger seasonal patterns. [a] and [b, c] indicate that the test statistic is statistically significant at a 1-, 5- or 10-percernt level, respectively. τ_1 is the OCSB seasonal unit root statistic for fist differences while τ_2 is the OCSB seasonal unit root statistic for annual differences. The critical values for τ_1 and τ_2 obtained from Rodrigues and Osborn (1997). $F_{1,2}$ statistics is the joint hypothesis critical value for $\tau_1 = \tau_2 = 0$.

Appendix. 5 Results for Johansen's Maximum Likelihood Co-integration Tests (Real values)

	Panel A: λ_{max}			Panel B: Trace			
	$r=0$	$r\leq 1$	$r\leq 2$	$r=0$	$r\leq 1$	$r\leq 2$	m
Food and live animals							
Cereals and animal feeding stuffs	47.0769[a]	6.4412	3.3789[c]	56.8969[a]	9.8200	3.3789[c]	2
Food	55.6704[a]	10.4712	2.5433	68.6850[a]	13.0145	2.5433	1
Fruit and vegetables	48.6503[a]	4.6574	4.3978[b]	57.7056[a]	9.0552	4.3978[b]	1
Meat	30.5926[a]	8.0925	5.0735[b]	43.7585[a]	13.1660	5.0735[b]	1
Beverages and tobacco							
Beverages and tobacco	50.8887[a]	12.2666	2.7796[c]	65.9348[a]	15.0461[b]	2.7796[c]	11
Basic Materials							
Metal Ores	55.3886[a]	6.2953	3.2256[c]	64.9095[a]	9.5209	3.2256[c]	11
Textile fibres	22.3218[b]	7.9707	2.9269[c]	33.2194[b]	10.8976	2.9269[c]	1
Fuels							
Fuels	18.2371	13.2065[c]	3.6767[b]	35.1203[a]	16.8832[b]	3.6767[c]	12
Chemicals							
Chemicals	27.3534[a]	4.8880	0.6735	32.9150[b]	5.5616	0.6735	1
Organic chemicals	17.6560	9.0103	3.1756[c]	29.8418[b]	12.1859	3.1756[c]	4
Inorganic chemicals	20.3054[c]	5.7484	5.0661[b]	31.1199[b]	10.8145	5.0661[b]	1
Plastics	40.8903[a]	5.1573	3.4891[c]	49.5367[a]	8.6464	3.4891[c]	1
Material Manufactures							
Iron and steel	25.3441[b]	5.7312	0.0076	31.0836[b]	5.7396	0.0076	13
Paper and paperboard	29.0277[a]	10.5584	3.6980[b]	43.2541[a]	14.2564[c]	3.6980[b]	1
Material manufactures	38.3290[a]	7.8233	2.6212	48.7735[a]	10.4445	2.6212	11
Mineral manufactures less precious stones	30.6326[a]	6.7549	0.7026	38.0902[a]	7.4575	0.7026	10
Miscellaneous metal manufactures	32.2883[a]	7.7339	2.4337	42.4559[a]	10.1676	2.4337	11
Non-ferrous metals	27.4674[a]	7.6807	4.7882[b]	39.9363[a]	12.4689	4.7882[b]	3
Textiles	57.0950[a]	5.8395	1.8219	64.7564[a]	7.6614	1.8219	1
Machinery and transport equipment							
Electronic machinery	41.7623[a]	4.7803	0.7194	47.2620[a]	5.4997	0.7194	11
Machinery and transport equipment	45.9365[a]	9.3621	1.2689	56.5676[a]	10.6310	1.2689	11
Machinery	48.5639[a]	7.1719	0.6876	41.3920[a]	6.4843	0.6876	11
Road vehicle	37.3514[a]	3.7056	2.7764[c]	43.8334[a]	6.4820	2.7764[c]	11
Miscellaneous							
Clothing	59.3516[a]	10.0751	2.5897	72.0164[a]	12.6649	2.5897	11
Clothing and footwear	61.1826[a]	11.2965	2.7421[c]	75.2212[a]	14.0386[c]	2.7421[c]	11
Scientific and photographic	24.5130[b]	7.3611	2.1420	34.0161[b]	9.5030	2.1420	11
Others							
Finished manufactures	59.2724[a]	4.5188	0.1743	63.9654[a]	4.6931	0.1743	11
Finished manufactures less erratic	59.4559[a]	4.8146	0.3392	64.6096[a]	5.1538	0.3392	11

[a] and [b, c] respectively indicates that the test statistic is significant at 1-percent level, 5-percent level or 10-percent level. r is the number of co-integrating vectors and m is the lag length for the VAR. The critical values are those provided by Pesaran, Shin and Smith (1996). The periods covered by the above results are similar to those shown in Table 3.1.

Appendix. 6 Results for the Co-integration Restriction Test (Real Values)

	H_1	H_2	H_3
Food and live animals			
Cereals and animal feeding stuffs	41.7954[a]	42.5106[a]	35.5684[a]
Food	52.7164[a]	49.8628[a]	51.4618[a]
Fruit and vegetables	43.7816[a]	44.1408[a]	42.2256[a]
Meat	22.2630[a]	25.3048[a]	22.5380[a]
Beverages and tobacco			
Beverages and Tobacco	40.8843[a]	17.1984[a]	45.3681[a]
Basic Materials			
Metal Ores	51.0276[a]	48.5145[a]	32.9203[a]
Textile fibres	19.0187[a]	19.3246[a]	14.4053[a]
Fuels			
Fuels	3.3857[a]	6.5224[a]	3.9048[a]
Chemicals			
Chemicals	22.5099[a]	23.4802[a]	25.4529[a]
Organic chemicals	7.8767[a]	4.7534[a]	11.9897[a]
Inorganic chemicals	14.4185[a]	15.0889[a]	14.5491[a]
Plastics	37.3589[a]	36.2123[a]	36.1938[a]
Material Manufactures			
Iron and steel	18.9503[a]	14.4238[a]	10.9914[a]
paper and paperboard	23.1944[a]	25.1789[a]	22.0536[a]
Material manufactures	35.6351[a]	33.8545[a]	23.8381[a]
Mineral manufactures less precious stones	24.6094[a]	20.5859[a]	29.0278[a]
Miscellaneous metal manufactures	28.9606[a]	28.3416[a]	28.1541[a]
Non-ferrous metals	21.0680[a]	19.8654[a]	11.8576[a]
Textiles	54.3440[a]	51.7468[a]	53.9174[a]
Machinery and transport equipment			
Electronic machinery	28.6240[a]	33.2455[a]	15.0394[a]
Machinery and transport equipment	44.1735[a]	30.2110[a]	12.7658[a]
Machinery	39.2224[a]	24.4268[a]	16.1385[a]
Road vehicles	32.1107[a]	29.2483[a]	24.8781[a]
Miscellaneous			
Clothing	56.1159[a]	44.9858[a]	38.8864[a]
Clothing and footwear	57.8185[a]	46.8217[a]	40.2069[a]
Scientific and photographic	16.1224[a]	15.4626[a]	18.1205[a]
Others			
Finished manufactures	57.0177[a]	54.9101[a]	57.7293[a]
Finished manufactures less erratic	57.4846[a]	55.1596[a]	55.7946[a]

[a, b] and [c] indicate that the test statistic is significant at a 1-, 5- or 10% level, respectively. Hypotheses are: H_1=[1, -1, 0]; H_2=[0, 1, -1]; H_3=[-1, 0, 1]