The Pricing Behaviour Of Firms In Foreign And Domestic Markets : Empirical Evidence From Business-Survey Data

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Abstract

The Pricing Behaviour Of Firms In Foreign And Domestic Markets : Empirical Evidence From Business Survey Data

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Concordia University, 1995

In recent years, movements in the prices of traded goods have been dominated by movements in nominal exchange-rates in most industrialized countries. The fact that changes in nominal exchange-rates do not appear to be immediately "passed-through" to prices has important implications for macroeconomic policy, as real exchange-rates are a primary channel through which international differences in economic policy and business conditions are transmitted to domestic economies. One explanation for the failure of import prices to fully reflect changes in nominal exchange-rates is that markets are not perfectly competitive; price setting firms adjust foreign and domestic prices in response to changes in the exchange rate as well as other conditions that may differ substantially between foreign and domestic markets. In this instance, firms are said to "price-to-market"(PTM) when foreign and domestic prices are different when expressed in a common currency, even though foreign and domestic goods are produced at equivalent cost.

This thesis argues that current empirical studies examining exchange rate passthrough and PTM have several weaknesses, and addresses these weaknesses through

the use of a unique dataset containing firm-specific responses to business surveys in the U.K. and Switzerland. These surveys contain specific questions concerning *realized* and *anticipated* pricing decisions in foreign and domestic markets. While the U.K. and Swiss business survey data are potentially quite informative about PTM behaviour, they also are extremely challenging econometrically, as most survey responses are ordered and categorical. The thesis employs a linear latent variable econometric approach that treats the categorical survey responses as being generated by continuous latent structural variables as they cross certain thresholds. Parameters in linear relationships amongst the latent variables can theoretically be estimated by maximum-likelihood, using theory for the estimation of polychoric correlation coefficients. Unfortunately, standard maximum-likelihood procedures are computationally infeasible in situations with more than three latent variables, due to problems associated with the computation of multivariate normal orthant probabilities. This thesis employs recently developed simulation procedures to compute the maximum likelihood estimates. The thesis also extends the standard latent variable framework to include time varying effects that are common across firms, and applies the methodology to investigate the effects of exchange rate changes on foreign and domestic price changes.

Empirically, there is strong evidence of PTM behaviour for Swiss manufacturing firms, and less evidence for British firms when considering realized foreign and domestic price changes. Alternatively, data concerning foreign and domestic price plans indicate PTM behaviour for British firms, with less support for Swiss firms. Finally, unanticipated changes in exchange rates with pre-set prices does not appear to be an important determinant of observed passthrough.

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Chapter 1

Introduction

In recent years, movements in the prices of traded goods have been dominated by movements in nominal exchange-rates in most industrialized countries. The fact that changes in nominal exchange-rates do not appear to be immediately "passed-through" to prices has important implications for macroeconomic policy, as real exchange-rates are a primary channel through which international differences in economic policy and business conditions are transmitted to domestic economies. One explanation for the failure of import prices to fully reflect changes in nominal exchange-rates is that markets are not perfectly competitive; price setting firms adjust foreign and domestic prices in response to changes in the exchange rate as well as other conditions that may differ substantially between foreign and domestic markets. In this instance, firms are said to "price-to-market"(PTM) when foreign and domestic prices are different when expressed in a common currency, even though foreign and domestic goods are produced at equivalent cost.

The relationship between local currency import prices and the exchange rate is often referred to as the "passthrough" relationship in international economics.

If there is a proportional relationship between exchange-rates and import prices, passthrough is said to be complete. Recent empirical evidence (Giovannini (1988), Marston (1990), Delgado (1991), Kasa (1992), Hooper and Mann (1989), Dixit(1989), and Knetter (1992)) suggests that exchange-rate passthrough is incomplete for most industrialized countries, due largely to PTM behaviour. In some instance, passthrough may even be "perverse", *i.e.* foreign currency export prices may actually increase in response to a home currency depreciation (Froot and Klemperer (1989)). From a theoretical perspective, the existence of incomplete or perverse passthrough casts substantial doubt on the application of the perfectly competitive paradigm to problems in international macroeconomics. As much recent empirical research in international macro has taken place within the framework of competitive real business cycle models (See Backus, Kehoe and Kydland (1992), and the related references for example), incomplete passthrough represents an important dimension in which these models fail. PTM behaviour may also be reflected in the persistence of trade deficits, even in the face of extreme depreciations, and this is obviously extremely important from a practical policy-oriented perspective. As a result, describing and explaining the empirical dimensions of observed pass-through has been the focus of considerable theoretical and empirical attention from economists in the last decade.

This thesis argues that current empirical studies examining exchange rate passthrough and PTM have several weaknesses. In particular, most previous empirical studies have used time series data, possibly disaggregated to an industry level, to investigate reduced form relationships between foreign and domestic prices, and exchange rates.[1] Cross-sectional aggregation of firm-level data may obscure important relationships that are visible at the micro-level. Firm-specific data can potentially allow for a much more detailed examination of the factors affecting pricing decisions

[1]One recent exception is Schembri (1989).

in foreign and domestic markets.

Several studies have also attempted to distinguish between passthrough that arises from the planned behaviour of firms in response to movements in the exchange rate, and unplanned passthrough that occurs with pre-set prices and unanticipated exchange rate changes. Of course, in the absence of direct survey evidence concerning pricing plans in foreign and domestic markets and exchange rate expectations, any attempt to distinguish between these two types of passthrough must inevitably be based on a joint hypothesis concerning firm behaviour and the nature of expectation formation. For example, Marston (1990) attempts to distinguish between planned and unplanned passthrough by investigating a variety of price-setting lags and assuming that exchange rates follow a martingale. Giovannini (1988) attempted a similar analysis, where the exchange rate was one of several exogenous variables with a VAR representation. While these assumptions make the analyses tractable, applications of these assumptions in situations with panel data would require that expectations are homogeneous across firms, and this seems implausible.[2]

This thesis addresses these weaknesses through the use of a unique dataset containing firm-specific responses to business surveys in the U.K. and Switzerland. These surveys contain specific questions concerning *realized* and *anticipated* pricing decisions in foreign and domestic markets. This thesis investigates whether observed passthrough appears to be the result of planned PTM behaviour, pre-set prices and unanticipated movements in the exchange rate, or some combination of the two, using direct survey evidence concerning foreign and domestic price plans and realizations.

While the U.K. and Swiss business survey data are potentially quite informative about PTM behaviour, they also are extremely challenging econometrically.

[2]Froot and Frankel (1989) examined survey evidence concerning the exchange rate expectations of informed financial market participants, and found substantial cross-sectional heterogeneity

An interesting feature of majority of the survey questions is that they require categorical responses: *i.e.*, firms respond "increase", "remain the same" or "decrease", in comparison with the previous month or quarter, to questions concerning a particular variable of interest. As a result, standard cross-section techniques for the analysis of continuous panel data are inappropriate. This dissertation provides a brief description of the techniques that have been used to analyze categorical survey data, and presents a general latent variable modelling approach that has great intuitive appeal and is more amenable to structural interpretation than standard statistical techniques for multivariate discrete data such as conditional log-linear probability models.

The latent variable approach treats the categorical survey responses as being generated by continuous latent structural variables as they cross certain thresholds. Parameters in linear relationships amongst the latent variables can theoretically be estimated by maximum-likelihood, using theory for the estimation of polychoric correlation coefficients. Unfortunately, standard maximum-likelihood procedures are computationally infeasible in situations with more than three latent variables, due to problems associated with the computation of multivariate normal orthant probabilities. This thesis employs recently developed simulation procedures (Geweke (1989), Hajivasillion and McFadden (1990), Borsch-Supan and Hajivasilliou (1991)) to compute the maximum-likelihood estimates.

Finally, the general latent variable framework presented in Nerlove, Ross, and Willson (1993) and Chowdhury and Willson (1994) is appropriate for situations with continuous and discrete survey data, but does not include time varying effects that are constant across firms. As a result, it is not immediately possible to include exchange rates in a useful way within that framework. This thesis extends the standard latent variable framework to include time varying effects that are common across firms, and applies the methodology to investigate the effects of exchange rate changes on foreign and domestic price changes.

The thesis will proceed as follows: Chapter 2 provides a brief survey of the existing literature concerning pricing-to-market, and motivates the theoretical and empirical work presented in subsequent chapters. Chapter 3 describes the survey data and presents a preliminary descriptive data analysis. Chapter 4 presents the general latent variable econometric approach, provides a brief overview of simulation estimation, and extends the approach to allow for time varying fixed effects that are constant across firms. Chapter 5 develops and estimates a PTM model that is a modest extension of Marston (1990). Chapter 6 attempts to distinguish between "planned" and "unplanned" passthrough using the firm-specific survey data on planned and unplanned foreign and domestic price changes. Chapter 7 concludes and suggests avenues for future research.

Chapter 2

Literature Survey

One of the cornerstones of traditional international economic modelling is the notion of the "Law-of-One-Price", where two goods are sold at the same price in different countries (when expressed in a common currency) if they are produced at the same cost. Numerous empirical studies have documented that there are deviations from this "law" which cannot be explained solely by transportation costs or taxes. Moreover, these price differentials seem to persist for long periods of time and to maintain a close relationship with the country's rate of exchange in the international market (Kasa (1992)). An obvious explanation for these empirical regularities is that price-setting firms charge different prices in foreign and domestic markets (when expressed in a common currency). This chapter briefly summarizes current theoretical and empirical explanations for this "pricing-to-market" behaviour, and argues that there are several weaknesses in empirical applications of these models.

Although the early literature examined PTM either from a demand-side perspective or a supply-side perspective, it is certainly the case that both perspectives could operate simultaneously, and more recent research has included both elements.

The discussion presented below will deal with demand and supply-side motivations for PTM separately (in sections 2.1 and 2.2 respectively), although the theoretical model presented in Chapter 5 will include both. In addition, it should be pointed out that the literature review will focus on general theoretical issues and empirical results; many of the theoretical models are consistent with a wide variety of demand and technology specifications, and empirical work is often based on simple estimation of linear reduced-forms. Section 2.3 highlights some of the weaknesses in current approaches that will be used to motivate the choice of data and the theoretical and empirical work presented in this thesis.

2.1 Demand-Side Explanations For PTM

Perhaps the simplest explanation for PTM is that firms face different demand curves in foreign and domestic markets. In the absence of differences in costs for output designated for foreign and domestic markets, firms will charge different prices in different markets if demand elasticities are different. For foreign demand curves that are less convex than a constant-elasticity curve, a fall in local currency prices increases the markup of prices over marginal costs and a rise in prices reduces it. As a result, a depreciation leads to an increase in the foreign markup and the *stabilization* of local currency foreign prices, relative to a constant markup policy. Passthrough is "less-than-complete" in this case.

Knetter (1989), Marston (1990), and Schembri (1989) have examined models that focus primarily on the price-discrimination mechanism for PTM. Knetter (1989) examined export price behaviour for a panel of selected German export industries. His econometric specification distinguished between country-specific changes in export prices and changes resulting from common unobserved changes in marginal costs.

Overall, the empirical results indicated significant differences in country-specific effects of exchange rates on export prices, which can be interpreted as evidence of price discrimination. Similarly, Marston (1990) examined monthly time series data for 17 Japanese industries, and found significantly different PTM elasticities across industries.

Unfortunately, the empirical work in Knetter (1989) and Marston (1990) was essentially reduced-form in nature, and structural interpretation of their results is therefore difficult. Schembri (1989) made explicit assumptions concerning cost and profit functions that allow for a structural interpretation of the impact of exchange rate changes on export prices. Unfortunately, the size and complexity of his model made the precise estimation of some parameters difficult. However, using panel data from firms in a Canadian export industry, he does find statistically significant differences in markups between U.S. and Canadian firms, indicating that firms could price discriminate between markets.

Overall, these three studies provide broad support for price discrimination as a driving force for PTM. However, as pointed out by Krugman (1987) and Kasa (1992), this explanation is not entirely satisfactory. For example, although Knetter's exchange-rate effects are statistically different across industries, it is not clear that the differences are economically significant and can be attributed directly to demand effects. In general, these difficulties can be attributed to the reduced-form nature of their empirical specifications. Moreover, there are a variety of alternative plausible theoretical explanations that could also result in PTM, and that are consistent with their results.

One problem with these models is the absence of demand-side dynamics. Demand dynamics may be extremely important in situations where it is costly to change prices in response to exchange rate changes. In particular, if price changes are costly and prices are pre-set over several time periods, current pass-through may simply be the result of fixed prices and unanticipated changes in the exchange rate. Moreover, the ex-ante pricing behaviour of firms will depend substantially on whether the exchange rate changes are perceived as permanent or transitory. Along these lines, Froot and Klemperer (1989) develop a theoretical model in which current demand depends on the previous period's market share, which in turn are determined by relative prices. In their model, when the price of foreign currency is perceived as *temporarily* high, exporting firms will not invest in foreign market share by reducing foreign currency prices; instead, firms will raise current profit margins and export-prices will respond less-than-proportionately to the exchange-rate changes. Moreover, it is even the case that passthrough may be *perverse* in some instances, *i.e.* foreign currency export prices may actually increase in response to a temporary home currency depreciation. Empirically, the authors provide some tentative evidence supporting the existence of perverse passthrough, using time-series data on export prices for the U.S., several European countries, and Japan, and several models for expected changes in the exchange rate.

One common theme that underlies much of this demand side research and that is also important in the supply-side explanations for PTM discussed in the next section is the difference between planned and unplanned passthrough. Not surprisingly, several authors have actually attempted to distinguish between the two, although these attempts have necessarily required some strong assumptions about the nature of exchange rate expectations. Marston (1990) allowed for the presence of price setting lags and assumed that the exchange rates followed a martingale process. In this instance, the expected value of next period's exchange rate is simply the value of the exchange rate today. Giovannini (1988) also attempted to distinguish between ex ante price discrimination and long-run price setting behaviour, using time-series data for a selection of Japanese industries that produce homogeneous goods.[1] His model for the exchange rate was somewhat more general (*i.e.* he assumed a vector autoregression for the exogenous variables in his model). For the patterns of price setting behaviour examined, both authors found evidence of planned price discrimination. In their attempt to distinguish between the effects of permanent and transitory changes in the exchange rate. Froot and Klemperer (1989) considered several different models for exchange rate expectations, including the forward discount and the mean expected depreciation from survey data examined in Frankel and Froot (1987).

It should be emphasized that distinguishing between PTM behaviour based on ex ante price discrimination or exchange rate surprises and fixed long-term prices, or based on perceptions concerning the permanence of exchange rate changes is difficult. In these situations, successful empirical work typically requires a structural model of firm behaviour and an assumption about how exchange rate expectations are formed. Both Giovannini (1988) and Marston (1990) chose fairly simple exchange rate stochastic processes and then assumed that expectations were formed rationally. Within the time series context of their empirical work, these simplifying assumptions made their analyses tractable, although it is not clear how reasonable this approach would be for analyzing the pricing behaviour of firms with cross section data. In particular, a blind application of these techniques in a cross-section context would imply that expectations are homogeneous across firms, which seems highly improbable.[2] Moreover, these formulations also preclude a distinction between permanent and transitory exchange rate changes. In these situations, survey data on pricing plans and exchange rate expectations are invaluable for distinguishing between

[1] In particular, Giovannini (1988) considered the ball bearings, screws, and nuts and bolts industries.

[2] Frankel and Froot (1987) examined survey expectations for informed foreign exchange market participants and found substantial cross-sectional heterogeneity.

alternative hypotheses. Although Froot and Klemperer (1989) do include survey evidence on exchange rate expectations in their empirical work, one wonders whether their *aggregate* regression equations provide much evidence concerning the pricing behaviour of firms, as their evidence is consistent with several competing explanations.

2.2 Supply-Side Explanations For PTM

Another simple explanation for PTM behaviour is that some costs of production or selling in foreign markets may actually be denominated in foreign currency. Along these lines, Baldwin (1986,1988) and Dixit (1987,1989) have emphasized the role of non-recoverable fixed costs of entry and exit to foreign markets as a cause for PTM. In these models, even temporary changes in the exchange rate, if large enough, can cause permanent changes in the number of firms competing in foreign markets, including permanent changes in import shares and passthrough. This might result in hysteresis. The observation that prices are not reversed instantaneously, or eventually, even though the original cause of price-change is no longer present is known as "hysteresis".

An alternative supply-side rationale for PTM was developed by Kasa (1992) in the form of convex, destination-specific adjustment costs. In his model, a change in the adjustment cost induces a change in the marginal cost of supplying the foreign market and leads to PTM behaviour. Using time-series data on U.S. and Canadian imports of seven German commodities, Kasa failed to find evidence against the structural restrictions implied by his model, and impulse response functions indicated differences in the response of U.S. and Canadian import prices to changes in the value of the Deutschmark. Krugman (1986) has also pointed out that if a rapid expansion of foreign sales is costly, foreign firms may not change foreign currency prices in the face of foreign currency appreciation.

One aspect of the supply-side explanations that severely impacts on their empirical implementation is that the presence of costs which are partly or fully fixed in nature and are associated with foreign sales may lead the firm to set prices for more than one period at a time. Exchange-rate surprises can then result in inadvertent deviations from the law-of-one-price. Once again, determining the plausibility of these two different supply-side PTM models using aggregate time-series data requires joint assumptions concerning the model of firm behaviour and the nature of exchange rate expectations.

2.3 Summary

There are three common themes from the previous theoretical and empirical research on PTM summarized here that we view as important for providing guidance on future research. First, both demand and supply-side sources appear to be important determinants of pricing-to-market behaviour. As a result, theoretical specifications should incorporate both supply and demand-side effects, and one important goal of empirical research should be to determine which is more important. The theoretical model developed in Chapter 5 will allow for both effects, although the empirical specification will be reduced-form in nature. As discussed in Chapter 4, the complexities of dynamic panel data modelling with categorical business survey data make even reduced form econometric modelling extremely challenging.

Second, determining between competing supply- and demand-side rationales for PTM is, to some extent, linked with distinguishing between ex-ante price discrimination (planned PTM) and long-term price setting behaviour coupled with unanticipated movements in the exchange rate. From a traditional time-series econometrics perspective, inferences regarding the importance of unplanned and planned PTM are inherently joint hypotheses concerning the model of firm behaviour and the nature of expectations formation. One benefit that results from the use of direct survey data is that it is possible to make inferences regarding foreign and domestic pricing plans without specifying a complete structural model. Unfortunately, although the business survey data employed in this thesis contain responses to questions concerning foreign and domestic price plans, they do not contain data on exchange rate expectations directly. As a result, it is not possible to base all PTM tests on the survey data without making assumptions on exchange rate expectations, and it therefore important to investigate alternative hypotheses concerning the formation of exchange rate expectations and their impact on conclusions regarding PTM.

Finally, most empirical work that has examined PTM has employed time series data, possibly disaggregated to an industry level, to make inferences concerning the behaviour of firms. From a statistical perspective, the use of aggregate data may obscure important relationships that exist at the micro level. From a modelling perspective, the use of firm-specific categorical business survey data can potentially provide important new insights into PTM behaviour.

Chapter 3

Data and Preliminary Empirical Work

This chapter provides a brief description of the survey data and presents results from a preliminary data analysis employing cross-sectional aggregation procedures that were originally developed by Theil (1952) and that have been the most prevalent form of statistical analysis employed in the analysis of business surveys.[1] We also introduce the latent variable procedure that will be applied in the empirical analysis in Chapters 5 and 6, although we defer a detailed discussion of econometric issues until Chapter 4. Chapter 4 also highlights some of the advantages of the latent variable technique, relative to the cross-sectional aggregation procedures. We would like to emphasize that the empirical results presented in this chapter should be considered as primarily descriptive, even though several authors have employed the cross-section aggregation procedures to estimate structural econometric models.

[1] Pesaran (1987) provides an extensive bibliography of applications involving this technique

3.1 Data

This research uses categorical survey data from business in the U.K. and Switzerland. The sources for the data, the frequency of each survey, and the time periods under consideration, are contained in Table 3.1.

Table 3.1: Business Surveys - Working Databases

Survey Organization	Country	Dates	Sample Frequency
Center For Research On Economic Activity	Switzerland	1978-1987	Monthly + Quarterly
C.B.I.	U.K.	1982-1987	Quarterly

The Swiss Business Survey organized by the Center For Research On Economic Activity contains microlevel survey response data for a wide cross-section of Swiss manufacturing industries.[2] Firms are asked questions at monthly or quarterly intervals concerning details on their economic status and expectations of future economic variables. Their responses are primarily ordered and categorical; that is they respond "increase", "decrease", or "remain the same" in comparison with the previous month or quarter. For this research, we will focus on firms' responses to questions regarding changes in raw material prices (ΔP_t^m), domestic prices (ΔP_t^d), and foreign prices (ΔP_t^f), as well as expectations for future changes of the same variables (i.e., $\Delta P_t^{de}, \Delta P_t^{fe}, \Delta P_t^{me}$) on a quarterly basis. For the Swiss survey, we will focus on years from 1982-1987 in which respondents were asked to seasonally adjust their responses. Prior to this time period, respondents were not required to seasonally adjust their

[2]Industry coverage is intended to be representative of Swiss manufacturing and includes electrical and electronics machines, metals, non-metallic mineral products, chemicals, watches, wood and furniture, man-made fibre products and rubber, clothes and shoes, textiles, papers, beverages, and tobacco and tobacco products.

responses. Nerlove, Ross, and Willson (1993) and Ghysels and Nerlove (1988) have examined seasonality in qualitative business survey data, and have compared self-seasonal adjustment procedures with statistical seasonal adjustment. In general, the choice between self-seasonal adjustment and statistical seasonal adjustment is not clear theoretically. Self-seasonal adjustment theoretically captures individual and aggregate seasonality when it is deterministic (*i.e* it can be represented by seasonal dummy variables) but will introduce non-sampling errors into the analysis if seasonality is stochastic. Statistical seasonal adjustment captures aggregate seasonality only, but does not introduce errors if the model for seasonality is well-specified. As the U.K. data are confined to the period 1982-1987, we will consider this time period for the Swiss survey as well.

The U.K. survey is conducted by the Confederation Of British Industries (CBI) and provides information concerning manufacturing firms in the U.K. on a quarterly basis. At present, we have data for approximately 5 consecutive years for a wide cross-section of British manufacturing industries. We will consider answers to questions concerning changes in average unit costs (ΔC_t), domestic prices (ΔP_t^d), and foreign prices (ΔP_t^f), as well as expectation of future changes for the same variables. For the U.K. survey, questions are asked on a quarterly basis but responses are measured as changes over a four month period. As a result, there is a one month overlap between successive survey responses that substantially complicates the derivation of appropriate modelling procedures, at least theoretically. For the descriptive analysis presented below, we will ignore this issue, although Chapter 4 discusses this issue in detail. Previous researchers employing the C.B.I. data have ignored this problem as well.[3]

It is important to note that the questions concerning cost components for

[3]See Pesaran (1987), and McIntosh, Sciantarelli and Low (1989), for example.

each of the surveys are different, *i.e.* the Swiss survey contains information on raw materials prices and the U.K. contains information on average costs. As a result, the development of the theoretical models in Chapter 5 will differ slightly, in order to accommodate the differences in data. For Switzerland, P_t^m is treated as a cost of production and some additional costs are modelled as separate components of the total cost functions. For the U.K., we cannot distinguish production costs from other costs incurred by the firms. As a result, we multiply C_t by the total quantity sold in the two markets (*i.e.*, $D_t^f + D_t^d$) to get total costs for each firm.

Another interesting difference between the two surveys is the currency denomination for foreign price changes and expected price changes. For the Swiss survey, firms are explicitly requested to convert foreign currency into Swiss francs for the purposes of the questionnaire. For the U.K. survey, the currency of denomination for responses concerning foreign prices is not clearly requested, and this introduces the potential for a (possibly substantial) measurement error into the analysis. Below we will proceed under the assumption that foreign prices are converted to domestic currency, as this will make the empirical specification consistent with the Swiss survey, although we recognize that this is certainly debatable.

One additional feature of both business surveys is that the "foreign market" variables are not destination-specific. As a result, the appropriate exchange rate to consider is trade-weighted. Nominal trade weighted exchange-rate data for this study were obtained from *The International Financial Statistics* and are measured with respect to SDR (special drawing rights) with 1973 as the base-year.[4] For this research,

[4]These data were supplied by Sylvie Leclerc from Reuters Canada. SDR are unconditional reserve assets that are created by the International Monetary Fund (IMF) to supplement existing reserve assets. They are allocated to Fund members (i.e., the participants in the SDR department) in proportion to their quotas. It should be pointed out that the SDR is the unit of account for the IMF and that the Fund changed its definition several times. Until June 1974, 1 SDR was equivalent to 1.20635 U.S. dollar. Since July 1974, the value of SDR has been determined daily by the IMF on the basis of a basket of currencies with each assigned a weight in the determination of the value. Since

quarterly nominal exchange-rate data for the U.K. and Switzerland have been used, with the nominal rate defined as *domestic currency vis-a-vis foreign currency.*

3.2 Empirical Methodology

As responses to business surveys are primarily ordered and categorical, researchers have generally employed two different procedures to handle the data. The first technique transforms the qualitative responses into aggregate quantitative variables, and then applies standard time series techniques to the aggregate data; a comprehensive discussion of this approach is contained in Pesaran (1987, Ch. 8). The second general approach employs the qualitative data directly; econometric techniques that are appropriate for analyzing the joint behaviour of micro-level expectations and realizations in business-surveys include log linear probability models (See Nerlove(1983), Koenig, Nerlove and Oudiz (1981)), classical maximum-likelihood procedures for testing inequality constraints on probabilities in contingency tables (See Gourieroux and Pradel (1986)), and maximum likelihood techniques in linear latent variable models where the survey responses are treated as being triggered by continuous latent variables as they move across certain thresholds (See Nerlove, Ross, and Willson (1993), and Chowdhury and Willson (1994)). We will briefly introduce the aggregation and latent variable procedures here, and defer a discussion of more substantial econometric issues to Chapter 4.

January 1, 1981, the "SDR valuation basket" consists of 5 currencies: the U.S. dollar, Deutsche mark, French franc, Japanese yen, and pound sterling. The currencies and their weights broadly reflect the relative importance of them in international trade and finance.

3.2.1 Aggregation Techniques

In order to aggregate the cross-sectional responses at a point in time, we must place some additional restrictions on the data generating process. For categorical responses z_{ijt}, i=1 ... N, j=1...M, t=1 ...T these assumptions are:

Assumption 1:

(i) At time t, the categorical responses z_{ijt} are triggered by a set of M latent variables, z^*_{jt}, as they move across thresholds a_{1j}, a_{2j}, j=1...M, *i.e*:

$$z_{ijt} = \begin{cases} 1, & z^*_{jt} < a_{1j} \\ 2, & a_{1j} \leq z^*_{jt} < a_{2j} \\ 3, & a_{2j} \leq z^*_{jt} \end{cases}$$

(ii) $Z^*_t \sim N(\mu_t, \Sigma_t)$

(iii) $-a_{1j} = a_{2j} = c_j$

Assumption 1(i) requires that thresholds be time invariant and identical across firms. Multivariate normality for the underlying latent variables is assumed in 1(ii): this is not generally required (other distributions can be employed) but normality is retained to make the results comparable with those obtained from the other empirical work. Assumption 1(iii) requires that the thresholds be symmetric; this will allow one to identify (up to a time invariant scale factor) μ_{jt} and σ^2_{jt}. While these assumptions appear to be quite strong, the results from empirical work employing the time-series aggregates appear to be insensitive to the distributional assumptions (Pesaran, (1987)).[5]

[5]Of course, this does not necessarily imply that the aggregation procedures are theoretically or empirically appropriate; rather, it appears that different aggregation procedures produce similar

Under these assumptions, the qualitative survey responses can be used to construct aggregate quantitative measures of the mean and variance of the underlying latent variables in the following manner. Defining π_{1j}, π_{2j}, and π_{3j} as the true marginal probabilities of observing responses "1", "2", and "3" respectively, it follows that these probabilities satisfy

$$\frac{-c_j - \mu_{jt}}{\sigma_{jt}} = \Phi^{-1}(\pi_{1j}) \tag{3.2.1}$$

and

$$\frac{c_j - \mu_{jt}}{\sigma_{jt}} = \Phi^{-1}(1 - \pi_{3j}) \tag{3.2.2}$$

where $\Phi(.)$ is the cumulative distribution function for a standard normal random variable. To estimate μ_{jt} and σ_{jt}, replace the theoretical probabilities with the empirical frequencies and rearrange to yield

$$\mu_{jt} = c_j\left[\frac{\Phi^{-1}(\frac{n_{1jt}}{n_{jt}}) + \Phi^{-1}(1 - \frac{n_{3jt}}{n_{jt}})}{\Phi^{-1}(\frac{n_{1jt}}{n_{jt}}) - \Phi^{-1}(1 - \frac{n_{3jt}}{n_{jt}})}\right], \tag{3.2.3}$$

and

$$\sigma_{jt} = \frac{2c_j}{\Phi^{-1}(1 - \frac{n_{3jt}}{n_{jt}}) - \Phi^{-1}(\frac{n_{1jt}}{n_{jt}})}. \tag{3.2.4}$$

For traditional econometric applications where aggregated responses are employed in a linear regression framework, an estimate of the scaling parameter c_j is crucial. For the purpose of this research, the cross-sectional aggregates will only be employed as a tool for descriptive data analysis, and it should be realized that without additional information, it is not possible to identify the scale of the aggregated

results. There are a wide variety of situations where the aggregation procedures produce results that are intuitively implausible or unacceptable; see Horvath, Nerlove, and Willson (1993), for example responses.

3.2.2 Latent Variable Techniques

This technique involves partitioning the categorical responses $\{z_{ijt}\} = \{y_{it}, x_{ijt}\}$. If $\{y_t^*, x_t^*\}$ have a multivariate normal distribution, estimates of linear structural relationships among the latent variables could hypothetically be obtained from estimates of the population regression coefficients, *i.e.*:

$$E(y_t^*|x_t^*) = \mu_{y_t^*} + B(x_t^* - \mu_{x_t^*}), \quad B = \Sigma_{x^*x^*}^{-1}\Sigma_{x^*y^*} \tag{3.2.5}$$

This technique is advantageous because it employs the micro-data directly, and because it shares an intuitive similarity with standard cross-sectional regression procedures that are familiar to users of time series data, a property that is not shared by other techniques that are appropriate for micro-data such as conditional log-linear probability models. We will discuss this econometric technique in more detail in Chapter 4.

3.3 Preliminary Empirical Work

As a precursor to more involved modelling, we examined the marginal tables for foreign and domestic price changes, changes in raw materials prices (Swiss survey), and changes in average costs (U.K. survey) in order to compare their properties with several well-known properties of other business surveys discussed in Nerlove (1983) for example. A prominent characteristic of expectations and plans, relative to realizations for the same survey variable, is that the marginal tables for the expectations are concentrated in the "no change" category, relative to the realizations. While this property is exhibited by production and demand (or orders) variables for both surveys (see Nerlove, Ross, and Willson (1993) and Horvath, Nerlove, and Willson (1993)), it does not appear to be true for foreign or domestic prices. In fact, approximately 70% of firms respond "no change" to questions concerning expectations *and* realizations for both foreign and domestic prices, and this number is much higher than the other survey variables. As argued in Horvath, Nerlove, and Willson (1993), this can be viewed as indicative of price setting behaviour in the presence of price adjustment costs, and provides some empirical motivation for the theoretical models discussed in Chapter 5.

3.3.1 Empirical Results Using Aggregation Technique

This section presents some graphical results for the Swiss and the U.K. business surveys using the cross-sectional aggregation procedure. For the purposes of drawing the graphs, we have assumed that $c_i=1$ for all variables. As mentioned previously, it is not possible to separately identify the variance and the thresholds from a single aggregated time series. As a result, one must be careful about drawing conclusions regarding the relative variability of the time series, and we will focus on sample correlations between the various aggregates and the appropriate nominal exchange rate.

Figures 1 and 2 present the relationship between the standardized percentage change in the exchange rate and foreign price aggregates for Switzerland and the U.K., respectively. The corresponding correlation estimates are 0.035 and 0.687 respectively, indicating that the U.K. foreign price aggregate is much more highly correlated with the trade-weighted exchange rate. However, before we attempt to draw structural conclusions from these simple correlations, it should be emphasized that the theoretical model developed in Chapter 5 actually allows for a wide range of correlations.

The relationships between domestic prices and exchange rates are graphed in Figures 3 and 4 for Switzerland and the U.K. respectively. The associated correlations are are 0.116 and 0.599. In general, one would expect the domestic prices to be less correlated with exchange rates than foreign currency prices; however, if survey responses to questions concerning foreign prices are converted into domestic currency, similar correlations with the nominal exchange rate would imply that there is a high degree of passthrough. Although the magnitudes of the foreign and domestic price correlations with the exchange rate are similar within countries, there appear to be extreme differences across countries that might suggest substantially different PTM behaviour. Figures 5 and 6 depict the relationship between aggregates constructed from survey responses to questions concerning raw materials prices (Switzerland) and average costs (U.K.), and changes in the nominal exchange rate. The associated correlation estimates are -0.658 and 0.422 respectively.

It is important to emphasize that the analysis of simple unconditional correlations can only really provide descriptive information concerning the foreign and domestic prices, costs, and the nominal exchange rate; one should not jump to conclusions and attempt to provide a structural interpretation of the correlations without estimating a model. The model that is developed in Chapter 5 actually allows for a wide variety of correlations, and there should be no presumption that the technological structure of industries in each country and the foreign markets to which firms export are similar. However, it is clear from the aggregates that the joint behaviour of prices and the exchange rate vary considerably across countries, and it will be interesting to see the results from a more careful econometric analysis.

Figure 1: Standardized % Change In S_t & Standardized % Change In P_t^f

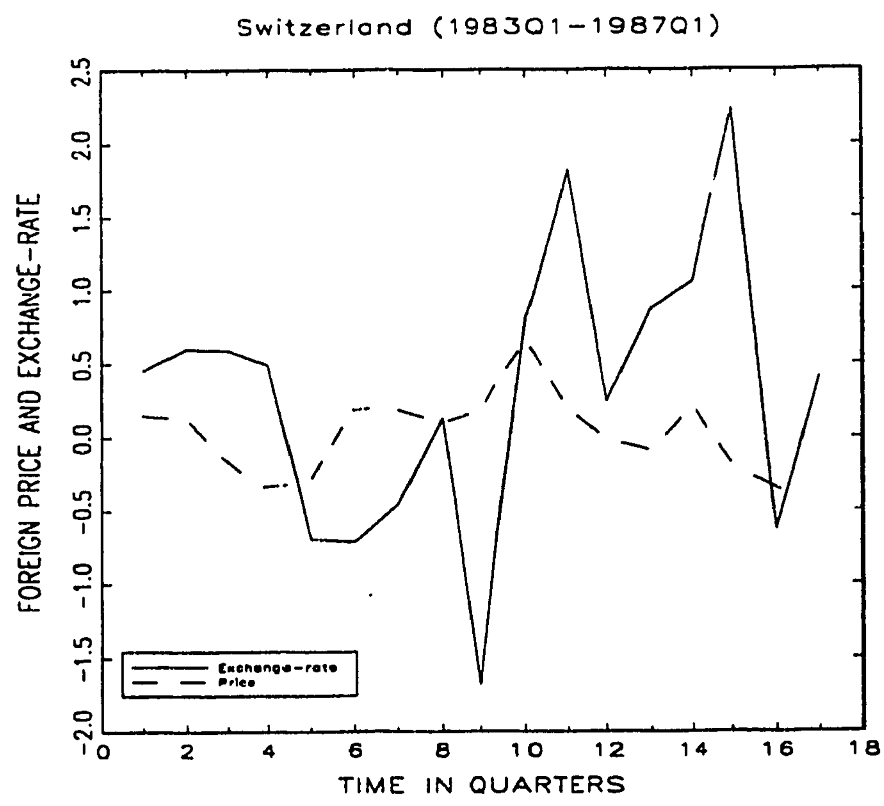


Figure 2: Standardized % Change In S_t & Standardized % Change In P_t^{f*}

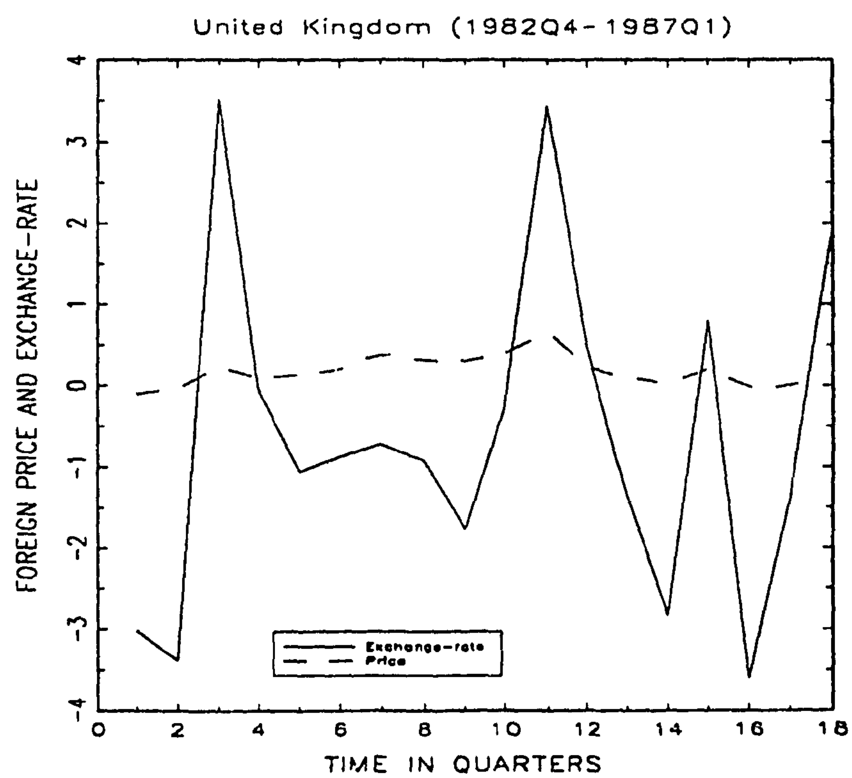


Figure 3: Standardized % Change In S_t & Standardized % Change In P_t^d

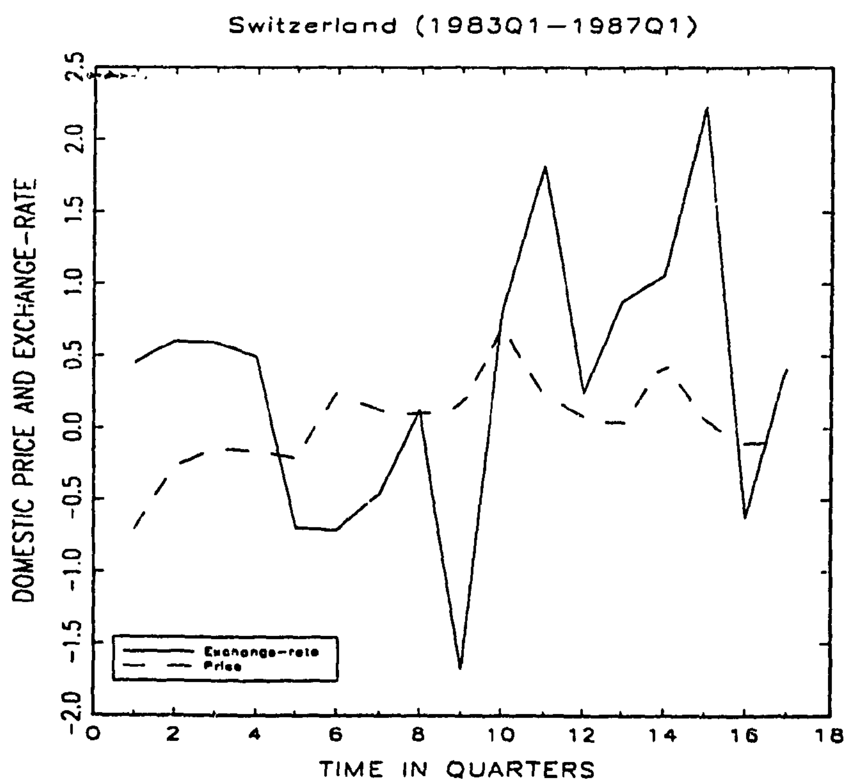


Figure 4: Standardized % Change In S_t & Standardized % Change In P_t^d

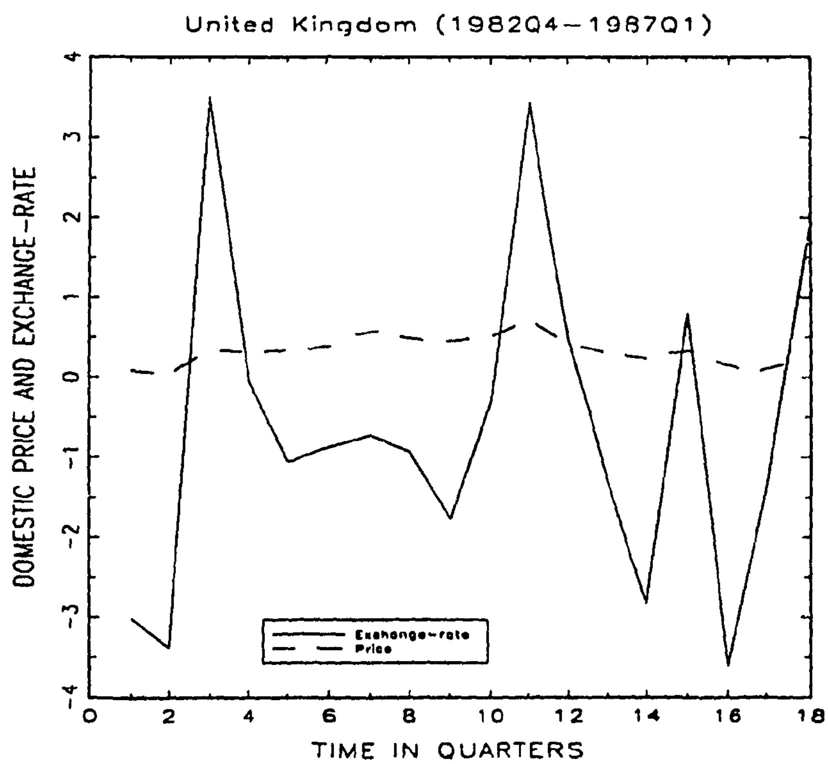


Figure 5: Standardized % Change In S_t & Standardized % Change In P_t^m

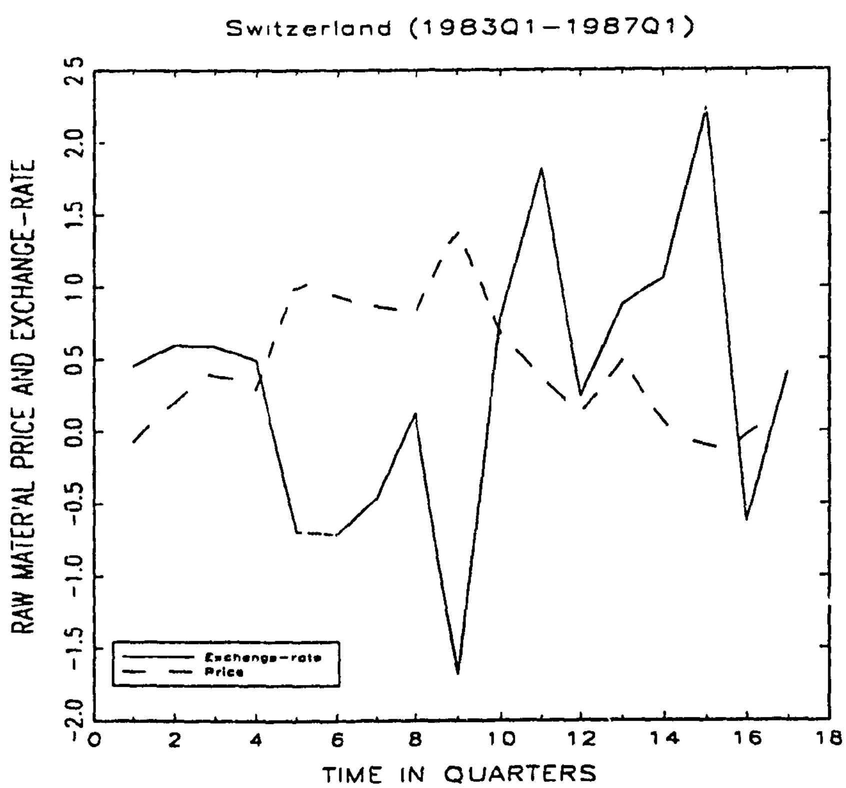
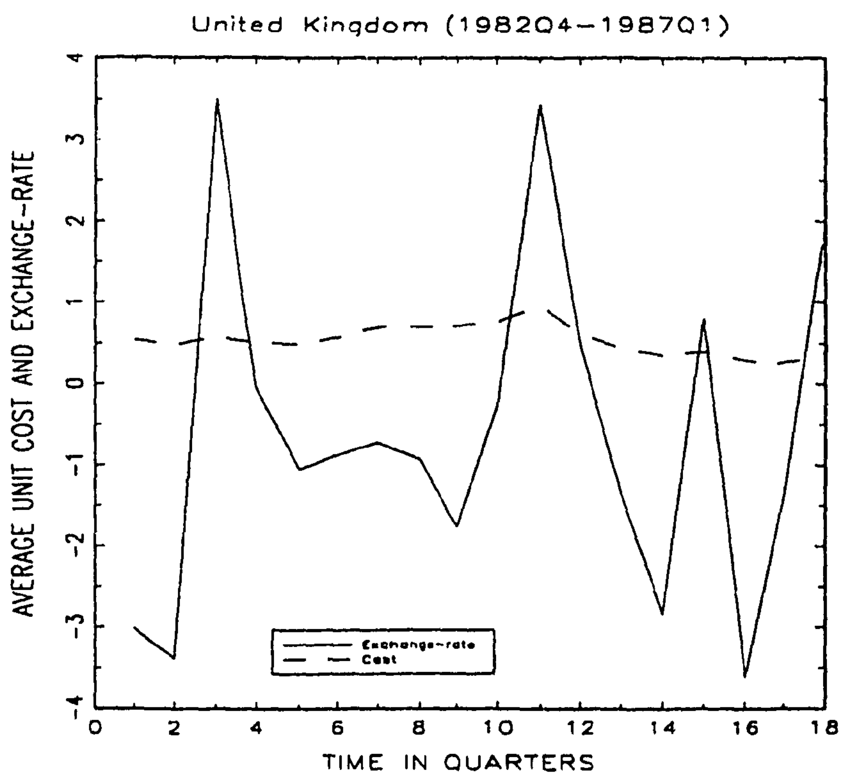


Figure 6: Standardized % Change In S_t & Standardized % Change In C_t



Chapter 4

Econometric Methods

This chapter provides a general discussion of the econometric techniques that will be employed in the empirical work presented in Chapters 5 and 6. As the survey data are primarily ordered and categorical, it is important to realize that the application of standard cross-section econometric procedures to the categorical survey data are strictly inappropriate. As discussed in Chapter 3, researchers have traditionally employed one of two techniques to estimate economic models with categorical business survey data. The first general approach transforms the qualitative responses into aggregate quantitative variables, and then applies standard time series tests to the aggregated data; the graphs and correlations in Chapter 3 are applications of this procedure. The second general approach employs the qualitative data directly: while there are a variety of econometric techniques that are appropriate for analyzing qualitative business survey data, we will employ maximum-likelihood techniques in linear latent variable models where the survey responses are treated as being triggered by continuous latent variables as they move across certain thresholds.(Nerlove, Ross, and Willson (1993), Chowdhury and Willson (1994)).

We follow the latent variable procedure here as it incorporates the ordered qualitative nature of the microdata directly into the statistical analysis. In addition, while standard full-information maximum-likelihood estimation is only feasible for general covariance structures in situations with at most three latent variables, larger models can be estimated using recently developed simulation procedures (Geweke (1989), Borsch-Supan and Hajivasilliou (1990)). Finally, the latent variable methods possess an intuitive similarity with standard cross-section and time series tests that are familiar to most economists. While conditional log-linear probability (CLLP) models have a long history in business survey analysis, they essentially treat the data as unordered and are perhaps better suited to descriptive data analysis.

We begin this chapter with a general discussion of the latent variable methodology in Section 4.1, including a description of traditional full-information maximum likelihood estimation, a discussion of the infeasibility of FIML in problems of even moderate dimension, and a brief critique of traditional solutions to the problem. Section 4.2 discusses the usefulness of simulation estimation techniques within this context. Section 4.3 generalizes the latent variable procedure to include time varying effects that are constant across firms. This is particularly important for the empirical work performed in Chapters 5 and 6, as the standard latent variable framework does not include this case directly, and because the exchange rate varies over time but is common across firms at a point in time. Section 4.4 discusses some key issues concerning the nature of the survey data and the analysis of latent variables of this type that impact critically on the nature of the theoretical models that can be investigated.

4.1 Estimating Linear Latent Variable Models

We will first consider the observed categorical indicators $\{z_{it}\}=\{y_{it}, x_{ijt}\}$, for a cross-section of N firms at time t, as being independently triggered by continuous latent structural variables $\{z_t^*\}=\{y_t^*, x_t^*\}$ as they move across certain thresholds, *i.e.*

$$z_{ijt} = \begin{cases} 1, & z_{jt}^* < a_{j1t} \\ 2, & a_{j1t} \leq z_{jt}^* < a_{j2t} \\ 3, & a_{j2t} \leq z_{jt}^* \end{cases} \quad j = 1 \ldots M. \tag{4.1.1}$$

If $\{z_t^*\}$ has a multivariate normal distribution, estimates of linear structural relationships among the latent variables could hypothetically be obtained from estimates of the population regression coefficients, *i.e.*

$$E(y_t^*|x_t^*) = \mu_{y_t^*} + B(x_t^* - \mu_{x_t^*}), \quad B = \Sigma_{x^*x^*}^{-1} \Sigma_{x^*y^*} \tag{4.1.2}$$

Unfortunately, as the latent variables are unobserved and the thresholds are unknown, it is generally not possible with a single cross-section of data to separately identify the means, variances, and covariances in the underlying multivariate distribution. For expositional purposes, it will be assumed that all latent variables have zero mean and unit variance, although the identification of mean and variance parameters is certainly possible with restrictions on the value and time variation of thresholds, and with the use of additional cross-sections of data.[1] In this instance, the parameters to be estimated (in addition to the thresholds) are contained in a correlation

[1] See Horvath, Nerlove, and Willson, (1993), Pesaran (1987, Ch. 8), Ivaldi (1990), and Chowdhury and Willson (1994) for examples.

matrix containing ones along the diagonal and (m-1)(m)/2 off-diagonal correlations. Full-information maximum-likelihood estimation of these *polychoric* correlations was first discussed by Olsson (1979) for bivariate situations, and this was generalized to multivariate situations in Poon and Lee (1987).[2]

To illustrate the use of FIML in this situation, it is useful to arrange the data in a contingency table with 3^M observed frequencies $d_{i_1 i_2 \ldots i_M}$, $i_1, \ldots, i_M = 1 \ldots 3$. If the probability of an observation falling in the $i_1 i_2 \ldots i_M^{th}$ cell is denoted as $\pi_{i_1 \ldots i_M}$, the log-likelihood for a survey sample of N firms can be written (except for inessential constants) as

$$L(\theta) = N \sum_{i_1=1}^{3} \cdots \sum_{i_M=1}^{3} d_{i_1 i_2 \ldots i_M} log(\pi_{i_1 \ldots i_M}) \tag{4.1.3}$$

where $\theta = \{a_{0_1}, \ldots, a_{3_M}, \rho_{ij}, i \neq j\}$, $a_{0_1}, \ldots, a_{3_0} = -\infty$, and $a_{3_1}, \ldots, a_{3_M} = \infty$. The associated score can be written as

$$\frac{\partial L(\theta)}{\partial(\theta)} = N \sum_{i_1=1}^{3} \cdots \sum_{i_M=1}^{3} W_{i_1 i_2 \ldots i_M}(\pi_{i_1 \ldots i_M} - d_{i_1 \ldots i_M}) \tag{4.1.4}$$

where

$$W_{i_1 i_2 \ldots i_M} = \frac{\partial log(\pi_{i_1 \ldots i_M})}{\partial(\theta)}. \tag{4.1.5}$$

As McFadden (1989) and others in related contexts have noted, the primary obstacle to computation of maximum-likelihood estimates for θ is the evaluation of $\pi_{i_1 \ldots i_M}$ and $W_{i_1 \ldots i_M}$, each involving integration over the M-dimensional multivariate normal density function. Practical FIML solutions involving numerical integration are

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[2] It should be emphasized that Poon and lee (1987) did not provide a computationally feasible full-information maximum-likelihood solution to the estimation problem for situations with more than three latent variables. See below

only available for integrals involving at most three latent variables. When FIML is not feasible, traditional solutions to higher dimensional problems involve the computation of polychoric correlation coefficient estimates pairwise, either by maximum-likelihood (Poon and Lee, 1987) or by conditioning initially on threshold estimates computed from marginal frequencies and than iterating to a root of the sample score (Martinson and Hamdan, 1971). These estimators ignore the true multivariate nature of the problem, and need not produce a matrix of estimated correlations that is positive definite.[3] In addition, standard errors in this framework are typically calculated from the information matrix evaluated at the correlation estimates conditional on the first stage threshold estimates, and are therefore biased.

Recent theoretical developments in Monte Carlo integration have allowed for the replacement of numerical quadrature procedures for integration with random number generators in standard gradient-based optimization procedures. The next section discusses the simulation literature in general and introduces a probability simulator that is well-suited to maximum-likelihood estimation within the latent variable framework.

4.2 Simulation Estimation Techniques

In an econometric context, Lerman and Manski (1981) were the first to consider simulation methods to estimate the cell probabilities $\pi_{i_1 \ldots i_M}$. More recently, Pakes and Pollard (1989) and McFadden (1989) have developed general asymptotic theories for various classes of simulation estimators, and these have been applied by Chowdhury and Willson (1994) to problems involving business survey data. To illustrate the basic idea behind simulation in this context, consider the problem of

[3]This problem has actually arisen in practice; see Nerlove, Ross, and Willson (1993).

calculating the elements of Π given an initial estimate of the thresholds and the correlations in θ. A simulation procedure for estimating Π would involve drawing a set γ_M of M pseudorandom standard normal variables, transforming them to a set of dependent variables with correlation matrix $\hat{\Sigma}_0$ using a lower triangular decomposition of $\hat{\Sigma}_0$, *i.e.* $\Omega\gamma_M$ where $\hat{\Sigma}_0=\Omega\Omega'$, and then counting the number of realizations in each particular cell of the contingency table, given the initial threshold estimates. Iterative procedures are then used to minimize the distance between the observed and the simulated frequencies.

More formally, Pakes and Pollard (1989) initially consider minimizing the objective function

$$G_n(\theta) = [D_n - \hat{\Pi}_s(\theta)]'[D_n - \hat{\Pi}_s(\theta)] \qquad (4.2.6)$$

where $\hat{\Pi}_s$ are the corresponding simulated probabilities and D_n are the empirical frequencies. The solution to the optimization problem, under certain regularity conditions, yields a consistent and asymptotically normal estimator of θ as $ns \rightarrow \infty$, where ns is the number of simulated random vectors, n is the sample size, and s is a positive number, not necessarily an integer. In practice, asymptotic efficiency of the parameter estimates is improved by choosing a norm other than that induced by the inner product. In particular, we may choose a sequence of nonsingular matrices of random variables possibly depending on θ, $A_n(\theta)$, and minimize $A_n(\theta)G_n(\theta)$ instead. Simulated maximum-likelihood, minimum chi-square, and modified minimum chi-square estimators can all be obtained within this minimum distance framework.

While the crude frequency simulator has intuitive appeal and is theoretically suitable here, its usefulness in practice is diminished by several factors. In particular, for the simulation of any probability there will always be a positive probability that the simulated frequency will be zero; in practice, this implies that the num ber of simulations must be quite large to estimate small probabilities with suitable accuracy. In addition, frequency simulators are not continuous functions of the parameters of interest, which invalidates traditional numerical optimization procedures. There are a variety of simulators that are continuous and differentiable functions of the parameters, and that are bounded between zero and one. One such simulator was recently proposed by Geweke (1989) and was also employed in a slightly different contexts by Borsch-Supan and Hajivassiliou (1990), Hajivassiliou and McFadden (1990) and Keane (1992). This *Smooth Recursive Conditioning* simulator, dubbed the GHK simulator after its inventors, is unbiased, smooth, and has a small variance.

To illustrate the use of the GHK simulator, consider simulating one specific probability indexed by the vector of thresholds $\{a_k^*, a_{k+1}^*\}$. Consider drawing a random vector $\epsilon^* \sim N(0,I)$ such that $a_k^* \leq \Omega\, \epsilon^* \leq a_{k+1}^*$. Due to the triangular structure of Ω, the restrictions are recursive, *i.e.*

$$\epsilon_1^* \sim N(0,1) \quad s.t. \quad a_{1k}^* \leq \omega_{11}\epsilon_1^* \leq a_{1k+1}^* \leftrightarrow \frac{a_{1k}^*}{\omega_{11}} \leq \epsilon_1^* \leq \frac{a_{1k+1}^*}{\omega_{11}}$$

$$\epsilon_2^* \sim N(0,1) \quad s.t. \quad a_{2k}^* \leq \omega_{21}\epsilon_1^* + \omega_{22}\epsilon_2^* \leq a_{2k+1}^* \leftrightarrow \frac{a_{2k}^* - \omega_{21}\epsilon_1}{\omega_{22}} \leq \epsilon_2^* \leq \frac{a_{2k+1}^* - \omega_{21}\epsilon_1}{\omega_{22}}$$

etc ...

The ϵ^*'s can be drawn sequentially by a univariate truncated simulator, will satisfy the restrictions, and have covariance $\Omega\Omega'$.[4] An unbiased simulator for the probability of interest is constructed as

$$\frac{1}{R}\sum_{r=1}^{R}\Pi_{i=1}^{M} Q_i(\epsilon_{1,r},\ldots,\epsilon_{i-1,r}) \tag{4.2.7}$$

[4] Note however that the e's do not have the correct truncated multivariate normal distribution because the recursive constraints are not independent. See Hajivassiliou and McFadden, (1990, Appendix 2), for a discussion.

where

$$\begin{aligned}
\pi_{i_1 \ldots i_M} &= Prob(\frac{a^*_{1k}}{\omega_{11}} \leq \epsilon^*_1 \leq \frac{a^*_{1k+1}}{\omega_{11}}) \\
&\quad .Prob(\frac{a^*_{2k} - \omega_{21}\epsilon_1}{\omega_{22}} \leq \epsilon^*_2 \leq \frac{a^*_{2k+1} - \omega_{21}\epsilon_1}{l_{22}} | \epsilon_1) \\
&\quad \ldots \\
&\quad Prob(\frac{a_{1k} - \omega_{M1}\epsilon_1 - \ldots - \omega_{MM-1}\epsilon_{M-1}}{\omega_{MM}} \leq \epsilon_M \leq \frac{a_{1k+1} - \omega_{M1}\epsilon_1 - \ldots - \omega_{MM-1}\epsilon_M}{\omega_{MM}} \\
&= Q_1.Q_2.Q_3 \ldots
\end{aligned}$$

Borsch-Supan and Hajivasiliou (1990) provide evidence that this simulator works well in simulated maximum-likelihood estimation, in the sense that the bias induced through taking the logarithm of the simulated probabilities is not substantial for R=20, and in direct contrast to the evidence presented by Lerman and Manski (1981) using frequency simulators.

4.3 Common Time Varying Effects

The empirical work presented in Chapters 5 and 6 does not fit directly within the general latent framework presented in the previous section. The reason for this is that the pricing equations under investigation in these chapters depend on the exchange rate which is constant across firms at a point in time. Although the exchange rate is observable, it is not possible to investigate the relationship between firm pricing plans and the exchange rate with a single cross-section of data, as there is no cross-sectional variability in the exchange rate.[5] In standard panel-data econometrics, the

[5]The latent variable framework can be augmented to include continuous (and observable) survey data however. In this instance, the general covariance structure will include estimates of covari

exchange rate would be viewed as a time-varying effect that is constant across firms at a point in time; this section extends the latent variable framework to this situation.

For simplicity, we will initially assume that there is one common fixed effect, and we will denote this as s_t. Generalizing to more than one common effect is straightforward. We will also assume that the joint distribution of $\{z_t^*, s_t\}$ is multivariate normal with mean vector $\mu=\{\mu_z, \mu_s\}$ and covariance matrix Σ.[6] We will be interested in estimating the population regression parameters associated with the conditional mean $E(y_t^*|x_t^*, s_t)$. Note that

$$E(y_t^*|x_t^*, s_t) = B[x_t, s_t] \qquad (4.3.8)$$

where

$$B = \Sigma_{12}\Sigma_{22}^{-1} \qquad (4.3.9)$$

for suitably partitioned Σ. Under the assumption of multivariate normality, it is also the case that $\{y_t^*, x_t^*\} = \{z_t^*\}$ are normally distributed, conditional on s_t. More specifically, we have

$$z_t^*|s_t \sim N(\mu_z + \beta(s_t - \mu_s), \Sigma_{zz.s}) \qquad (4.3.10)$$

where

$$\Sigma_{zz.s} = \Sigma_{zz} - \Sigma_{zs}\Sigma_{ss}^{-1}\Sigma_{sz}. \qquad (4.3.11)$$

Note that $\Sigma_{zz.s}$ is a matrix of constants and does not depend on s_t. Our approach

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ances between between latent and continuous variables that will be based on estimates of *polyserial* correlation coefficients. See Poon and Lee (1987) for details.

[6]It is also possible to obtain similar results under the assumption of conditional normality of the latent variables and s_t, provided the conditional mean is linear in s_t and the conditional variance does not depend on s_t

for estimating the population regression parameters consists of estimating the standardized thresholds and *conditional* correlations associated with the distribution of z_t^* conditional on s_t, and then relating these conditional correlations to the appropriate coefficients in equation (4.3.8). As in the previous section, the categorical data for one cross-section sample at time t can be summarized in a contingency table with 3^M observed frequencies $d_{i_1 i_2 \ldots i_M t}$, $i_1, \ldots, i_M = 1 \ldots 3$. If the probability of an observation falling in the $i_1 i_2 \ldots i_M^{th}$ cell at time t is denoted as $\pi_{i_1} \ldots i_M t | s_t$, the log-likelihood can be written (except for inessential constants) as

$$L(\theta) = N_t \sum_{i_1=1}^{3} \cdots \sum_{i_M=1}^{3} d_{i_1 i_2 \ldots i_M t} log(\pi_{i_1 \ldots i_M t} | s_t) \qquad (4.3.12)$$

where $\theta = \{a_{0_1}, \ldots, a_{3_M}, \rho_{ij}, i \neq j\ \beta_1, \ldots, \beta_M\}$, $a_{0_1}, \ldots, a_{3_0} = -\infty$, and $a_{3_1}, \ldots, a_{3_M} = \infty$. In general, identification is somewhat more complicated than in the general latent variable model without time varying fixed effects that are constant across firms, and is best considered on a case-by-case basis. However, it is obvious that it is not possible to identify B with a single cross-section of data, as this procedure would simply represent a redefinition of the standardized thresholds. If we assume that the correlations and thresholds are constant over time and that the latent variables are serially uncorrelated, it is possible to identify B as long as s_t is time varying. In this instance, the joint likelihood function over T time periods is

$$L(\theta) = \sum_{t=1}^{T} N_t \sum_{i_1=1}^{3} \cdots \sum_{i_M=1}^{3} d_{i_1 i_2 \ldots i_M t} log(\pi_{i_1 \ldots i_M t} | s_t). \qquad (4.3.13)$$

In most cases, we are not interested in the conditional correlation estimates directly, but rather would like to make inferences regarding the unconditional regression parameters in equation (4.3.8). As the population regression coefficients can be viewed as nonlinear functions of the conditional correlation estimates (subject to identification conditions, of course), inferences can be obtained from the asymptotic distribution of the maximum-likelihood estimates *via* the "Delta Method" (Serfling (1980)). More specifically, under standard regularity conditions which are satisfied in this situation and assuming that the distribution of the latent variables is correctly specified, it follows that

$$\sqrt{n}(\hat{\theta}_{MLE} - \theta) \xrightarrow{d} N(0, V) \tag{4.3.14}$$

where

$$V = [E\frac{\partial L}{\partial \theta}\frac{\partial L}{\partial \theta'}]^{-1} = [I_{(\theta)}]^{-1} \tag{4.3.15}$$

is the inverse of the information matrix. Let $g(.)$ be a totally differentiable function of θ. The Delta Method implies that

$$\sqrt{n}(g(\hat{\theta}_{MLE}) - g(\theta)) \xrightarrow{d} N(0, \frac{\partial g}{\partial \theta} V (\frac{\partial g}{\partial \theta})') \tag{4.3.16}$$

While inferences regarding the parameters in the population regression equation can theoretically be obtained using this procedure, we must first determine the conditions under which the parameters are identified. As the following example illustrates, there are several subtle issues associated with identification within this framework that greatly affect the interpretation of the parameter estimates.

4.4 Example

Assume that three variables $\{y^*, x^*, s^*\}$ are normally distributed with mean vector μ and covariance matrix Σ. For our problem, $\{y^*, x^*\}$ are the latent variables and $s^*=s$ is observed. We are interested in estimating the population regression parameters $\beta=\Sigma_{12}\Sigma_{22}^{-1}$, where

$$\beta_1 = (\frac{\sigma_y}{\sigma_x})(\frac{\rho_{yx} - \rho_{ys}\rho_{xs}}{1-\rho_{xs}^2})$$

and

$$\beta_2 = (\frac{\sigma_y}{\sigma_s})(\frac{\rho_{ys} - \rho_{yx}\rho_{xs}}{1-\rho_{xs}^2}).$$

To proceed, we would like to estimate the parameters in the conditional distribution of $\{y^*, x^*\}$ on s, and must therefore determine which parameters are identified. Conditional on s, $\{y^*, x^*\}$ are normally distributed with mean $\mu_1=\{\mu_y + \gamma_1(s-\mu_s), \mu_x + \gamma_2(s-\mu_s)\}$, and covariance matrix $\Sigma_{11.2}$ where

$$\gamma_1 = (\frac{\sigma_y}{\sigma_s})\rho_{ys},$$

$$\gamma_2 = (\frac{\sigma_x}{\sigma_s})\rho_{xs}$$

and

$$\Sigma_{11.2} = \begin{bmatrix} \sigma_y^2 - \frac{\sigma_{ys}^2}{\sigma_s^2} & \\ \sigma_{yx} - \frac{\sigma_{ys}\sigma_{xs}}{\sigma_s^2} & \sigma_x^2 - \frac{\sigma_{xs}^2}{\sigma_s^2} \end{bmatrix}.$$

If we standardize the latent variables by subtracting their conditional mean and dividing by their conditional standard deviation, we could estimate (in addition to the standardized thresholds) one conditional correlation ρ_{yx}^c and two standardized gamma coefficients, *i.e.*

$$\gamma_1' = \frac{\gamma_1}{\sigma_{ys}\sqrt{1-\rho_{ys}^2}} \tag{4.4.17}$$

and

$$\gamma_2' = \frac{\gamma_2}{\sigma_{xs}\sqrt{1-\rho_{xs}^2}}. \tag{4.4.18}$$

Note that from the definitions of the unstandardized γ's, we can write the standardized estimates as

$$\gamma_1' = \frac{\rho_{ys}}{\sigma_s\sqrt{1-\rho_{ys}^2}} \tag{4.4.19}$$

and

$$\gamma_2' = \frac{\rho_{xs}}{\sigma_s\sqrt{1-\rho_{xs}^2}}. \tag{4.4.20}$$

Since σ_s is identified (it can obviously be estimated from the time series data), it follows that the estimates of γ_1' and γ_2' identify ρ_{ys} and ρ_{xs}. Finally note that from the standardized conditional correlation,

$$\rho_{yx}' = \frac{\rho_{yx} - \rho_{ys}\rho_{xs}}{\sqrt{1-\rho_{ys}^2}\sqrt{1-\rho_{xs}^2}}, \tag{4.4.21}$$

it is possible to identify ρ_{xy} and to reconstruct estimates of β_1 and β_2, provided we choose normalizations for σ_y and σ_x. It should not be surprising that scale normalizations are required here for the latent variables. As the data are categorical, this is the analog of the scale normalizations that are required in the multinomial probit.

4.5 Some Additional Issues

This section considers some additional issues that arise in this context that are due primarily to the nature of the business surveys, and critically impact on the nature of the theoretical models that can be evaluated with these techniques.

For the British surveys, it is the case that firms are surveyed on a quarterly basis while the questions refer to changes over four months; as a result, changes measured over consecutive quarters will overlap by one month. For the likelihood functions presented in the previous sections, we have assumed that samples from adjacent quarters are independent, which clearly cannot be true if some of the same firms are in each sample. Unfortunately, accounting for this overlap within the current context is extremely difficult, for at least two reasons. First, incorporating the dependence into the analysis increases the dimensionality of the integrals under consideration, and the computational burden increases accordingly. Second, all firms typically do not respond to the survey every quarter, so that amount of data available to estimate models that incorporate intertemporal dependence is actually lower. (We will return to the issue of missing data below.) For the empirical work presented in Chapters 5 and 6, we will ignore this issue, although we are fully aware that a more complete analysis would attempt to account for this asymmetry.

The simplest procedure for constructing a balanced panel from a series of cross-sectional surveys is through listwise deletion of any firm with at least one missing value. In general, there are two issues of concern when missing data are excluded in this fashion. First, to the extent that missing firms are different from firms that answer consecutive surveys, the remaining sample will not be representative of the true population of firms, and maximum-likelihood estimates may be biased and inconsistent. Second, the sample size is obviously reduced if firms are excluded, relative to a situation where responses are imputed for firms who respond to one but not all surveys, and this decreases the efficiency of the parameter estimates. Missing data in sample surveys can be categorized as either *item nonresponse* or *unit non-response*, corresponding to the situations where the firm fails to answer a specific question but completes the remainder of the survey, or where the firm fails to answer the entire survey. For the British and Swiss surveys, the majority of missing data responses for domestic price changes represent unit non-responses, while foreign price changes have a larger proportion of item non-response because some firms don't sell in foreign markets. In this instance, it is unlikely that firm specific information from the same survey will be extremely useful for imputing missing responses, although information from past surveys might be used. Rizvi (1983) has suggested a procedure for imputing missing categorical data that is similar to weighting class adjustments for quantitative data, and this procedure could be modified and applied here.

We decided not to impute for missing values for the empirical work presented in Chapters 5 and 6 for two reasons, in addition to the extra computational burden. First, it should be remembered that imputed responses represent estimates of true responses and are therefore measured with error: the estimation error associated with imputation must be accounted for in the statistical analysis and complicates the direct interpretation of statistical tests. Second, Horvath, Nerlove, and Willson (1993) have compared the distribution of firms who responded in consecutive surveys with those who responded in one quarter or the other, and in the majority of cases there are no significant differences between firms.[7]

One additional issue that deserves discussion at this time is the observation that economic theories are traditionally dynamic, while econometric techniques we

[7]It should also be pointed out that cross-sectional aggregation procedures essentially ignore the missing data problem as well. Previous research that has investigated the time series properties of cross-sectional averages has not employed a common set of firms on all survey dates.

have outlined are essentially appropriate for static models. Of course, the comments concerning missing data and computational difficulties increasing with dimension suggest that consideration of dynamic models, while theoretically feasible, would not be profitable. In addition, as pointed out in Keane (1992) and illustrated in Chowdhury and Willson (1994), latent variable models of this type have a *fragile* identification problem that precludes serious consideration of unrestricted high-dimensional models. Fragile identification occurs when theoretically identified covariance structures achieve a maximum over an extremely wide range of parameter values. In general, this is not a problem with the data or the econometric theory, but simply reflects the fact that the data *are* categorical and the one should not expect the same degree of informativeness from a multivariate sample of trivariate indicators than from a mutlivariate sample from the underlying continuous distribution. Overall, the lesson to be learned from the discussion in this section is that simple theoretical models present the best opportunities for empirical investigation with categorical business survey data.

Chapter 5

Pricing-To-Market

5.1 Introduction

This chapter develops a simple model to explain the PTM behaviour of firms in the U.K. and Switzerland, and then estimates reduced form PTM elasticities for both countries using the categorical business survey data described in Chapter 3 and the latent variable techniques described in Chapter 4.

From a theoretical perspective, the models investigated in this chapter are interesting in that they can explain a wide variety of PTM behaviour, including perverse passthrough. While most previous research has focused on either demand or supply-side explanations of PTM, the models considered here allow for both. The demand-side explanation for PTM is a standard price discrimination story in which firms charge different prices in different markets because demand elasticities are different. Unfortunately, pure demand side explanations of PTM that are based entirely on demand elasticites are inadequate in the sense that they cannot explain perverse passthrough. Froot and Klemperer (1989) argued that perverse passthrough was a theoretical possibility, and provided some tentative empirical evidence to support their claim. In addition, although Marston's (1990) model does not provide a theoretical justification for perverse passthrough, he obtained several point estimates of PTM elasticities that exceeded one.

In order to allow for the possibility of perverse passthrough, the models developed in this chapter contain a variable cost component that depends on the exchange rate; this is perhaps the most simplest supply side explanation of PTM, *i.e.* foreign producers are not entirely foreign. In comparison with alternative supply-side explanation that emphasize fixed costs of entry and exit in foreign markets (Baldwin (1986, 1988), Dixit (1989)), the approach taken here is more amenable to empirical interpretation with the categorical survey data on price changes in foreign and domestic markets. As emphasized in Chapter 2, once one allows for market specific costs that are at least partly or fully fixed by nature, firms have an incentive to fix prices for more than one period, and observed passthough may be the result of fixed prices and unanticipated movements in the exchange rate, rather than ex ante price discrimination. Distinguishing between these two different rationales for PTM is the subject of Chapter 6.

Empirically, it is clear from the discussion in Chapter 4 that the estimation of linear latent variable models with categorical business survey data is much more challenging than standard econometric modelling with continuous panel data. For this reason, we investigate simple reduced form relationships in this chapter that are essentially static in nature, rather than complicated nonlinear dynamic models that might provide more structural information. As a result, the empirical work presented here should be viewed as a first attempt at examining PTM behaviour with these data. However, it is still the case that the work presented here is based on firm-specific survey data concerning foreign and domestic prices and costs, and the results may be more informative about PTM than standard time series modelling with aggregate data.

This chapter begins with a brief review of the theoretical motivation for the model. Section 5.2 develops separate models for Switzerland and the U.K., as the cost data from each survey are different. Section 5.3 describes the empirical specification and estimation procedure. Section 5.4 presents the empirical results. Section 5.5 concludes and suggests avenues for future research.

5.2 Theoretical Model

The theoretical model that is developed below has two main avenues through which firms may exhibit PTM behaviour. First, we include a standard price-discrimination rationale for PTM where firms charge different prices in foreign and domestic markets (when expressed in a common currency) because elasticities of demand are different. As mentioned in Chapter 2, price discrimination provides a natural explanation for PTM, although previous empirical work that has focused on price-discrimination as the driving force behind PTM has not been completely successful. The second avenue for PTM behaviour comes from the supply side, in the form of variable costs that depend specifically on the exchange rate. In general, we will assume that this cost enters into a firm's objective function in terms of domestic currency, but is incurred in foreign currency. For example, these costs could represent expenses incurred in building or expanding sales infrastructure. These costs are sensitive to exchange-rate fluctuations, depend on the size of the market, and are purely variable by assumption.

We will also assume that this cost is not simply linear in s_t; rather, we will assume that marginal costs are increasing in s_t. For example, this would occur when the cost of selling in foreign markets is a quadratic function of s_t, *i.e.* when the cost can be written as $C = (as_t + bs_t^2) \cdot Q_t$ where a and b are positive constants, and Q_t is the foreign demand at time t. While the motivation for the linear term is straightforward, the motivation for the quadratic term deserves further explanation.

We view assumption that marginal costs are increasing in s_t as reflecting firm preferences for avoiding foreign exchange risk. For example, the term associated with s_t^2 mentioned above represents additional costs associated with the variability of s_t. While avenues for hedging foreign exchange risk have certainly expanded in recent years, it is generally the case that it is not possible to hedge all risks.[1] In addition, some (or perhaps many) of the manufacturing firms in the U.K. and Swiss surveys may not have the expertise or funds to actively participate in hedging activities. Finally, Froot and Klemperer (1989) have suggested an additional motivation for the risk term, in that the value of firm investments in foreign market share may be negatively affected by increased exchange rate variability.[2] In this sense, this cost term re-emphasizes their argument that exporting firms may either increase or decrease their foreign prices when the home-currency depreciates. Thus, even though the commodities are "produced" at the same costs, these variable costs can lead to the deviations from the "Law of One Price" irrespective of the curvature of the demand schedules.

Finally, we would like to emphasize that while the theoretical models developed below for the two countries are broadly similar, there are some differences in the specification of the cost functions between countries that arise because of the

[1] Of course, firms may prefer to hedge some, but not all of the risk. The models developed in the next section are partial equilibrium in nature, the exchange rate is taken to be exogenous and capital markets are ignored. A more complete analysis would address all of these issues within a general equilirium framework

[2] Giovannini (1988) argues that the firm decisions should be unaffected by exchange rate variability, although his model has perfect capital markets. He also cites a large body of empirical evidence suggesting that trade flows are unaffected by exchange rate variability, we feel this evidence is unconvincing as most of the results are based on aggregate data.

differences in cost data in the two surveys. More specifically, for Switzerland we have data on raw material prices, while for the U.K. we have data on average unit costs.

The notation for the remainder of this chapter is described below:

P_t^m=Raw material price (for Switzerland),

C_t=Average cost (for the U.K.),

P_t^d=Domestic price,

P_t^{f*}=Foreign price in terms of foreign currency,

S_t=Nominal exchange-rate (domestic currency *vis-a-vis* foreign currency) at time t,

$P_t^f = P_t^{f*} \cdot S_t$=Foreign price in terms of domestic currency,

S_t^e=Expectation at time $(t-1)$ about the nominal exchange-rate at time t,

D^d=Demand in the domestic market,

D^f=Demand in the foreign market,

C_1=Cost of production (for Switzerland),

C_2=Market-specific variable cost in the foreign market (for Switzerland),

C_3=Market-specific variable cost in the domestic market (for Switzerland),

$(\cdot)'$=First derivative of the term in parenthesis, with respect to its first argument.

Note that the total cost for the British firms is $C \cdot (D^d + D^f)$, whereas it is $C_1 + C_2 + C_3$ for the Swiss firms. Also, C_2 is the cost in terms of domestic currency. Both models will be developed under the following set of assumptions:

(1) This is a partial equilibrium analysis with an exogenous exchange-rate.

(2) Firms set prices and face a domestic market and an aggregate foreign market.[3]

(3) Production costs are incurred domestically.

(4) There is no fixed cost which is market-specific.

[3]Theoretically, we might assume monopolistic competition in the markets with D^f and D^d as the residual demands.

(5) Variable costs in the foreign market depend on the nominal exchange rate.

The first assumption simply says that the models will investigate the effect of the stochastic exchange-rates on the control variables, namely prices. The second assumption is needed to match the theoretical models with the survey data. As mentioned in Chapter 3, the business surveys do not contain destination-specific export or foreign-price data. Instead, they ask questions about "foreign quantities" or "foreign prices" in general. Assumption three requires that all production take place domestically, and is a standard assumption in the PTM literature. The rationale for not assuming any market-specific fixed cost, as has been discussed in Chapter 2, is to avoid modelling firm price setting behaviour over longer time periods. Assumption five was discussed above.

5.2.1 Model for Switzerland

Firm i's period-t objective function is assumed to be

$$\pi_{it} = P^d_{it} \cdot D^d_i(P^d_{it}) + (S_t \cdot P^{f*}_{it}) \cdot D^f_i(P^{f*}_{it}). - C_1[(D^d_i + D^f_i), P^m_{it}] - C_2(D^f_i, S_t) - C_3(D^d_i) \tag{5.2.1}$$

Note that we have assumed that firms only care about profits in domestic currency. Dropping the i's and t's (except for the nominal exchange-rate) and deriving the first order conditions with respect to the controls leads to the following equations:

$$P^{f*} \cdot S_t = P^f = \frac{(C_1' + C_2') \cdot (D^f)' - D^f \cdot S_t}{(D^f)'} \tag{5.2.2}$$

$$P^d = \frac{(C_1' + C_3') \cdot (D^d)' - D^d}{(D^d)'} \qquad (5.2.3)$$

Following Marston (1990), we will now derive an expression for the passthrough coefficient.[4] Manipulating equation (5.2.2) and taking the first derivative with respect to S_t allow us to write it as

$$dP^{f*}/dS_t = \frac{S_t \cdot \frac{dC_1'}{dS_t} - C_1'}{S_t^2} + \frac{S_t \cdot \frac{dC_2'}{dS_t} - C_2'}{S_t^2} - \frac{d(D^f/(D^f)')}{dS_t}. \qquad (5.2.4)$$

Note that the derivatives in the right hand side of the above equation can be written as

$$\frac{dC_1'}{dS_t} = C_1'' \cdot (D^f)' \cdot dP^{f*}/dS_t$$

and

$$\frac{d(D^f/(D^f)')}{dS_t} = (dP^{f*}/dS_t) \cdot [1 - \frac{D^f \cdot (D^f)''}{((D^f)')^2}].$$

As a result, it follows that

$$\begin{aligned} \delta_1 &= \frac{dP^{f*}/P^{f*}}{dS_t/S_t} \\ &= [\frac{-(C_1' + C_2') \cdot S_t}{P^f} + \frac{S_t^2 \cdot dC_2'/dS_t}{P^f}] \\ &\cdot \frac{((D^f)')^2}{2S_t((D^f)')^2 - S_t D^f (D^f)'' - C_1''(D^f)'((D^f)')^2} \end{aligned}$$

Similarly, manipulating equation(5.2.3) yields

$$\delta_2 = \frac{dP^d/P^d}{dS_t/S_t}$$

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[4]Note that we can also express these equations in terms of elasticities of demand, i.e. $P^d = (C_1' + C_3') \cdot \frac{\epsilon^d}{\epsilon^d - 1}$ and $P^{f*} = (C_1' + C_2') \cdot \frac{\epsilon^f}{\epsilon^f - 1}$, where ϵ^d and ϵ^f are price-elasticities of demand in the domestic and foreign markets respectively.

$$= C_1'' \cdot (D^f)' \cdot (dP^{f*}/dS_t) \cdot (S_t/P^d).$$

δ_1 is known as the "passthrough coefficient" since it reflects the extent to which a change in the nominal exchange rate is passed through to the foreign price. δ_2 describes the magnitude of the effect of the exchange rate on the domestic price. If we define the export-domestic price margin as $X_t = (P_t^{f*} \cdot S_t)/P_t^d = P_t^f/P_t^d$, it follows that the effect of the nominal exchange-rate on X_t, known as the PTM elasticity, can be derived as

$$\alpha_1 = \frac{dX_t/X_t}{dS_t/S_t} = 1 + \delta_1 - \delta_2. \tag{5.2.5}$$

Note that with the absence of any other but domestically incurred production costs, *i.e.* ignoring the second and the third term in δ_1, the passthrough coefficient is always negative irrespective of the slopes of the marginal cost of production and the foreign demand curve (i.,e., C_1'' and $(D^f)'$).[5] As a result, a depreciation of the home-currency must lower the foreign currency prices of the exportable. However, passthrough is incomplete when the demand is more elastic than a constant elasticity curve and markup increases with the fall in price. On the contrary, with a demand curve more convex than a constant elasticity one, δ_1 is still negative but passthrough is more-than-proportionate. Similar arguments along these lines are contained in Marston (1990).

The third term in δ_1 is crucial for determining the sign of α_1. It has a positive effect on δ_1 as long as $C_2(.)'$ is increasing in S_t. If the third term is a large positive number, it could offset the other two negative entries and the resulting passthrough coefficient could be positive and α_1 is greater than one, indicating perverse passthrough.

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[5]This occurs because the multiplier term is positive by the second order condition of profit maximization

In this case, the margin between foreign and domestic prices is actually increasing more than proportionately with the rise in the nominal exchange-rate.

Turning to δ_2, domestic prices will remain unaffected by exchange rate changes only if marginal costs are constant, *i.e.* $C_1'' = 0$. In other cases, there will be an effect. Let us consider the most plausible case of an increasing marginal cost technology. With incomplete passthrough and a negative passthrough coefficient, domestic price will go up (less than proportionately) with a lowered markup. α_1 will be a positive fraction in this case since a rise in price reduces the markup while a fall in price increases it. As a result, the margin between foreign and domestic prices will increase by a fraction of the rise in the nominal exchange-rate. This probably represents most conventional views of PTM, and is popularly referred to as ***local currency price stabilization***, or LCPS. With more-than-proportionate passthrough (and a negative passthrough coefficient), δ_2 will still be positive but larger in magnitude. This can lead to a negative α_1, since δ_1 has a greater value too. On the other hand, with perverse-passthrough and a positive passthrough coefficient, δ_2 will be negative and the PTM elasticity will be greater than one in magnitude. Therefore, it is δ_1 which is relatively more important in dictating the PTM elasticity.

Finally, for estimation purposes, we will need to derive an equation that is the empirical analog of equation (5.2.5). From equation (5.2.2) and equation (5.2.3), we have

$$X_t = (P^{f*} \cdot S_t)/P^d = \frac{[(C_1' + C_2') \cdot (D^f)' - (D^f)' \cdot S_t]/(D^f)'}{[(C_1' + C_3') \cdot (D^d)' - (D^d)']/(D^d)'}. \qquad (5.2.6)$$

Taking the total derivative and solving for dX_t/X_t implies that

$$dX_t/X_t = \alpha_0 \cdot dP_t^m/P_t^m + \alpha_1 \cdot dS_t/S_t, \qquad (5.2.7)$$

where $\alpha_0 = \frac{dX_t/X_t}{dP_t^m/P_t^m}$ and $\alpha_1 = \frac{dX_t/X_t}{dS_t/S_t}$.

Alternatively, using the lower-case letters for the same variables in log form, we have

$$\Delta x_t = \alpha_0 \Delta p_t^m + \alpha_1 \Delta s_t \quad (5.2.8)$$

where $x_t = ln(X_t)$ and $\Delta x_t = x_t - x_{t-1}$. Similar expressions are used for the other two variables, where α_0 is the elasticity of export-domestic price margin with respect to raw-material price, and α_1 is the same with respect to the nominal exchange-rate. Equation (5.2.8) is the regression equation that we will estimate, where α_1 will be the primary focus of attention. When α_1 is a positive fraction, passthrough is less than proportionate with a foreign demand curve which is less convex than a constant elasticity demand curve. On the other hand, if α_1 takes a negative value, passthrough is bound to be "more than proportionate" (with a high value of δ_1) with a foreign demand curve which is more convex than a constant-elasticity curve. Finally, a positive α_1 with a value greater than 1 indicates the "perverse passthrough".

5.2.2 Model for the U.K.

For the U.K., we have data on average unit costs, instead of raw material prices. We will consider a slightly different model with an implicit form of total cost function for the British firms. Because of this limitation, it is not possible to clearly isolate the market-specific costs. As a result, production costs are mixed with the other costs and for the empirical work a common marginal cost is considered for the two markets. Nevertheless, we will assume that marginal cost is actually a function of the nominal exchange-rate.

Firm i's period-t objective function is assumed to be

$$\pi_{it} = P_{it}^d \cdot D_i^d(P_{it}^d) + (S_t \cdot P_{it}^{f*}) \cdot D_i^f(P_{it}^{f*}) - C(D_i^d, D_i^f, S_t) \cdot (D_i^d + D_i^f). \qquad (5.2.9)$$

Except for the cost term, this functional form is identical to that of Switzerland. Dropping out i's and t's (except for S_t) and deriving the first order conditions with respect to the controls leads to the following equations :

$$P^{f*} \cdot S_t = P^f = \frac{[C' \cdot (D^d + D^f) + C] \cdot (D^f)' - D^f \cdot S_t}{(D^f)'} \qquad (5.2.10)$$

$$P^d = \frac{[C' \cdot (D^d + D^f) + C] \cdot (D^d)' - D^d}{(D^d)'} \qquad (5.2.11)$$

In the above equations, $C' \cdot (D^d + D^f) + C$ represents marginal cost in terms of average cost. We will assume that this is a function of S_t. As a result, a change in the nominal exchange-rate will affect both the domestic and foreign prices.
Manipulating equation(5.2.10) and taking the first derivative with respect to S_t allows us to write the derivative of the foriegn price with respect to s_t as

$$\begin{aligned} dP^{f*}/dS_t &= \frac{-C' \cdot (D^f + D^d)}{S_t^2} \\ &+ \frac{S_t \cdot \frac{dC'}{dS_t} \cdot (D^d + D^f) - C + S_t \cdot \frac{dC}{dS_t} + S_t \cdot C' \cdot \frac{dD^f}{dS_t}}{S_t^2} \\ &- \frac{d(D^f/(D^f)')}{dS_t} \end{aligned}$$

It is possible to write the derivatives on the right-hand side of this equation as

$$\frac{dC'}{dS_t} = C'' \cdot (D^f)' \cdot dP^{f*}/dS_t,$$

$$\frac{d(D^f/(D^f)')}{dS_t} = dP^{f*}/dS_t(1 - \frac{D^f \cdot (D^f)''}{((D^f)')^2})$$

and

$$\frac{dC'}{dS_t} = C'' \cdot (D^f)' \cdot dP^{f*}/dS_t.$$

It follows that

$$\begin{aligned}\delta_1 &= \frac{dP^{f*}/P^{f*}}{dS_t/S_t} \\ &= [\frac{-(C' + C'' \cdot (D^d + D^f))S_t}{P^f}] \cdot \\ &\quad [\frac{((D^f)')^2}{2S_t((D^f)')^2 - 2C''((D^f)')^3 - C'''((D^f)')^3(D^f + D^d) - S_t D^f (D^f)''}]\end{aligned}$$

Similarly, manipulating (5.2.11) yields

$$\begin{aligned}\delta_2 &= \frac{dP^d/P^d}{dS_t/S_t} \\ &= [\frac{dP^{f*}}{dS_t} \cdot ((D^f)'(2C'' + C''' \cdot (D^d + D^f)))] \cdot (S_t/P^d)\end{aligned}$$

δ_1 and δ_2 have the same definitions as before, and the PTM elasticity is therefore $\alpha_1 = 1 + \delta_1 - \delta_2$. In this model, the passthrough coefficient δ_1 is bound to be negative, as long as there is no identifiable market-specific variable cost in the foreign market which is directly affected by S_t.[6] However, depending on the curvature of the demand schedules, passthrough will be either less-than-proportionate or more-than-proportionate. Also, except for a constant average cost technology, domestic prices will always be affected by a change in the exchange-rate. A domestic-currency depreciation will therefore lead to a rise in the domestic price when the

[6]Once again, this occurs because the multiplier term is positive by the second-order condition of profit maximization

passthrough coefficient is negative. As before, the PTM elasticity will be a positive fraction when passthrough is incomplete and negative when passthrough is more-than-proportionate.

Defining X_t as the export-domestic price margin, and α_1 as the PTM elasticity, a reduced form equation that is similar to the Swiss equation can be derived. Taking the total derivative of X_t and solving for dX_t/X_t yields

$$dX_t/X_t = \alpha_0 \cdot dC_t/C_t + \alpha_1 \cdot dS_t/S_t \tag{5.2.12}$$

which can equivalently be expressed as

$$\Delta x_t = \alpha_0 \Delta c_t + \alpha_1 \Delta s_t \tag{5.2.13}$$

where $x_t = ln(X_t)$ and $\Delta x_t = x_t - x_{t-1}$. As in the Swiss model, α_0 is the elasticity of export-domestic price margin with respect to average cost, whereas α_1 is the elasticity with respect to the nominal exchange-rate. The interpretation of the parameters is identical to the Swiss case.

5.3 Econometric Specification

5.3.1 Identification

In order to estimate the PTM elasticity for each of the countries, we propose to estimate a variation of the equation (5.2.8) and equation (5.2.13) using survey data concerning proportionate changes in P_t^f, P_t^d, and P_t^m for Switzerland and P_t^f, P_t^d, and C_t for the U.K. More specifically, for Switzerland, we estimate the following regression equation :

$$\Delta p_t^f = \Delta p_t^d + \alpha_0 \Delta p_t^m + \alpha_1 \Delta s_t. \qquad (5.3.14)$$

For the U.K., the corresponding regression equation is

$$\Delta p_t^f = \Delta p_t^d + \alpha_0 \Delta e_t + \alpha_1 \Delta s_t. \qquad (5.3.15)$$

As mentioned in the Chapter 1, the fact that the survey data are categorical seriously complicates identification of the parameters in these equations, and we now turn to this issue.[7] Assume that we are interested in estimating parameters in the equation

$$x_1 = \beta_1 x_2 + \beta_2 x_3 + \beta_3 x_4 \qquad (5.3.16)$$

where x_4 is an observed continuous variable that is constant across firms at a point in time but varies over time, and where x_1, x_2, and x_3 are latent variables that trigger trichotomous survey responses. For the equation (??), $\beta_1 = 1$, $x_1 = \Delta p_t^f$, $x_2 = \Delta p_t^d$ and $x_4 = \Delta p_t^m$. For equation (5.3.15), $\beta_1 = 1$, $x_1 = \Delta p_t^f$ and $x_3 = \Delta e_t$. In both equations, $x_4 = S_t$.

Assume that the variables $\{ x_1, x_2, x_3, x_4 \}$ are normally distributed with mean vector $\mu = \{ \mu_y, \mu_1, \mu_2, \mu_3 \}'$ and covariance matrix Σ. We are interested in estimating the population regression parameters $\beta = \Sigma_{12}\Sigma_{22}^{-1}$, where

$$\beta_1 = \left(\frac{\sigma_1}{\sigma_2}\right)\left(\frac{\rho_{12} - \rho_{31}\rho_{32} - \rho_{41}\rho_{42} + \rho_{31}\rho_{34}\rho_{42} + \rho_{41}\rho_{34}\rho_{32} - \rho_{12}\rho_{34}^2}{1 - \rho_{34}^2 - \rho_{32}^2 - \rho_{24}^2 + 2\rho_{32}\rho_{34}\rho_{42}}\right),$$

[7] The notation here will follow Chapter 4

$$\beta_2 = (\frac{\sigma_1}{\sigma_3})(\frac{\rho_{31} - \rho_{12}\rho_{32} - \rho_{41}\rho_{43} + \rho_{12}\rho_{34}\rho_{42} + \rho_{41}\rho_{21}\rho_{32} - \rho_{31}\rho_{42}^2}{1 - \rho_{34}^2 - \rho_{32}^2 - \rho_{24}^2 + 2\rho_{32}\rho_{34}\rho_{42}}).$$

and

$$\beta_3 = (\frac{\sigma_1}{\sigma_4})(\frac{\rho_{41} - \rho_{12}\rho_{42} - \rho_{31}\rho_{43} + \rho_{12}\rho_{34}\rho_{32} + \rho_{31}\rho_{24}\rho_{32} - \rho_{41}\rho_{32}^2}{1 - \rho_{34}^2 - \rho_{32}^2 - \rho_{24}^2 + 2\rho_{32}\rho_{34}\rho_{42}}).$$

In order to determine which parameters are identified, we proceed by estimating the parameters in the conditional distribution of $\{ x_1, x_2, x_3 \}$ on x_4. Conditional on x_4, $\{x_1, x_2, x_3\}$ are normally distributed with mean $\mu_{1.2}=\{ \mu_1 + \gamma_1(x_4 - \mu_4), \mu_2 + \gamma_2(x_4 - \mu_4), \mu_3 + \gamma_3(x_4 - \mu_4)\}'$ and covariance matrix $\Sigma_{11.2} = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21}$, where

$$\gamma_1 = (\frac{\sigma_1}{\sigma_4})\rho_{14},$$

$$\gamma_2 = (\frac{\sigma_2}{\sigma_4})\rho_{24},$$

$$\gamma_3 = (\frac{\sigma_3}{\sigma_4})\rho_{34},$$

and

$$\Sigma_{11.2} = \begin{bmatrix} \sigma_{11} - \frac{\sigma_{14}^2}{\sigma_{44}} & & \\ \sigma_{21} - \frac{\sigma_{24}\sigma_{14}}{\sigma_{44}} & \sigma_{22} - \frac{\sigma_{24}^2}{\sigma_{44}} & \\ \sigma_{31} - \frac{\sigma_{34}\sigma_{14}}{\sigma_{44}} & \sigma_{32} - \frac{\sigma_{34}\sigma_{24}}{\sigma_{44}} & \sigma_{33} - \frac{\sigma_{34}^2}{\sigma_{44}}. \end{bmatrix}.$$

Simplifying yields

$$\Sigma_{11.2} = \begin{bmatrix} \sigma_{11}(1 - \rho_{14}^2) & & \\ \sigma_2\sigma_1(\rho_{12} - \rho_{24}\rho_{14}) & \sigma_{22}(1 - \rho_{24}^2) & \\ \sigma_3\sigma_1(\rho_{31} - \rho_{14}\rho_{43}) & \sigma_2\sigma_3(\rho_{23} - \rho_{24}\rho_{34}) & \sigma_{33}(1 - \rho_{34}^2) \end{bmatrix}.$$

If we standardize the latent variables, it is possible to estimate conditional correlations ρ'_{12}, ρ'_{23}, ρ'_{31} and three standardized gamma coefficients γ'_1, γ'_2, γ'_3, in addition to the standardized thresholds. Using the definitions of the unstandardized coefficients, we can write the stadardrized coefficients as:

$$\gamma'_1 = \frac{\beta_1}{\sigma_1\sqrt{1-\rho_{14}^2}} = \frac{\rho_{14}}{\sigma_4\sqrt{1-\rho_{14}^2}} \tag{5.3.17}$$

$$\gamma'_2 = \frac{\beta_2}{\sigma_2\sqrt{1-\rho_{24}^2}} = \frac{\rho_{24}}{\sigma_4\sqrt{1-\rho_{24}^2}} \tag{5.3.18}$$

$$\gamma'_3 = \frac{\beta_3}{\sigma_3\sqrt{1-\rho_{34}^2}} = \frac{\rho_{34}}{\sigma_4\sqrt{1-\rho_{34}^2}} \tag{5.3.19}$$

$$\rho'_{12} = \frac{\rho_{12}-\rho_{14}\rho_{42}}{\sqrt{1-\rho_{14}^2}\sqrt{1-\rho_{24}^2}} \tag{5.3.20}$$

$$\rho'_{23} = \frac{\rho_{23}-\rho_{43}\rho_{42}}{\sqrt{1-\rho_{43}^2}\sqrt{1-\rho_{24}^2}} \tag{5.3.21}$$

$$\rho'_{31} = \frac{\rho_{31}-\rho_{14}\rho_{43}}{\sqrt{1-\rho_{43}^2}\sqrt{1-\rho_{14}^2}} \tag{5.3.22}$$

Since σ_4 can obviously identified from the observed continuous data, it follows from the first three equations that the estimates of γ'_1, γ'_2 and γ'_3 identify ρ_{14}, ρ_{24} and ρ_{34}, and the last three equations can be used to identify ρ_{12}, ρ_{23}, and ρ_{31}. Finally, β estimates can be constructed from their definitions, provided we choose normalizations for $\frac{\sigma_1}{\sigma_2}$, $\frac{\sigma_1}{\sigma_3}$ and $\frac{\sigma_1}{\sigma_4}$. As β_1=1 in both theoretical regression equations, and we do not have information concerning the relative variability of domestic and foreign prices, it is not possible to impose this constraint on the estimation. For the empirical work presented in the next section, we report results under the assumption that $\frac{\sigma_1}{\sigma_2}$=1. We also assume that $\frac{\sigma_1}{\sigma_3}$ and σ_1 are both equal to one. As we are not focussing primarily on the magnitude of the cost coefficicents, this normalization is innocuous. The magnitude of the PTM elasticity will depend crucially on the magnitude of $\frac{\sigma_1}{\sigma_4}$ however. In order to provide some support for the chosen normalization, we constructed a time series for ΔP_t^f using time series data on domestic prices along with the data on real and nominal trade-weighted exchange rates.[8] For Switzerland, the value of the standard deviation of the change in foreign price is around .95, whereas it is around 1.2 for the U.K. As a result, we can say that the normalization is not an unjustified one, though it might overestimate the parameter for Switzerland and underestimate it for the U.K. The bias, however, is not very significant.

5.4 Empirical Results

Maximum likelihood estimates of the parameters of interest were calculated based on the likelihood function presented in Chapter 4 under the assumption that the latent variables are temporally independent. As mentioned in Chapter 4, this assumption greatly simplifies the complexity of estimation problem, and avoids problems associated with missing data. While the assumption would obviously not be appropriate for surveys measuring levels, the assumption is less objectionable for survey responses concerning changes.

Maximum-likilohood estimates were computed in Gauss, using the trivariate normal CDF routine to calculate the probabilities. Numerical derivatives and Broyden-Fletcher-Goldfarb-Shanno iterations were employed to attain a local maxi

[8]The domestic price data were CPI indexes taken from the OECD main economic indicators

mum, with a final Newton-Raphson iteration to calculate the observed information matrix. In order to verify that the local maximum was in fact a global maximum, we varied starting values to make sure that convergence was obtained at the same point in the parameter space. Standard errors for the estimates of the population regression coefficeints were then obtained via the Delta Method, as described in Chapter 4.

The estimation results are based on quarterly survey samples from the first quarter of 1983 to the first quarter of 1987 for Switzerland, and from the last quarter of 1982 to the first quarter of 1987 for the U.K. The first two tables report the results from the first-stage estimation resulting in three estimated conditional correlations, three standardized β coefficients and the standardized thresholds. The third and fourth tables report the actual correlations between the variables, and the two elasticities α_0 and α_1 along with their standard errors for Switzerland and the U.K. respectively.

For each of the countries, we also divide the total time-period into two parts and run the same estimation for each part. As a result, three sets of results are presented for both of the countries, one for the first half, another for the second half and then for the whole period. The rationale for doing that is to examine whether or not any substantial change regarding the market-structure actually takes place during that period of time.

Table 5.1: ML Estimates(SW)† - f(Δp_t^d, Δp_t^f, Δp_t^m | Δs_t)

Date	a'_{11}	a'_{12}	a'_{21}	a'_{22}	a'_{31}	a'_{32}	ρ'_{12}	ρ'_{23}	ρ'_{31}	β'_1	β'_2	β'_3
83Q1	-1.284	1.322	-1.202	1.062	-1.809	0.534	0.634	0.228	0.339	-25.966	-16.740	4.067
-85Q1	(0.022)	(0.023)	(0.018)	(0.020)	(0.031)	(0.017)	(0.013)	(0.018)	(0.019)	(3.066)	(2.628)	(0.843)
85Q2	-1.489	1.206	-1.088	1.246	-1.197	0.754	0.780	0.351	0.332	-10.484	-8.042	-16.366
-87Q1	(0.032)	(0.026)	(0.023)	(0.010)	(0.023)	(0.021)	(0.009)	(0.003)	(0.017)	(2.061)	(1.489)	(0.898)
83Q1	-1.364	1.173	-1.186	1.051	-1.389	0.657	0.712	0.332	0.376	-13.926	-15.721	-4.377
-87Q1	(0.019)	(0.017)	(0.017)	(0.016)	(0.017)	(0.013)	(0.008)	(0.012)	(0.013)	(1.728)	(1.535)	(0.674)

† - Standard errors in parentheses.

Table 5.2: ML Estimates(U.K.)† - f(Δp_t^d, Δp_t^f,Δc_t | Δs_t)

Date	a'_{11}	a'_{12}	a'_{21}	a'_{22}	a'_{31}	a'_{32}	ρ'_{12}	ρ'_{23}	ρ'_{31}	β'_1	β'_2	β'_3
82Q4	-1.382	0.723	-1.354	0.833	-1.480	0.476	0.812	0.326	0.259	11.430	12.580	8.097
-84Q4	(0.017)	(0.013)	(0.016)	(0.013)	(0.017)	(0.010)	(0.004)	(0.010)	(0.010)	(0.614)	(0.611)	(0.400)
85Q1	-1.323	0.745	-1.283	0.819	-1.291	0.570	0.815	0.384	0.341	7.325	8.819	2.019
-87Q1	(0.017)	(0.014)	(0.016)	(0.014)	(0.016)	(0.013)	(0.005)	(0.011)	(0.012)	(0.607)	(0.614)	(0.361)
82Q4	-1.348	0.729	-1.315	0.820	-1.378	0.527	0.816	0.361	0.306	9.343	10.654	4.827
-87Q1	(0.011)	(0.008)	(0.010)	(0.009)	(0.006)	(0.008)	(0.004)	(0.008)	(0.008)	(0.436)	(0.437)	(0.268)

† - Standard errors in parentheses.

Table 5.3: Estimates(SW)† - $\Delta p_t^d = \Delta p_t^f + \alpha_0 \Delta p_t^m + \alpha_1 \Delta s_t$

Date	ρ_{14}	ρ_{24}	ρ_{34}	ρ_{12}	ρ_{23}	ρ_{31}	α_1	α_0
83Q1	-.201	-.131	.032	.642	.222	.325	16.626	-.201
-85Q1	(.023)	(.020)	(.006)	(.013)	(.017)	(.018)	(2.311)	(.018)
85Q2	-.094	-.072	-.146	.781	.356	.341	1.478	-.067
-87Q1	(.018)	(.013)	(.007)	(.009)	(.003)	(.016)	(2.061)	(.020)
83Q1	-.133	-.149	-.042	.717	.334	.378	2.842	-.156
-87Q1	(.016)	(.014)	(.006)	(.008)	(.012)	(.013)	(1.264)	(.013)

† - Standard errors in parentheses.

Table 5.4: Estimates(U.K.)† - $\Delta p_t^d = \Delta p_t^f + \alpha_0 \Delta c_t + \alpha_1 \Delta s_t$

Date	ρ_{14}	ρ_{24}	ρ_{34}	ρ_{12}	ρ_{23}	ρ_{31}	α_1	α_0
82Q1	.222	.243	.159	.822	.351	.285	-.203	.005
-84Q4	(.011)	(.011)	(.007)	(.004)	(.010)	(.010)	(.463)	(.012)
85Q1	.162	.194	.045	.820	.385	.343	.822	-.032
-87Q1	(.015)	(.012)	(.008)	(.005)	(.011)	(.012)	(.481)	(.012)
82Q4	.191	.216	.099	.823	.372	.318	.375	-.014
-87Q1	(.008)	(.008)	(.005)	(.004)	(.007)	(.007)	(.325)	(.008)

† - Standard errors in parentheses.

The primary focus of our attention will be the PTM elasticites associated with the parameter estimates for α_1 in Tables 5.3 and 5.4. The first thing to notice about the results is that there is definite evidence of PTM behaviour, in that the PTM elasticities are significantly different from zero at the 5% level for each sub-period and the total sample for Switzerland, and for the second sub-period for the U.K. This conclusion is also invariant to the normalization imposed for identification. However, conclusions regarding the precise type of PTM behaviour are somewhat more difficult to make, as tests of null hypotheses concerning values of α_1 that are different from zero will be affected by the chosen normalization. Under the assumption that the normalizations imposed for identification purposes are correct, it is not possible to reject the null hypothesis that α_1 is greater than 1 (passthrough is perverse) for the first Swiss subsample. For the other Swiss subsample and the combined samples, it is the case that the point estimates exceed one in each case but are not estimated precisely enough to reject the null hypothesis that α_1 is less than 1. For the U.K. results in the second sub-sample, passthrough appears to be less than proportionate; for the remaining subsample and the overall sample, it is not possible to reject the null hypothesis that passthrough is complete and $\alpha_1=0$.

The differences in results between countries may be interpreted in a number of different ways. First, the results may be indicative of fundamental differences in the PTM behaviour of Swiss and U.K. firms, and this in turn may reflect differences in the nature of the foreign industries in which manufacturers from both countries compete. However, considerable caution should be exercised with this interpretation, as there may be measurement errors associated with responses to the U.K. survey, there were a variety of strong identification conditions imposed on the joint distribution of the latent variables over time to ensure that α_1 was identified, and it appears that the tests regarding α_1 may not be that powerful. Unfortunately, the precise estimation of α_1 will depend crucially on the number of time series observations included in the panel, and the evidence presented here appears to suggest that more data is required in order to provide accurate estimates of PTM behaviour within this framework.

It is also the case that both sets of estimates appear to exhibit intertemporal instability, when broken into subsamples. This may indicate model misspecification, as there are a variety of alternative rationales for PTM that are not captured by the model. In particular, models that incorporate demand- and supply-side dynamics suggest that permanent changes in market structure may result from changes in exchange rates, and these changes would show up as parameter instability within the current framework. Some of these issues are discussed in Chapter 6.

5.5 Conclusion

This chapter developed a simple model of PTM behaviour for firms and then estimated reduced form relationships implied by the models using categorical business survey data from the U.K. and Switzerland, using the linear latent variable modelling framework developed in Chapter 4. We found strong evidence of PTM behaviour for Swiss manufacturing firms, with less evidence for U.K. firms.

As this is the first application of the extended linear latent variable framework with time varying effects that are constant across firms, it is difficult to say whether the results presented here are due to the specific characteristics of the data, or whether they are the manifestation of more general features of the econometric problem. At a minimum, one important area of future research will be a Monte Carlo investigation of the finite sample properties of the estimation procedure, in order to evaluate what panel dimensions are required to produce precise estimate of coefficients associated with time varying effects that are common across firms at a point in time. More generally, it will also be important to consider alternative plausible models of PTM behaviour. Along these lines, Chapter 6 investigates survey data concerning expected foreign and domestic price changes to determine whether firms pre-set prices for more than one period.

Chapter 6

Planned v.s. Unplanned Passthrough

6.1 Introduction

Stochastic exchange-rates can affect the domestic currency prices received by exporting firms in at least two different ways. First, firms will adjust their pricing plans in response to rate changes in order to maximize profits. Second, to the extent that there are significant costs associated with changing prices, firms may preset prices for more than one period, and changes in the relationship between foreign and domestic prices will primarily be caused by unanticipated movements in the exchange rate. As has been emphasized in several of the previous chapters, distinguishing between these two types of passthrough is an important task in PTM research, as the theoretical rationales for each type of PTM behavior are different.

The empirical evidence concerning PTM that was presented in Chapter 5 was derived from a model characterizing planned PTM behavior. The primary motivating factors behind this type of PTM were ex ante price discrimination and the presence of variable costs that depended on the exchange rate. While the empirical results from Chapter 5 tended to support th. existence of planned PTM, at least for Switzerland, the model incorporated no dynamics on either the supply side or demand side, the empirical implementation placed fairly restrictive assumptions on the joint distribution of the latent variables underlying the categorical responses, and there was some evidence of structural instability that might potentially be attributed to model misspecification.

Perhaps more fundamentally, as the survey data actually responses concerning future pricing plans in foreign and domestic markets, it seems logical that these data might be more informative regarding PTM behaviour in firms' plans than the corresponding realizations. As a first step in directly analyzing the behaviour of foreign and domestic price plans, this chapter investigates an ex ante version of the model described in Chapter 5 using survey data on pricing plans and expected future costs. While other researchers have investigated this issue under assumptions concerning the nature of firms' price setting plans and a model or the exchange rate (Marston (1990), Giovannini (1988)), this appears to be the first research investigating foreign and domestic pricing plans with direct survey data.

In comparsion with planned PTM behaviour, unplanned passthrough results when prices are fixed for several periods. Typically, models with unplanned passthrough are based on substantial fixed costs of entry and exit (Dixit (1987), Baldwin (1986)). Modelling the behaviour of firms that set prices for more than one period is difficult, in the sense that firms must choose a price and the number of periods for which the price will be fixed. While this complicates the theoretical development of pricing models and their empirical implementation, it is possible to investigate the effect of multi-period price setting in foreign and domestic markets using the survey data, without specifying a complete model of firm behavior. In this chapter, we test the null hypothesis of no unplanned PTM by relating unanticipated changes in foreign prices to unanticipated changes in costs, and unanticipated changes in the exchange rate. As we have no data on exchange rate expectations, we investigate several different models of expectation formation.

The chapter will proceed as follows: Section 2 develops and estimates an ex ante version of the model discussed in Chapter 5. Section 3 provides some motivation for the test of no price-setting lags, and discusses the empirical implementation of the test. As the linear latent variable model employed in the test contains four latent variables, we employ the simulation based estimation procedures described in Chapter 4 to compute the probabilities underlying the likelihood function. Section 4 concludes.

6.2 Plans of PTM

This section examines the empirical implications of the model developed in Chapter 5, from the perspective of the previous period, *i.e.* we consider the situation where firms maximize expected profits at time t based on time $t-1$ information. The theoretical motivation for the model is identical to the motivation presented in the previous Chapter.

There are two problems associated with following the derivation in the previous chapter to determine the effect of anticipated changes in exchange rates on prices. First, it is not possible to totally differentiate the first order conditions for the ex ante problem and separate planned foreign prices and exchange rate expectations, as was done for realizations in Chapter 5, because of the nonlinearity in the profit function. Second, although exchange rates are observed, exchange rate expectations are not. In order to keep this portion of the analysis tractable, we will assume that the exchange rate follows a martingale and that this is common knowledge across all firms. In this instance, all firms will use the current exchnage rate as their best guess of tomorrow's rate, and expectations will be homogeneous. Of course, as mentioned several times in previous chapters, this is highly unlikely, but it will serve as an interesting base case from which to view alternative assumptions.

Following Marston (1990), we will proceed with an analysis of "expected" versions of equation (5.3.14) and equation (5.3.15). In particular, for Switzerland we will consider a regression equation relating planned margin changes to anticipated changes in costs and anticipated changes in the exchange rate, *i.e.*

$$\Delta x_t^e = \alpha_0^e \Delta p_t^{me} + \alpha_1^e \Delta s_t^e \qquad (6.2.1)$$

and where we have imposed the martingale expectation assumption. For the U.K., the analagous equation is

$$\Delta x_t^e = \alpha_0^e \Delta c_t^e + \alpha_1^e \Delta s_t^e. \qquad (6.2.2)$$

We follow the same empirical methodology, described in the last chapter, to estimate the *expected* PTM elasticities for the Swiss and U.K. firms. The final results are presented in Tables 6.1 and 6.2.

Table 6.1: Estimates(SW)† - $\Delta p_t^{de} = \Delta p_t^{fe} + \alpha_0^e \Delta p_t^{me} + \alpha_1^e \Delta s_t^e$

Date	ρ_{14}^e	ρ_{24}^e	ρ_{34}^e	ρ_{12}^e	ρ_{23}^e	ρ_{31}^e	α_1^e	α_0^e
83Q1	-.030	.060	-.584	.822	.268	.268	11.625	.001
-85Q1	(.003)	(.004)	(.003)	(.007)	(.013)	(.015)	(2.296)	(.023)
85Q2	.015	.006	-.077	.913	.347	.384	-1.220	-.077
-87Q1	(.001)	(.002)	(.001)	(.007)	(.016)	(.019)	(.209)	(.018)
83Q1	.050	.057	-.007	.850	.432	.368	-.102	-.001
-87Q1	(.004)	(.007)	(.004)	(.005)	(.011)	(.013)	(.946)	(.013)

† - Standard errors in parentheses.

Table 6.2: Estimates(U.K.)† - $\Delta p_t^{de} = \Delta p_t^{fe} + \alpha_0^e \Delta c_t^e + \alpha_1^e \Delta s_t^e$

Date	ρ_{14}^e	ρ_{24}^e	ρ_{34}^e	ρ_{12}^e	ρ_{23}^e	ρ_{31}^e	α_1^e	α_0^e
82Q1	.115	.101	.178	.868	.400	.332	-.544	.024
-84Q1	(.019)	(.011)	(.009)	(.004)	(.010)	(.012)	(.685)	(.012)
85Q1	.116	.053	.159	.839	.457	.390	-2.380	.004
-87Q1	(.013)	(.013)	(.009)	(.005)	(.010)	(.011)	(.455)	(.012)
82Q1	.113	.076	.164	.854	.428	.359	-1.502	.015
-87Q1	(.008)	(.008)	(.006)	(.003)	(.008)	(.007)	(.320)	(.008)

† - Standard errors in parentheses.

Comparing these two tables with the results in Chapter 5, it is clear that they are qualitatively similar, although the overall levels for α_1^c are somewhat lower here. For example, for Switzerland the value of α_1^c is significantly positive in the first half of the sample, significantly negative in the second, and insignificantly different from zero for the overall sample. For the U.K., α_1^c is negative and significantly different from zero in the second sub-sample and for the overall sample.

Taken at face value, the expectations based equations paint a slightly different picture of PTM behaviour. In particular, for the U.K, the majority of the estimates are negative and statistically significant, suggesting that that passthrough is more than proportionate. For the Swiss results, the PTM elasticity is significantly different from zero and of different sign in both subsamples, but is not significantly different from zero for the whole sample. As a result, there appears to be less evidence of PTM when considering the Swiss data, while there appears to be significant evidence of PTM for the U.K. data. Overall, it is still the case that there is some evidence of structural instability. Reconciliation of the differences between the results with expectations and realizations obviously represents an important task for future research.

However, it is important to emphasize that the results here depend on an assumed model of exchange rate expectation formation, *i.e.* the martingale model, and there is no guaranteee that this is neccesarily correct. As mentioned previously, under this assumption it will be the case that expectations are homogeneous across firms, and this seems highly unlikely. This issue is examined more closely in the next section, within the context of an attempt to distinguish between ex ante price discrimination and long-term price-setting as explanations of observed passthrough.

6.3 Unplanned v.s Planned Passthrough: A Test

In this section, we propose a test of the null hypothesis that there is no unplanned passthrough. The test employs the survey data on pricing plans and does not make any assumption about the model generating PTM behaviour. However, the test requires an assumption about exchange rate expectations; we will begin with the martingale assumption and then investigate the effects of alternative expectation formation mechanisms.

The basic intuition behind the test is that differences between planned and realized prices should reflect shocks that are unknown at time $t-1$. We simply propose a test of the null hypothesis that unanticipated changes in foreign prices are unrelated to unanticipated changes in the exchange rate. To the extent that prices are preset, and remembering that survey responses concerning foreign prices are reported in terms of domestic currency, it will be the case that unanticipated changes in the exchange rate will be reflected in the reported difference between realized and planned foreign price changes. We will consider equations for changes in foreign prices, rather than changes in margins, for computational purposes, as the corresponding margin equations would involve anticipated and realized changes in foreign prices, domestic prices, and costs, and would contain six latent variables. In any event, the effects of exchange rate change should be seen primarily in the foreign prices.

For Switzerland, the following regression equation will be estimated:

$$(P_t^f - P_t^{fe}) = \lambda_1(P_t^m - P_t^{me}) + \lambda_2(S_t - S_t^e) + u_t. \qquad (6.3.3)$$

Similalrly, for the U.K., the following regression equation will be estimated:

$$(P_t^f - P_t^{fe}) = \lambda_1(C_t - C_t^e) + \lambda_2(S_t - S_t^e) + u_t \qquad (6.3.4)$$

An implication of no unplanned passthrough is that $\lambda_2 = 0$ in these equations. We include the cost forecast error on the right-hand-side because it will hopefully make the test more powerful, as this is one source of expectational error that we can control for. One added benefit of this type of test is that it will be unaffected by the choice of normalization concerning the relative varability of foreign price changes, and the exchange rate.

As in Chapter 5, it is important to consider identification before estimation in this context.

6.3.1 Identification

Consider the variables in the above equations as ordered from 1 to 5, *i.e.* $\{x_1, x_2, x_3, x_4, x_5\}$, where x_5 is the exchange rate shock term which we will assume is observable (after the fact) and is constant across firms. Following the steps outlined in Chapters 4 and 5, assume that the variables $\{ x_1, x_2, x_3, x_4, x_5 \}$ are jointly normal with mean vector $\mu = \{ \mu_1, \mu_2, \mu_3, \mu_4, \mu_5\}'$ and covariance matrix Σ. Population regression parameters can be obtained with appropriate partitioning of the covariance matrix as $B = \Sigma_{12}\Sigma_{22}^{-1}$. We are specifically interested in estimating $\lambda_2 \cdot \beta_4 \cdot (\frac{\sigma_1}{\sigma_5}) \cdot (M/N)$.

$$
\begin{aligned}
M = {} & (\rho_{12}\rho_{23}\rho_{35} - \rho_{12}\rho_{23}\rho_{34}\rho_{45} + \rho_{12}\rho_{24}\rho_{45} - \rho_{12}\rho_{25} - \rho_{12}\rho_{34}\rho_{24}\rho_{35} + \rho_{12}\rho_{25}\rho_{34}^2 + \\
& \rho_{31}\rho_{34}\rho_{45} - \rho_{31}\rho_{35} - \rho_{31}\rho_{24}\rho_{23}\rho_{45} + \rho_{35}\rho_{31}\rho_{24}^2 + \rho_{31}\rho_{35}\rho_{23} - \rho_{31}\rho_{25}\rho_{24}\rho_{34} \\
& \rho_{14}\rho_{45} + \rho_{14}\rho_{34}\rho_{35} + \rho_{14}\rho_{45}\rho_{23}^2 - \rho_{14}\rho_{23}\rho_{24}\rho_{35} - \rho_{14}\rho_{25}\rho_{23}\rho_{34} + \\
& \rho_{14}\rho_{25}\rho_{24} + \rho_{15} - \rho_{15}\rho_{34}^2 - \rho_{14}\rho_{23}^2 - \rho_{15}\rho_{24}^2 + 2\rho_{15}\rho_{23}\rho_{24}\rho_{34} - \rho_{15}\rho_{24}^2)
\end{aligned}
$$

$$
\begin{aligned}
N = {} & (1 - \rho_{23}^2 - \rho_{34}^2 - \rho_{35}^2 - \rho_{25}^2 - \rho_{45}^2 - \rho_{24}^2 + \rho_{23}^2\rho_{45}^2 + \rho_{24}^2\rho_{35}^2 + \rho_{25}^2\rho_{34}^2 + 2\rho_{34}\rho_{35}\rho_{45} \\
& + 2\rho_{23}\rho_{25}\rho_{35} + 2\rho_{24}\rho_{25}\rho_{45} + 2\rho_{23}\rho_{24}\rho_{34} - 2\rho_{23}\rho_{34}\rho_{25}\rho_{45}
\end{aligned}
$$

$-2\rho_{23}\rho_{24}\rho_{35}\rho_{45} - 2\rho_{24}\rho_{35}\rho_{34}\rho_{25})$

In order to determine which parameters are identifiable, we proceed by estimating the parameters in the conditional distribution of $\{ x_1, x_2, x_3, x_4 \}$ on x_5. Conditional on x_5, $\{ x_1, x_2, x_3, x_4 \}$ are normally distributed with mean $\mu_{1.2}$=$\{ \mu_1 + \gamma_1(x_5 - \mu_5), \mu_2 + \gamma_2(x_5 - \mu_5), \mu_3 + \gamma_3(x_5 - \mu_5, \mu_4 + \gamma_4(x_5 - \mu_5)\}'$ and covariance matrix $\Sigma_{11.2} = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21}$, where

$$\gamma_1 = (\frac{\sigma_1}{\sigma_5})\rho_{15},$$

$$\gamma_2 = (\frac{\sigma_2}{\sigma_5})\rho_{25},$$

$$\gamma_3 = (\frac{\sigma_3}{\sigma_5})\rho_{35},$$

$$\gamma_4 = (\frac{\sigma_4}{\sigma_5})\rho_{45},$$

and

$$\Sigma_{11.2} = \begin{bmatrix} \sigma_{11} - \frac{\sigma_{15}^2}{\sigma_{55}} & & & \\ \sigma_{21} - \frac{\sigma_{25}\sigma_{15}}{\sigma_{55}} & \sigma_{22} - \frac{\sigma_{25}^2}{\sigma_{55}} & & \\ \sigma_{31} - \frac{\sigma_{35}\sigma_{15}}{\sigma_{55}} & \sigma_{32} - \frac{\sigma_{32}\sigma_{25}}{\sigma_{55}} & \sigma_{33} - \frac{\sigma_{35}^2}{\sigma_{55}} & \\ \sigma_{41} - \frac{\sigma_{45}\sigma_{15}}{\sigma_{55}} & \sigma_{42} - \frac{\sigma_{45}\sigma_{25}}{\sigma_{55}} & \sigma_{43} - \frac{\sigma_{45}\sigma_{35}}{\sigma_{55}} & \sigma_{44} - \frac{\sigma_{45}^2}{\sigma_{55}} \end{bmatrix}.$$

Simplifying yields

$$\Sigma_{11.2} = \begin{bmatrix} \sigma_{11}(1 - \rho_{15}^2) & & & \\ \sigma_2\sigma_1(\rho_{12} - \rho_{25}\rho_{15}) & \sigma_{22}(1 - \rho_{25}^2) & & \\ \sigma_3\sigma_1(\rho_{31} - \rho_{15}\rho_{35}) & \sigma_2\sigma_3(\rho_{23} - \rho_{25}\rho_{35}) & \sigma_{33}(1 - \rho_{35}^2) & \\ \sigma_1\sigma_4(\rho_{14} - \rho_{15}\rho_{45}) & \sigma_2\sigma_4(\rho_{42} - \rho_{25}\rho_{45}) & \sigma_4\sigma_3(\rho_{43} - \rho_{45}\rho_{35}) & \sigma_{44}(1 - \rho_{45}^2) \end{bmatrix}.$$

If we consider the appropriately standardized latent variables, it is possible to estimate conditional correlations ρ'_{12}, ρ'_{23}, ρ'_{31}, ρ'_{14}, ρ'_{24}, ρ'_{34}, standardized coefficients γ'_1, γ'_2, γ'_3, γ'_4, and the standardized thresholds. Using the definitions of the unstandardized coefficients, we can write the standardized versions as

$$\gamma'_1 = \frac{\gamma_1}{\sigma_1\sqrt{1-\rho_{15}^2}} = \frac{\rho_{15}}{\sigma_5\sqrt{1-\rho_{15}^2}}, \qquad (6.3.5)$$

$$\gamma'_2 = \frac{\gamma_2}{\sigma_2\sqrt{1-\rho_{25}^2}} = \frac{\rho_{25}}{\sigma_5\sqrt{1-\rho_{25}^2}}, \qquad (6.3.6)$$

$$\gamma'_3 = \frac{\gamma_3}{\sigma_3\sqrt{1-\rho_{35}^2}} = \frac{\rho_{35}}{\sigma_5\sqrt{1-\rho_{35}^2}}, \qquad (6.3.7)$$

$$\gamma'_4 = \frac{\gamma_4}{\sigma_4\sqrt{1-\rho_{45}^2}} = \frac{\rho_{45}}{\sigma_5\sqrt{1-\rho_{45}^2}}, \qquad (6.3.8)$$

$$\rho'_{12} = \frac{\rho_{12} - \rho_{15}\rho_{25}}{\sqrt{1-\rho_{15}^2}\sqrt{1-\rho_{25}^2}}, \qquad (6.3.9)$$

$$\rho'_{23} = \frac{\rho_{23} - \rho_{35}\rho_{25}}{\sqrt{1-\rho_{25}^2}\sqrt{1-\rho_{35}^2}}, \qquad (6.3.10)$$

$$\rho'_{31} = \frac{\rho_{31} - \rho_{15}\rho_{35}}{\sqrt{1-\rho_{15}^2}\sqrt{1-\rho_{35}^2}}, \qquad (6.3.11)$$

$$\rho'_{14} = \frac{\rho_{14} - \rho_{15}\rho_{45}}{\sqrt{1-\rho_{15}^2}\sqrt{1-\rho_{45}^2}}, \qquad (6.3.12)$$

$$\rho'_{24} = \frac{\rho_{24} - \rho_{25}\rho_{45}}{\sqrt{1-\rho_{25}^2}\sqrt{1-\rho_{45}^2}}, \qquad (6.3.13)$$

and

$$\rho'_{34} = \frac{\rho_{34} - \rho_{45}\rho_{35}}{\sqrt{1-\rho_{45}^2}\sqrt{1-\rho_{35}^2}}. \qquad (6.3.14)$$

Since σ_5 is identified from the observed data, the first four equations identify ρ_{15}, ρ_{25}, ρ_{35} and ρ_{45}, and the last six equations allow us to identify ρ_{12}, ρ_{23}, ρ_{31}, ρ_{14}, ρ_{24} and ρ_{34}.

The magnitude of λ_2 will be affected by the normalization chosen for σ_1, although the value of test statistic for the null hypothesis that λ_2=0 will not. For the empirical work reported below, we will assume that σ_1=1. In addition, as in Chapter 5, we will not attempt to impose the normalizations concerning anticipated price plans *i.e.* β_1=1 above. It should be pointed out that we would not like to constrain σ_2=1 in this situation, as there is no basis for assuming that the variances of price plans and realizations are the same.

6.3.2 Empirical Results

Simulated maximum-liklihood estimates of the parameters of interest were calculated based on the likelihood function presented in Chapter 4, and using the GHK simulator with 100 replications. Estimates were computed in GAUSS, using numerical derivatives and Broyden-Fletcher-Goldfarb Shanno iterations to obtain a local maximum. A final Newton-Raphson iteration was employed to estimate the observed information matrix. In order to ensure that the achieved maximum was in fact a global maximum, starting values were varied to make sure that convergence was obtained at the same point in the parameter space. Standard errors for the estimates of the population regression coefficients were then obtained via the Delta method, as described in Chapter 4.

Simulation methods are required in this problem because there are four latent variables, and quadrivariate normal orthant probabilities are required as parametric representations of the 81 empirical frequencies. In general, moving up one dimension from Chapter 5 seriously increased the computational burden, and convergence typically took as many as 20 hours on a 486 50Mhz machine.

One other issue concerning the development of the likelihood function is the assumption of temporal independence employed in Chapter 5. As the construction of contingency tables containing expectations and subsequent realizations requires the use of adjacent surveys, the assumption of intertemporal independence is obviously inappropriate on a per-period basis. In order to avoid this overlap and still maintain a large enough sample size, we constructed estimates from quadrivariate contingency tables taken from every second quarter, under the assumption that each separate quadrivariate sample is independent. In table below, we report the correlation estimates, the value of λ_2, and a χ^2 test (W) of the null hypothesis that λ_2=0.

Table 6.3: Estimates of The Test Equations and The Test-statistic

Country	Date	ρ_{12}	ρ_{23}	ρ_{31}	ρ_{14}	ρ_{24}	ρ_{34}	ρ_{15}	ρ_{25}	ρ_{35}	ρ_{45}	λ_2	W
SW	83Q1-87Q1	-.0242	.1305	-.0012	.2277	.0669	-.0516	-.0010	-.0003	-.0026	-.0014	-.1012	.0038
U.K.	82Q4-87Q1	.1629	-.0033	.0496	.1870	.0880	.2279	.1722	.0996	.0074	-.0155	.0346	.0730

It is clear from the low values of W for both countries that we fail to reject the null hypothesis of 'no unplanned passthrough'. This is potentially important, as it supports the null hypcthesis that planned PTM is the most important driving force behind observed deviations from the law-of-one-price. It is also important to realize that these conclusions could not be reached without the survey data. However, enthusiasm for this approach must be tempered by the observation that the test may not be sufficiently powerful to distinguish unplanned from planned passthrough. In addiiton, the test is obviously based on a simple assumed model of expectation formation. The sensitivity of the results to an alternative assumption about exchange rate expectations is discussed below.

6.4 Alternative Exchange Rate Expectations

Much of the previous empirical work has assumed that exchange rates follow a martingale, and used this as a basis for modelling exchange rate expectations. Within the context of a cross-section analysis, the assumption of homogeneous exchange rate expectations across firms seems highly unlikely. In this section we investigate the effects of introducing heterogeneity in exchange rate expectations into the analysis.

Consider a situation where exchange-rate expectations are measured with an error which is firm-specific. If we represent the true expectation as $\tilde{S}_t^e$ and the measurement error with zero-mean and constant variance as v_t, we have

$$S_t^e = \tilde{S}_t^e + v_t \qquad (6.4.15)$$

In the usual errors in variables model v_t is assumed to be uncorrelated with $\tilde{S}_t^e$, and econometric analysis proceeds using the error corrupted data.

The situation presented here is actually slightly different, in that the variance of the "true" expectations will exceed the variance of the proxy which was based (in our case) on the martingale model In the usual econometric analysis of models with errors-in-variables, estimates based on error corrupted data are biased downwards, so that "correcting" for the error will increase the values of coefficient estimates. In our situation, the variance of the proxy is *less* than the variance of true expectation, and in the absence of other effects, one would expect the coefficients to be biased upwards.

However, one must be careful in this simple analogy, as the additional "error" differentiating the true expectations from the proxy and representing heterogeneity will actually be correlated with many of the variables in the regression. However, the heterogeneity factor will be uncorrelated with the expectational error on the left hand-side of the regression equations in this section *under the null hypothesis* of no unplanned PTM, and in this instance it is possible to show that the upward bias actually holds. However, under alternative hypotheses, this is not true, and it is an open question whether the test as formulated has power against plausible alternatives when heterogeneity is accounted for.

6.5 Conclusion

This chapter investigated the behaviour of foreign and domestic pricing plans using categorical business survey data for the U.K. and Switzerland and used two separate approaches. First, we investigated the ex ante pricing behavior of firms in foreign and domestic markest using an ex ante version of the model developed in Chapter 5. The results were slightly different than those presented in Chapter 5, in the sense the U.K. survey data indicated PTM behaviour, while the evidence from the

Swiss data was much weaker. The opposite result occurred in Chapter 5. Second, we employed the direct qualitative evidence concerning foreign and domestic price plans to investigate the null hypothesis of no unplanned passthough. Our results fail to reject the null hypothesis, which provides some support for models of PTM behaviour that emphasize the planned behaviour of firms in response to anticipated exchange rate changes, rather than long-term price-setting and unanticipated movements in the exchange rate as primary explanations of observed passthrough.

As was also pointed out in Chapter 5, additional research needs to focus on the finite sample properties of the parameters estimates in these models. Researchers should also focus attention on incorporating heterogenous expectations into PTM models.

Chapter 7

Conclusion

This thesis investigated the pricing behaviour of firms in foreign and domestic markets, using a unique dataset containing firm-specific responses to business surveys in the U.K. and Switzerland. These surveys contain specific questions concerning *realized* and *anticipated* pricing decisions in foreign and domestic markets.

While the U.K. and Swiss business survey data are potentially quite informative about PTM behaviour, they also are extremely challenging econometrically, as most survey responses are ordered and categorical. The thesis employed a linear latent variable econometric approach that treated the categorical survey responses as being generated by continuous latent structural variables as they cross certain thresholds. Parameters in linear relationships amongst the latent variables were estimated by maximum-likelihood in small-dimensional problems. In situations where standard FIML was infeasible, recently developed simulation procedures were employed to compute the maximum-likelihood estimates. The thesis also extended the standard latent variable framework to include time varying effects that are common across firms.

Empirically, it appears that survey evidence on observed price changes provides strong evidence of PTM behaviour for Swiss manufacturing firms, and less evidence for British firms. However, survey evidence on pricing plans appears to find strong evidence of PTM behavior for British firms, and less evidence for Swiss firms. Finally, unanticipated changes in exchange rates with pre-set prices does not appear to be an important determinant of observed passthrough.

Important tasks for future research include a thorough investigation of the finite sample properties of the estimates. In particular, it would be useful to know whether the econometric procedures are sufficiently powerful to capture economically relevant deviations from the null hypothesis within the models in Chapters 5 and 6. In addition, an important guideline for research in this area is that survey evidence on expectations should provide important diagnostic information concerning the behaviour of realizations. As a result, an interesting topic for future research will be a reconciliation of the the different results in Chapters 5 and 6.

Chapter 8

Appendix A

A CONSERVER

KOF, Centre ETH, Zurich

Explications sur la manière de répondre au test conjoncturel

Indications générales

Le test conjoncturel précède les statistiques officielles et parfois même les statistiques internes de l'entreprise. Il ne s'intéresse donc qu'à des *tendances*. Pour cette raison, les réponses des personnes dirigeantes doivent être fondées sur les *connaissances générales de la situation*. Il n'est donc pas nécessaire de consulter les chiffres de la comptabilité. Chaque questionnaire porte sur un groupe de produits déterminé. Seuls ces produits sont à prendre en considération. Pour les entreprises ne recevant qu'un seul questionnaire, celui-ci reflètera la marche des affaires de l'entreprise dans son ensemble.

La plupart des questions portent sur des données quantifiables. En règle générale, les réponses devraient tenir compte des quantités, surtout s'il s'agit de produits standardisés. Lorsque ce n'est pas possible, on peut se baser sur la valeur en francs, mais après élimination des variations dues uniquement à des fluctuations de prix (autrement dit sur le volume). Il est demandé de conserver d'une enquête à l'autre la même méthode d'évaluation. Les changements de méthode éventuels sont à signaler dans la rubrique «Remarques». Par ailleurs, celle-ci est réservée à des descriptions générales de la situation, à des indications sur une situation particulière dans le cadre du groupe de produits, de l'entreprise ou de la branche. C'est là que vous indiquerez par exemple le passage d'une méthode d'évaluation à une autre (quantité ou valeur) ou un changement de la durée normale de travail. De temps à autre, nous poserons des questions supplémentaires dans cette rubrique.

Les indications ci-dessous ne sont que des conseils, étant donné les situations très différentes d'un produit à l'autre et d'une entreprise à l'autre. Nous vous prions cependant de vous tenir à la même méthode d'évaluation d'une enquête à l'autre, dans la mesure du possible.

A. Test mensuel

Evolution et appréciations

1 L'entrée globale des commandes

Il doit s'agir exclusivement de l'entrée de commandes de clients; les commandes internes ne doivent pas être prises en considération. En règle générale, nous nous intéressons à la quantité commandée (volume).

2 L'entrée de commandes de l'étranger

Si vous vendez régulièrement à l'étranger, que ce soit directement ou par l'intermédiaire d'un exportateur suisse, il y a lieu de répondre à cette question. Si ce n'est pas le cas, il faut cocher la case «normalement inexistantes».

3 Le carnet de commandes

Il s'agit de la quantité (volume) des commandes de la clientèle qui n'ont pas encore atteint le stade de production. Le carnet de commandes est trop peu chargé (3b) s'il ne permet pas une utilisation normale des capacités. Il est très chargé si les commandes ne peuvent pas être exécutées dans les temps habituels.

4 La production

Il faut se baser sur la quantité (volume), ou éventuellement la valeur, des produits finis et semi-finis. Le total des heures de travail effectuées ou des heures d'exploitation des machines peut servir, le cas échéant, à évaluer la production.

5 Les stocks de produits en cours de fabrication

Ce sont tous les stocks de produits non-finis fabriqués par l'entreprise sur la base de commandes ou non. Ils sont trop élevés (5b) s'ils ne peuvent plus être considérés comme réserve pour une augmentation de production déjà prévue et trop faibles s'ils provoquent un goulet d'étranglement.

6 Les stocks de produits finis

Il ne s'agit que de la partie des stocks de produits finis qui a été constituée sans qu'il y ait eu de commande correspondante: on n'y inclut pas les stocks appartenant à la clientèle et les produits finis déjà vendus qui, pour des raisons techniques ou de délais, sont encore stockés dans l'entreprise. Les stocks sont trop grands (6b) si leur état actuel trahit une mévente et trop petits si les commandes ne peuvent être exécutées à partir des stocks dans les temps souhaités. En cas de modifications dues uniquement à des fluctuations de prix, cocher la case «sont restés identiques».

Perspectives

7 a) L'entrée globale des commandes et b) la production

Voir les explications des questions 1 et 4 du test mensuel.

7 c) L'achat de matières premières et de produits semi-finis

Si plusieurs matières premières et produits semi-finis sont nécessaires à la production, on ne retiendra que les plus importants.

8 Marche prévisible des affaires

Cette question porte sur l'évolution prévisible des affaires au-delà des 3 prochains mois, par rapport à l'évolution attendue pour ces 3 mois.

B. Test trimestriel

Evolution et appréciations

1 L'emploi

a) Il s'agit du nombre de personnes occupées à *la fabrication* ou, à la rigueur, du nombre d'heures utilisées à la fabrication (à l'exclusion du personnel administratif et de vente).

b) Les heures supplémentaires sont celles qui de par la loi ou par contrat sont rétribuées avec supplément. La question porte sur leur proportion en % du temps normal de travail. Des variations de celui-ci sont à signaler dans la rubrique «Remarques»

c) Il faut apprécier le nombre de personnes occupées par rapport au carnet de commandes ou, à défaut, aux stocks de produits finis et aux nouvelles commandes prévues

2 La capacité technique de production

La capacité technique désigne la possibilité de produire donnée par les bâtiments et les équipements, quelle que soit la main-d'œuvre disponible. Les arrêts momentanés dus à des réparations ne doivent pas être considérés comme diminution de la capacité ou de son degré d'utilisation. Le degré d'utilisation de la capacité technique se définit par le rapport en % entre la production effective et la production possible. Pour l'évaluation du degré d'utilisation de la capacité technique, il faut se baser sur le nombre habituel d'équipes de travail. Des variations du nombre d'équipes sont à indiquer sous «Remarques».

La capacité technique doit être considérée comme trop élevée lorsque cela est dû à des débouchés ou des ventes trop faibles. Elle n'est pas trop élevée si ce phénomène est dû à un manque momentané de personnel. Elle est trop faible si les nouvelles commandes risquent de provoquer des allongements des délais de livraison.

3 Les stocks de matières premières et de produits semi-finis

Ce sont les stocks de matières premières et de produits semi-finis qui ont été exclusivement fournis par des tiers (produits intermédiaires). On ne s'intéresse ici qu'aux variations de quantités. Il faut apprécier (3b) leur niveau en fonction de leur rapport usuel avec les plans de production.

4 Les prix des matières premières et des produits semi-finis

Il s'agit des prix d'achat actuels des matières premières et produits semi-finis normalement utilisés. Ce sont les prix nets, en francs suisses, qui doivent servir de base. Si plusieurs matières premières et produits semi-finis sont nécessaires, on ne retiendra que les plus importants.

5 Les prix de vente

Nous vous prions de répondre non pas sur la base de vos prix catalogues, mais sur la base des prix effectifs obtenus dans vos contrats et vos ventes, après déduction de tous les rabais.

6 Le bénéfice brut

Il s'agit des variations du bénéfice brut en valeur absolue. Ainsi une croissance des ventes sans changement de la marge bénéficiaire provoque l'augmentation du bénéfice brut. Cette question fait apparaître la force économique d'un groupe de produits, donc son taux de couverture. Elle recouvre l'influence du groupe de produits sur le «cash-flow».

Perspectives

7 + 8. Les prix

Voir les explications des questions 4 et 5 du test trimestriel.

Test conjoncturel

Enquête trimestrielle complémentaire

Centre de recherches conjoncturelles à l'EPF
ETH-Zentrum, 8092 Zürich
Téléphone 01/47 18 88

Veuillez

- ne répondre que pour le groupe de produits indiqué sur le questionnaire
- mettre une croix dans la case correspondante; veuillez, en cas de difficulté, consulter les explications du test conjoncturel
- renvoyer le questionnaire avant le 20 du mois.

Rétrospective et appréciations

1 L'emploi

a) Le nombre de personnes occupées à la fin du trimestre, comparé à la fin du trimestre précédent, – après élimination des variations saisonnières*

☐ a augmenté ☐ est resté identique ☐ a diminué

b) Nous jugeons le nombre de personnes occupées

☐ trop élevé ☐ satisfaisant ☐ trop faible

c) La part des heures supplémentaires dans le total du travail effectué a représenté, durant le trimestre écoulé, (en %)

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
☐ 7 ☐ 8 ☐ 9 ☐ 10

2 La capacité technique de production

a) La capacité technique de production à la fin du trimestre, comparée à la fin du trimestre précédent,

☐ a augmenté ☐ est restée identique ☐ a diminué

b) Nous jugeons la capacité technique de production

☐ trop élevée ☐ satisfaisante ☐ trop faible

c) Le degré moyen d'utilisation de la capacité technique de production a atteint, durant le trimestre écoulé, (en %)

☐ 50 ☐ 55 ☐ 60 ☐ 65 ☐ 70 ☐ 75 ☐ 80
☐ 85 ☐ 90 ☐ 95 ☐ 100 ☐ 105 ☐ 110

3 Stocks de matières premières et de produits semi-finis

a) Le volume des stocks de matières premières et de produits semi-finis à la fin du trimestre, comparé à la fin du trimestre précédent, – après élimination des variations saisonnières*

☐ a augmenté ☐ est resté identique ☐ a diminué

b) Nous jugeons les stocks de matières premières et de produits semi-finis

☐ trop élevés ☐ satisfaisants ☐ trop faibles

4 Les prix d'achat des matières premières et des produits semi-finis utilisés, comparés au trimestre précédent,

☐ ont augmenté ☐ sont restés identiques ☐ ont diminué

5 Prix de vente

a) Les prix de vente pour le marché intérieur, comparés au trimestre précédent,

☐ pas de vente en Suisse

☐ ont augmenté ☐ sont restés identiques ☐ ont diminué

b) Les prix de vente pour les marchés d'exportation (exprimés en francs suisses), comparés au trimestre précédent,

☐ pas d'exportations

☐ ont augmenté ☐ sont restés identiques ☐ ont diminué

6 Le bénéfice brut du trimestre, comparé au trimestre précédent,

☐ s'est amélioré ☐ est resté identique ☐ s'est détérioré

Perspectives

Durant le prochain trimestre et en comparaison du trimestre précédent,

7 les prix de matières premières et des produits semi-finis utilisés

☐ augmenteront ☐ resteront identiques ☐ diminueront

8 a) nos prix de vente pour le marché intérieur

☐ augmenteront ☐ resteront identiques ☐ diminueront

b) nos prix de vente pour les marchés d'exportation (exprimés en francs suisses)

☐ augmenteront ☐ resteront identiques ☐ diminueront

* Il s'agit des fluctuations saisonnières de la demande, ainsi que des variations entraînées par les vacances et jours fériés, l'entretien régulier et les réparations courantes.

CBI Industrial Trends Survey Number 95: January 1985

Please tick appropriate answers: If question not applicable, tick N/A

Please use space overleaf for any comments you would like to make on points not covered by your replies

1 Are you more, or less, optimistic than you were four months ago about THE GENERAL BUSINESS SITUATION IN YOUR INDUSTRY

More	Same	Less	
			11

2 Are you more, or less, optimistic about your EXPORT PROSPECTS for the next twelve months than you were four months ago

More	Same	Less	N/A	
				12

3 Do you expect to authorise more or less capital expenditure in the next twelve months than you authorised in the past twelve months on:

	More	Same	Less	N/A	
a. buildings					13
b. plant & machinery					14

4 Is your present level of output below capacity (i.e., are you working below a satisfactory full rate of operation)

Yes	No	N/A	
			15

5 Excluding seasonal variations, do you consider that in volume terms:

	Above Normal	Normal	Below Normal	N/A	
a. Your present total order book is					16
b. Your present export order book is					17

(firms with no order book are requested to estimate the level of demand)

	More than Adequate	Adequate	Less than Adequate	N/A	
c. Your present stocks of finished goods are					18
	1	2	3	4	

Excluding seasonal variations, what has been the trend over the PAST FOUR MONTHS, and what are the expected trends for the NEXT FOUR MONTHS, with regard to:

	Trend over PAST FOUR MONTHS				Expected trend over NEXT FOUR MONTHS				
	Up	Same	Down	N/A	Up	Same	Down	N/A	
6 Numbers employed									19-20
7 Volume of total new orders									21-22
of which: a. domestic orders									23-24
b. export orders									25-26
8 Volume of output									27-28
9 Volume of: a. domestic deliveries									29-30
b. export deliveries									31-32
10 Volume of stocks of: a. raw materials and brought in supplies									33-34
b. work in progress									35-36
c. finished goods									37-38
11 Average costs per unit of output									39-40
12 Average prices at which: a. domestic orders are booked									41-42
b. export orders are booked									43-44
	1	2	3	4	1	2	3	4	

13 Approximately how many months' production is accounted for by your present order book or production schedule.

Less than 1	1-3	4-6	7-9	10-12	13-18	More than 18	N/A	
								45
1	2	3	4	5	6	7	8	

14 What factors are likely to limit your OUTPUT over the next four months. *Please tick the most important factor or factors. If you tick more than one factor it would be helpful if you could rank them in order of importance*

Orders or Sales	Skilled Labour	Other Labour	Plant Capacity	Credit or Finance	Materials or Components	Other	
							46 52

15 What factors are likely to limit your ability to obtain EXPORT ORDERS over the next four months. *Please tick the most important factor or factors. If you tick more than one factor if would be helpful if you could rank them in order of importance*

Prices (compared with overseas competitors)	Delivery Dates (compared with overseas competitors)	Credit or Finance	Quota & Import Licence Restrictions	Political or Economic Conditions Abroad	Other	
						53 58

16 a. In relation to expected demand over the next twelve months is your present fixed capacity:

More than adequate	adequate	less than adequate	
			59

b. What are the main reasons for any expected CAPITAL EXPENDITURE AUTHORISATIONS ON BUILDINGS, PLANT OR MACHINERY over the next twelve months. *If you tick more than one factor it would be helpful if you could rank them in order of importance.*

to expand capacity		60	other *(please specify)*		63
to increase efficiency		61	N/A		64
for replacement		62			

c. What factors are likely to limit (wholly or partly) your capital expenditure authorisations over the next twelve months. *If you tick more than one factor it would be helpful if you could rank them in order of importance.*

Inadequate net return on proposed investment		65	Uncertainty about demand		69
Shortage of internal finance		66	Shortage of labour including Managerial and Technical Staff		70
Inability to raise external finance		67	Other *(please specify)*		71
Cost of finance		68	N/A		72

Please enter here the code number of the main manufacturing activity covered by this return (See Standard Industrial Classification circulated previously). [ ] 73-76

How many EMPLOYEES are covered by this return

(a) 0 – 199 [ ] (b) 200 – 499 [ ] (c) 500 – 4,999 [ ] (d) 5,000 and over [ ] 77

What is the annual ex-works value of your direct EXPORTS

Nil – £75th	£75th – £1m	£1m – £3m	£3m – £8m	£8m – £15m	£15m – £25m	£25m – £40m	£40m – £60m	£60m – £100m	£100m – £150m	Over £150m	
											78
0	1	2	3	4	5	6	7	8	9	10	

Signature ....

Company ....
(Block Capitals)

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