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Business Cycle Fluctuations and International Financial Integration

by

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Abstract

Theoretical research on the determinants of business-cycle fluctuations implies that the degree of international financial integration can have important implications for the propagation of, e.g., macroeconomic policy shocks in an open economy. An important assumption underlying this research is that the degree of financial integration can be taken as exogenously given. Because recent empirical research has demonstrated that financial integration may change over time, we use data for the G7 countries to test how well this assumption fits to the data. We find that one can maintain, as a rule, the assumption that the degree of financial integration is invariant to the determinants of the business-cycle fluctuations. We find, however, a few exceptions from this rule, and we also find that shocks tend to have a highly persistent effect on financial integration.

Keywords: Open economy macroeconomics; Business cycles; Financial integration

JEL classification: F33, F36, F41

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1. Introduction

The globalization of financial markets has become one key manifestation of the increasing world-wide economic integration. As a result, international financial markets have grown rapidly during the past decades and financial integration has increased significantly. This increase in the degree of financial integration is of major importance for research in macroeconomics because macroeconomic theories of open economies imply that the degree of financial integration can play a key role for the propagation of shocks in an open economy.

For example, the workhorse model of international macroeconomics – the model Mundell (1963) and Fleming (1962) developed in the 1960s – implies in its most basic textbook version that, in a flexible exchange rate system, the short-run output effect of a monetary (fiscal) policy shock is an increasing (decreasing) function in the degree of financial integration. Sutherland (1996) and Senay (1998) have argued that one obtains in general very similar results if one studies the influence of financial integration on the propagation of a macroeconomic policy or a productivity shock in a modern micro-founded, sticky-price dynamic general equilibrium model of the type developed by Obstfeld and Rogoff (1995, 1996). In the context of international real business-cycle models, Baxter and Crucini (1993), Baxter (1995), and Kollmann (1995) have shown that the structure of international financial markets can play an important role for business-cycle fluctuations in an open economy.

A common assumption made by these authors is that the degree of financial integration can be treated as exogenously given and constant in analyses of the determinants of business-cycle fluctuations. Thus, while it is generally acknowledged that the degree of financial integration can have a significant impact on business-cycle fluctuations, the propagation of a shock is commonly analyzed under the *ceteris paribus* assumption that the degree of financial integration does *not* change over the business cycle.

In this paper, we ask whether this assumption provides a reasonably close approximation of real-world data. Our research is motivated by recent empirical evidence reported in the international finance literature. This empirical evidence suggests that the degree of financial integration significantly increased during the last three decades of the twentieth century. A by no means complete list of significant contributions to this literature includes Lane and Milesi-Ferretti (2001), Kaminsky and Schmukler (2001), Fratzscher (2002), Hardouvelis et al. (1999), and Bodard and Reding (1999), to name just a view. Furthermore, the results of recent empirical evidence suggests that the process of integration of financial markets has been all but monotonous. For example, Bekaert and Harvey (1995) have reported empirical evidence that the integration of a number of emerging markets into international financial markets has significantly varied over time, and that phases of relatively high integration may be followed by phases of relatively low integration. Other authors (e.g., Baele 2002) have emphasized the time-varying nature of volatility spillovers across national equity markets, an empirical result which further lends support to the view that the degree of financial integration may have undergone changes over time.

Yet another piece of evidence in favor of this view has been provided by Erb et al. (1995), who have found that international stock market correlations are systematically linked to the stance and the cross-country co-movement of business cycles. Specifically, correlations tend to be higher during recessions than during economic upswings and tend to be low when business cycles are out of phase. Similarly, Longin and Solnik (1995) have found that the correlations of international stock markets have been rising during the last thirty years, but also that correlations tended to decline during periods of high volatility. This result is interesting because, e.g., Schwert (1989a, 1989b) and Hamilton and Lin (1996) have argued that stock market volatility tends to rise in period of business cycle downturns. Thus, it could be the case that business-cycle fluctuations and the correlation of international stock markets are systematically linked.[1]

Against the background of this empirical evidence, we used monthly data for the G7 countries for the period 1970:1 – 2000:12 in order to analyze whether

[1] It should be noted that the international correlation of stock markets returns should not be used as a direct measure of financial integration. A high international correlation of stock market returns may indicate financial integration or merely a close international co-movement of economic fundamentals. See Dumas et al. (2003) for a discussion.

empirical evidence supports the assumption commonly made in the macroeconomics literature that the degree of financial integration can be regarded as independent of the stance of the business cycle. To this end, we estimated, in a first step, a time-varying parameter model in order to measure the time-varying nature of the integration of international stock markets. Thus, as has been done, e.g., by Bekaert and Harvey (1995) and, more recently, by Fratzscher (2002), we rely on a stock-market based approach to measure the time-varying integration of international financial markets. In a second step, we used the estimates of the time-varying parameter model in a vector autoregressive model (VAR). As in, e.g., Rotemberg and Woodford (1996), the VAR we estimated contains an equation for the short-term interest rate (which summarizes information on the stance of monetary policy), an equation for the inflation rate (which summarizes information on the supply side of an economy), and an equation for industrial production (which summarizes information on demand conditions). In addition, and this is the core innovative feature of our small-scale VAR model, our VAR contains an equation that captures the dynamics of the variation in the integration of international stock markets over time. In a third step, we identified the structural disturbances of our VAR and analyzed whether and, if so, how financial integration in the G7 countries has changed over the business cycle.

We found that financial integration has undergone significant changes over time, but that it is, with a few exceptions, not linked in a systematic way to the stance of the business-cycle. Hence, our results lend support to the widely used assumption that the degree of financial integration can be assumed exogenous and constant when using open economy business-cycle models for the study of the propagation of shocks. Of course, this result does *not* imply that financial integration is completely invariant to business-cycle fluctuations. For example, our results imply that shocks typically have a highly persistent effect on the degree financial integration and that both aggregate real demand and monetary policy shocks tend to bring about a decline in financial integration. These implications clearly have interesting implications for macroeconomic policy and economic theory. But, taken together, our results indicate that, e.g., macroeconomic policy shocks themselves do not result in significant changes in the degree of financial integration at business-cycle frequencies in the majority of countries we study. Thus, while empirical evidence indicates that, e.g., increased trade integration (Forbes and Chinn 2003), equity market development and low inflation (Baele 2000), and lower exchange rate volatility (Fratzscher 2002) seem to have had a significant impact on financial integration, macroeconomic shocks that led to shorter-run business-cycle fluctuations seem to have had only a rather moderate impact on financial integration. This is an important result because it suggests that the conventional wisdom derived from the open-economy macroeconomic literature, which is based on the assumption of an exogenously given degree of financial integration, may provide a reasonable approximation of the interaction between the business-cycle fluctuations and international financial markets.

We organize our analysis as follows. In Section 2, we lay out the time-varying parameter model we use in order to compute estimates of the time-varying financial integration of the G7 countries. We also report our measures of time-varying financial integration. In Section 3, we provide details concerning our VAR model, we discuss how we identify the structural shocks of the VAR model, and we present the empirical results of our VAR-based analysis. In Section 4, we offer some concluding remarks.

2. Measuring Time-Varying Financial Integration

In the international finance literature, a consensus on the techniques that should be used to measure financial integration has not yet emerged. (See Buch and Pierdzioch (2000) for a survey of various concepts that have been advanced to measure financial integration.) In this paper, we use stock market data to measure financial integration. This is in line with the approach commonly used in the international finance literature. In the international finance literature, most researchers have relied on the capital asset pricing model (CAPM) in testing for financial market integration.

2.1 Using Stock-Market Data to Measure Financial Integration

According to the standard mean-variance portfolio theory developed by Sharpe (1964), Lintner (1965), and Black (1972), risk-averse investors who face the same investment opportunity set will choose the same optimal portfolio. The main idea of the International CAPM (Adler and Dumas 1983) is that, if financial markets are completely integrated, investors will have access to the same world investment opportunity set. Thus, if international financial markets are integrated, investors who reside in different countries will choose the same optimal world portfolio. Consistent with this idea, Bekaert and Harvey (1995) have defined market integration as a situation in which internationally traded assets with the same risk characteristics have identical expected returns across national financial markets. In this paper, we use a similar definition of financial integration. Specifically, we follow Bekaert, Harvey, and Ng (2003) and define that a national financial market is more integrated into the international financial market the stronger domestic returns depend upon the contemporaneous returns in the international financial market.

As a proxy for the international financial market, we use the MSCI indexes of the European and the World stock market. Using both European and the World stock market is reasonable because we use data for the G7 countries. For the European countries among the G7 countries the European stock market may have become relatively more important than the World stock market. In contrast, for the stock markets in the United States and Japan the World stock market is maybe more important. We downloaded the MSCI indexes of the European and the World stock market as well as the other MSCI stock-market data we use in order to measure financial integration from Thompson Financial Datastream. The data set we use covers the sample period from 1970:1 through 2000:12. Table 1 summarizes a number of important summary statistics of the returns of the MSCI stock market indexes we use in our empirical analysis.

— Insert Table 1 about here. —

2.2 Theoretical Foundations

Building on the condition of uncovered interest rate parity condition, one may derive the following condition of uncovered asset return parity:

$$E_{t-1}R_{t,i} = E_{t-1}R_{t,W} + E_{t-1}\Delta S_{t,i}\,, \tag{1}$$

where E_t denotes the conditional expectations operator, t denotes time, $R_{t,i}$ denotes returns in time t in country i, $R_{t,W}$ denotes world stock market returns, S_t denotes the logarithm of the nominal exchange rate, and Δ denotes the first-difference operator. Equation (1) stipulates that, in a no-arbitrage equilibrium, expected local returns in country i should be equal to the sum of the expected returns on investing in the world stock market and the expected rate of change of the exchange rate of country i. The *ex post* form of the condition in Equation (1) can be written as

$$R_{t,i} = R_{t,W} + \Delta S_{t,i}\,. \tag{2}$$

If one measures the stock market returns of country i and world stock market returns in a common currency (we use the U.S. dollar), then Equation (2) simplifies to $R_{t,i} = R_{t,W}$. If one takes, in addition, into account risk premia and potential impediments to cross-border capital flows that may affect international relative asset returns, then a generalized version of the condition of uncovered asset return parity is given by (see also Fratzscher 2002):

$$R_{t,i} = \gamma_{t,i,W} R_{t,W} + \phi_{t,i}\,, \tag{3}$$

where the term $\gamma_{t,i,W}$ captures the sensitivity of local returns with respect to world stock market returns. The term $\phi_{t,i}$, which captures all those factors that may drive a wedge between the returns in country i and in the rest of the world, may be decomposed into an expected and an unexpected component as follows:

$$\phi_{t,i} = \beta_{t,i} E_{t-1} R_{t,i} + \varepsilon_{t,i}\,. \tag{4}$$

Using this expression in Equation (3) gives

$$R_{t,i} = \beta_{t,i} E_{t-1} R_{t,i} + \gamma_{t,i,W} R_{t,W} + \varepsilon_{t,i}\,. \tag{5}$$

Equation (5) stipulates that the term $\gamma_{t,i,W}$ can be used as a measure of the integration of the stock market of country *i* with the world stock market. The term $\beta_{t,i}$, in contrast, measures time-variation in the degree of predictability of the stock market. As detailed in Section 2.3, we use lagged local returns as an instrument for time *t*-1 expectations of time *t* local returns.

2.3 Measuring the Time-Varying Nature of Financial Integration

Because financial integration may have undergone changes over time (Bekaert and Harvey 1995), we use a time-varying parameter model to quantitatively substantiate our definition of financial integration. A specific time-varying parameter model we use is the Kalman-filter model (see Harvey 1992; Kim and Nelson 2000). The advantage of the Kalman-filter model is that it allows time-varying parameters and latent factors to be taken explicitly into account. The reason for this is that the degree of integration of a financial market into the international financial market cannot be directly observed. Rather, it is a possibly time-varying latent factor which must be inferred from the data. It is, therefore, not surprising that the Kalman-filter model has been applied in the recent literature to measure financial integration. For example, Rockinger and Urga (2001) have used the Kalman-filter model to study whether the Central and Eastern European transition economies evolved toward greater integration with the international financial market over the 90s.

The Kalman-filter model has a further advantage over alternative approaches that have been used in the literature to measure financial integration. For example, many authors have relied on an instrument approach to account for time-variation in the degree of financial integration. In order to setup this approach, the time-variation in the degree of financial integration is captured by making financial integration dependent upon a set of instruments. The instruments can be thought of to represent the time variation in the information set available to international investors. The drawback of the instrument approach is that using a different set of instruments is likely to result in a different pattern of the time variation in the degree of financial integration. In contrast, in the Kalman-filter model, the data, and not some more or less arbitrary instruments, can determine the time variation in the information set available to international investors. Hence, as it has been emphasized by Rockinger and Urga (2001), modeling financial integration as a latent factor in a Kalman-filter model is a natural way of capturing the time variation in the information set available to international investors.

In order to measure the time-varying degree of financial integration of the G7 countries, we use the following Kalman-filter model:

$$z_{t,i} = \beta_{0,t,i} + \beta_{1,t.i} z_{t-1} + \beta_{2,t,i} z_{t,B} + u_{t,i}, \tag{6}$$

$$\beta_{m,t,i} = \beta_{m,t-1,i} + v_{m,t,i}, \tag{7}$$

$$u_{t,i} \sim i.i.d.N(0, \sigma^2_{u,i}), \tag{8}$$

$$v_{t,i} \sim i.i.d.N(0, \sigma^2_{v,i}), \tag{9}$$

$$E(u_{t,i} v_{m,t,i}) = 0, \tag{10}$$

where $i \in G7$, $B \in \{EU, WORLD\}$, $m = 0,1,2$, $t = 1,....,T$. Here and in the following, $z_{t,i}$ denotes the continuously compounded (U.S. dollar) returns on the MSCI stock index of country i and $z_{t,B}$ denotes the returns on a benchmark (European on World) MSCI stock index. Equation (6) stipulates that the returns in country i depend on a constant, the own lagged returns, and on the returns in the European stock market or the World stock market.[2] The coefficients, $\beta_{m,t,i}$, of this regression equation have a time index and can, thus, change over time. Equation (7) implies that the time-varying coefficients follow a random walk process. Hence, the only source of variation in $\beta_{m,t,i}$ is due to the variance of the error term, $v_{t,i}$. The error terms, $u_{t,i}$ and $v_{t,i}$, are independently normally distributed (Equations (8) and (9)) and are uncorrelated with each other (Equation (10)).

[2] One could also use both World and European MSCI financial returns in Equation (6). However, we decided to include only one of them due to a high coefficient of correlation between World and European returns.

It should be noted that our model enables us to control for potential financial market inefficiencies due to return predictability.[3] Recently, Fratzscher (2002) has stressed the importance of controlling for potential financial market inefficiencies in analyses of financial market integration. In our model, the slope coefficient $\beta_{1,t.i}$ captures the impact of potential financial market inefficiencies on returns. It should also be noted that our model is consistent with the International CAPM. In fact, if the lagged local returns and the contemporaneous global financial returns are used as pricing factors, one can interpret the respective slope coefficients as time-varying betas.

2.4 Implementing the Kalman-Filter Model

In order to implement the Kalman-filter model, two steps have to be taken.

1. Prediction: At the beginning of time t, an optimal predictor of $z_{t,i}$ is determined on the basis of all the available information up to time $t-1$: $z_{t|t-1,i}$. In order to be able to do this, one has to calculate $\beta_{m,t|t-1,i}$.
2. Updating: Once $z_{t,i}$ is observed at the end of time t, the prediction error can be calculated: $\eta_{t|t-1,i} = z_{t,i} - z_{t|t-1,i}$. This prediction error can then be used to collect additional information about $\beta_{m,t,i}$ beyond those contained in $\beta_{m,t|t-1,i}$. Hence, having observed $z_{t,i}$ at time t and having calculated the prediction error, $\eta_{t|t-1,i}$, the estimate of $\beta_{m,t,i}$ can be updated in the following way: $\beta_{m,t|t,i} = \beta_{m,t|t-1,i} + K_{t,i}\eta_{t|t-1,i}$, where $K_{t,i}$ denotes the weight assigned to new information about $\beta_{m,t,i}$ contained in the prediction error.

[3] Return predictability does not necessarily imply that the Efficient Market Hypothesis (Fama 1972, 1991) does not hold. Return predictability could also be due to, e.g., time-varying expected returns. Note, however, the time-varying intercept term of Equation (6) should also reflect time-variation in expected returns.

The computations that have to be carried out in order to take these two steps can be summarized by the following six equations (the notation follows Kim and Nelson 2000):

Prediction:

$$\beta_{t|t-1,i} = F_i \beta_{t-1|t-1,i}\,, \tag{11}$$

$$P_{t|t-1,i} = F_i P_{t-1|t-1,i} F_i{}' + Q_i\,, \tag{12}$$

$$\eta_{t|t-1,i} = z_{t,i} - z_{t|t-1,i} = z_{t,i} - x_{t,i}\beta_{t|t-1,i}\,, \tag{13}$$

$$\omega_{t|t-1,i} = x_{t,i} P_{t|t-1,i} x_{t,i}^{'} + \sigma_{u,i}^2\,, \tag{14}$$

Updating:

$$\beta_{t|t,i} = \beta_{t|t-1,i} + K_{t,i}\eta_{t|t-1,i}\,, \tag{15}$$

$$P_{t|t,i} = P_{t|t-1,i} + K_{t,i} x_{t,i} P_{t|t-1}\,, \tag{16}$$

where $K_{t,i} = P_{t|t-1,i} x'_{t,i} \omega_{t|t-1,i}^{-1}$ is the so-called Kalman gain, which determines the weight assigned to new information about $\beta_{m,t,i}$ contained in the prediction error. In Equations (11) – (16), we use the following notation:

$$\beta_{t,i} = (\beta_{0,t,i} \quad \beta_{1,t,i} \quad \beta_{2,t,i})'\,,\ x_{t,i} = (1 \quad z_{t-1,i} \quad z_{t,B})'$$

$$F_i = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}, \qquad Q_i = \begin{pmatrix} \sigma_{v,1,i}^2 & 0 & 0 \\ 0 & \sigma_{v,2,i}^2 & 0 \\ 0 & 0 & \sigma_{v,3,i}^2 \end{pmatrix},$$

Furthermore, $\beta_{t|t-1,i} = E[\beta_{t,i} \mid \Omega_{t-1}]$ denotes expectation, E, of $\beta_{t,i}$ conditional on information, Ω, up to $t-1$, $P_{t|t-1,i} = E[(\beta_{t,i} - \beta_{t|t-1,i})((\beta_{t,i} - \beta_{t|t-1,i})']$ denotes the covariance matrix of $\beta_{t,i}$ conditional on information up to time $t-1$, $\beta_{t|t,i} = E[\beta_{t,i} \mid \Omega_t]$ denotes the expectation (estimate) of $\beta_{t,i}$ conditional on information up to t, and $P_{t|t,i} = E[(\beta_{t,i} - \beta_{t|t,i})(\beta_{t,i} - \beta_{t|t,i})']$ denotes the covariance matrix of $\beta_{t,i}$ conditional on information up to time t. The term $z_{t|t-1,i} = E[z_{t,i} \mid \Omega_t] = x_{t,i}\beta_{t|t-1,i}$ denotes the forecast of $z_{t,i}$ given information up to time $t-1$, $\eta_{t|t-1,i} = z_{t,i} - z_{t|t-1,i}$ denotes the prediction error, $\omega_{t|t-1,i} = E[\eta^2_{t|t-1}]$ denotes the conditional variance of the prediction error, and $K_{t,i} = P_{t|t-1,i} x'_{t,i} \omega^{-1}_{t|t-1,i}$ denotes the Kalman gain, which determines the weight assigned to the new information about $\beta_{t,i}$ contained in the prediction error.

2.5 Filtered Versus Smoothed Estimates

When using the Kalman-filter model to estimate financial integration, one can either use the filtered or the smoothed estimates of the coefficients in order to measure financial integration. The difference between the filtered and the smoothed estimates lies in the information set one uses to compute these estimates (Kim and Nelson 2000). The filtered estimates refer to an estimate of the coefficients, $\beta_{m,t,i}$, based on information available up to time t. In contrast, smoothed estimates refer to an estimate of the coefficients, $\beta_{m,t,i}$, based on all available information in the entire sample. Because our aim is to study financial integration from the perspective of an international investor, we use the filtered estimates of the coefficients. The reason is that, at time t, an international investor, who seeks to choose a portfolio on the efficient mean-variance world-wide portfolio frontier, can only use information up to time t for making inferences about time-varying betas. In other words, as long as an international investor cannot foresee the estimate of the coefficients, $\beta_{m,T,i}$, at the end of the sample period, he or she cannot employ the backward recursion that must be implemented to infer the smoothed coefficient estimates, $\beta_{m,t|T,i}$. Moreover, the smoothed estimates, of course, depend upon the sample period used, which means that different sample periods (with a different T) would lead to different smoothed coefficient estimates, $\beta_{m,t|T,i}$.

2.6 The Time-Varying Nature of Financial Integration

We used a maximum likelihood estimator to estimate the Kalman-filter model outlined in Section 2.3 for each G7 country's MSCI returns.[4] The estimated parameters are summarized in Table 2, while Figure 1 depicts the time-varying regression coefficients of our Kalman-filter model.

— Insert Table 2 and Figure 1 about here. —

Several interesting results can be inferred from Figure 1. It is evident from Figure 1 that the degree of financial integration has undergone significant changes over time. Most interestingly, in general, the degree of financial integration has *not* increased monotonously during our sample period. The degree of financial integration shows a clear upward trend in the cases of Germany and Italy, and remained roughly constant in the case of France. In the cases of the United States and Canada, the degree financial integration tended to reach a trough in the early 1990s, but has since then increased again. In the case of Japan, the degree of financial integration showed a tendency to increase only if one uses the World stock market index as a benchmark index. Also, if one uses a World index as a benchmark, the degree of financial integration of the Japanese economy has started to decline in the second half of the 1990s when the Japanese bubble started to burst.

We obtain the perhaps most surprising results for the United Kingdom. In the case of the United Kingdom, we find no clear tendency that the degree of financial integration has increased over time. If the World market stock index is used as a benchmark, financial integration even showed a tendency to decrease over time. The reason for this finding could be that the coefficient, which captures the degree of financial integration of the United Kingdom, assumed a relatively high numerical value throughout the entire sample period, implying that the scope

[4] We used Gauss 3.6 to estimate the Kalman filter models. We acknowledge use of computer routines described in Kim and Nelson (1998).

for further increasing the degree of financial integration of the United Kingdom was limited.

Finally, some remarks regarding the predictive content of lagged stock index returns are in order. As regards the degree of predictability of stock index returns, for the majority of countries the predictive power of the own lagged stock index returns decreased, which may suggest that the efficiency of these markets increased. Italy may be an exception. But, in general, the coefficient that captures the predictability of stock index returns seems to be fairly constant and is, as indicated by the estimation results summarized in Table 2, hardly significant.

3. Financial Integration and Macroeconomic Dynamics

In order to trace out the possible interplay between financial integration and business-cycle fluctuations, we estimated a VAR. The vector of the endogenous variables of the VAR we estimated is defined by $Y_{t,i} \equiv (y_{t,i} \quad \pi_{t,i} \quad r_{t,i} \quad f_{t,i})'$. Here, the variable $y_{t,i}$ denotes output growth in country i, defined as month-to-month changes in the natural logarithm of seasonally adjusted industrial production. The variable $\pi_{t,i}$ denotes consumer price inflation in country i as measured in terms of month-to-month changes in the natural logarithm of the seasonally adjusted consumer price index. The variable $r_{t,i}$ denotes the short-term interest rate in country i.[5] Finally, the variable $f_{t,i}$ denotes the first difference of our measure of financial integration. We use the first difference of the measure of financial integration in order to account for the fact that integration not only varied widely during the sample period we study, but also showed a trend in some cases.

[5] We used one month Treasury bill rates. In the case of Germany, we used a three months money market rate because of data availability problems. In the case of Japan, we used a two months Treasury bill rate. We downloaded the Japanese data from the homepage of the Bank of Japan. We used the one month Treasury bill rate taken from Thompson Financial Datastream to fill some gaps in the Japanese series. In the case of Italy, we downloaded data on a money market rate from the IFS CD-Rom disseminated by the IMF.

The first three components of the vector of endogenous variables in our VAR model are those also used, e.g., by Rotemberg and Woodford (1996), and others. These three components can be thought of to represent the three basic building blocs of a simple macroeconomic model of a closed economy: a Phillips curve equation, an aggregate demand equation, and an interest rate rule that describes the policy of the central bank. These three components are also the basic components of, e.g., the canonical closed-economy New Keynesian Model, which has been widely used in recent years for policy analysis (see Clarida et al. 1999; Goodfriend 2002).[6] Because we do not wish to study a closed economy, we included our measure of financial integration as the fourth component, $f_{t,i}$, in the vector of the endogenous variables of our VAR model.

Clearly, our VAR model provides a very stylized representation of macroeconomic dynamics in an open economy. Yet, it has the advantages that it (i) provides a parsimonious model of the business cycle of an open economy, and (ii) is consistent with standard macroeconomic theories of business-cycle fluctuations.

3.1 Representation of the VAR

The reduced form representation of the systems to be estimated is given as below:

$$Y_{t,i} = A_{0,i} + \sum_{j=1}^{p} A_{j,i} Y_{t-j,i} + e_{t,i} , \tag{17}$$

where $A_{0,i}$ is a (4×1) vector of constants, $A_{j,i}$ are (4×4) matrices of coefficients, and $e_{t,i}$ represents a (4×1) disturbance vector. Using ordinary least squares, consistent and asymptotically efficient estimates of the coefficients of the reduced form representation of the VAR obtain. We determined the lag length, p, of our VAR by minimizing the Schwartz–Bayesian Criterion. Because this

[6] Of course, there is no simple one-to-one link between the canonical New Keynesian Model and VAR models of the type we use in this paper. See Leeper and Zha (2001) for a discussion.

criterion implied that a relatively short lag length should be chosen, we included two lags of the vector endogenous variables in all VARs we estimated.

As long as the roots of the characteristic equation of the VAR in equation (17) can be found inside the unit circle, the unrestricted VAR can be represented in its infinite vector moving average representation as (neglecting the matrix of constants)

$$Y_{t,i} = \sum_{j=0}^{\infty} L^j U_{j,i} e_{t,i} , \tag{18}$$

where $U_{j,i}$ denotes a (4×4) matrix comprising the coefficients of the reduced system and L denotes the lag operator. The infinite moving average representation of the underlying structural model is given by:

$$Y_{t,i} = \sum_{j=0}^{\infty} R_{j,i} \varepsilon_{i,i} , \tag{19}$$

where $R_{j,i}$ denotes a (4×4) matrix and $\varepsilon_{t,i}$ is the vector of orthogonal serially uncorrelated structural shocks.

These structural shocks can be identified from the sequence of the residuals of the reduced-form VAR upon invoking a set of identifying restrictions on the VAR. Several alternative identification strategies for VARs have been studied in the literature. We employed an identification scheme proposed by Sims (1980), who has suggested obtaining a unique Choleski decomposition of the residuals of the reduced-form VAR by imposing a specific ordering of the endogenous variables included in the VAR. The ordering of a set of time series in a VAR implies that a shock to a variable placed in a lower position of this ordering scheme exerts no contemporaneous effect on the variables placed in a relatively higher position of the ordering. In contrast, a shock to a variable placed in a higher position of this ordering scheme exerts a contemporaneous effect on the variables placed in a relatively lower position of the ordering.

3.2 Ordering of the Variables in the VAR

The ordering scheme we use in this paper implies that the variables are ordered as follows: $(y_{t,i} \quad \pi_{t,i} \quad r_{t,i} \quad f_{t,i})$. Thus, we place financial integration in the lowest position of the ordering. This ordering captures the idea that financial markets may be forward-looking and may instantaneously jump if new information arrives at the market. If this is indeed the case, then it can be argued that our measure of financial integration reacts contemporaneously to all shocks hitting the VAR and should, in consequence, be placed in the lowest place of the ordering of the endogenous variables in our VAR model. In all other respects, our ordering scheme is based on a "conservative" identification strategy. The reason for this is that the ordering of the three other endogenous variables industrial production, consumer price inflation, and the short-term interest rate is rather standard. It implies that, possibly due to decision lags, consumer price inflation and industrial production do not respond to contemporaneous shocks in the interest rate equation and in the equation for financial integration. Thus, as in Gali (1992), our ordering captures the idea that consumer price inflation and industrial production are not directly affected by such shocks. Rather, they are only indirectly affected through the change in financial conditions such shocks bring about. The fact that industrial production does not respond contemporaneously to shocks to the equation for consumer price inflation captures the notion that pricing decisions can be revised more timely than purchasing decisions.

3.3. Empirical Results

We use impulse response functions in order to analyze the properties of our VAR model. The impulse response functions we plot in Figure 2 summarize our estimation results. The impulse response functions plotted in this figure summarize the response of our measure of financial integration to a unit shock to the equation for consumer price inflation (a shock one could interpret as a supply shock), to the equation for industrial production (a shock one could interpret as a real aggregate demand shock), and to the equation for the short-term interest rate (a shock one could interpret as a monetary policy shock). Together with the impulse response functions we plot 95 percent confidence bands, which we obtained upon running Monte Carlo simulations (1000 simulation runs).

— Insert Figure 2 about here. —

The impulse response functions reveal that the impact of the three shocks on the degree of financial integration is not significantly different from zero in the majority of countries. There are, however, a few interesting exceptions. For example, in the case of France, a real aggregate demand shock (a cost push shock) results in a significant and persistent decrease (increase) in financial integration if a World stock market index is used as a benchmark.. In the case of Germany, a cost push shock exerts a significant and persistent negative effect on financial integration if a European stock market index is used as a benchmark. If a World stock market index is employed as a benchmark, the effect of a monetary policy shock on financial integration is significantly negative and highly persistent. In the case of Italy, both an aggregate real demand shock and a monetary policy shock tend to result in a significant decrease in the degree of financial integration if a World stock market index is used as a benchmark. In the case of Japan, a real aggregate demand shock and a cost push shock result in a significant and persistent decline in financial integration if the European stock market index is used as a benchmark. As for the United Kingdom, a cost push shock has a significantly positive and highly persistent influence on the degree of financial integration with the World financial market. In the case of the United States, a cost push shock (a real demand shock) has a positive (negative) and persistent impact on financial integration.

In order to analyze the robustness of our results with respect to the ordering scheme we use in order to identify our VAR, we also used two alternative ordering schemes. In the first alternative ordering scheme, the variables are ordered as follows: $(y_{t,i} \quad \pi_{t,i} \quad f_{t,i} \quad r_{t,i})$. The attractive feature of this ordering is that the short-term interest rate can react contemporaneously to a shock to financial integration. In the second alternative ordering scheme, the variables are ordered in yet a different way: $(\pi_{t,i} \quad y_{t,i} \quad f_{t,i} \quad r_{t,i})$. This ordering reflects the idea that inflation may be very "sticky" and that it, therefore, may not react contemporaneously to the other endogenous variables we include in our VAR. We found that the main conclusions we draw from our VAR-based analysis do not depend upon which of the three orderings we use, so we report in Figure 2 only the results for the ordering $(y_{t,i} \quad \pi_{t,i} \quad r_{t,i} \quad f_{t,i})$, i.e., the ordering in which we place financial integration in the lowest place.

In a nutshell, the main results of our VAR-based analysis can be summarized as follows: 1) The broad picture that emerges from inspecting the impulse response functions shown in Figure 2 is that business-cycle fluctuations do not give rise to significant changes in the degree of financial integration in the G7 countries. 2) A real aggregate demand shock tends to result in the majority of countries in a decrease in the degree of financial integration. 3) The sign of the effect a cost push shock varies across countries. 4) A monetary policy shock in general results in a decrease in the degree of financial integration. 5) Even if the impulse response functions are not significantly different from zero, the three shocks under consideration tend to have a persistent effect on financial integration.

4. Conclusions

The results of our analysis of the link between business-cycle fluctuations and financial integration have interesting implications for macroeconomic theory. They clearly imply that one can conclude that the widely-used *ceteris paribus* assumption that the degree of financial integration can be taken as exogenous when one analyzes the propagation of shocks in macroeconomic models of open economies seems to be a good approximation of real-world data. We think that this is an important result. It lends support to the assumption that the degree of financial integration can be taken as exogenously given at business-cycle frequencies, an assumption most often invoked in the literature on open-economy macroeconomics. Hence, our results demonstrate that, as a rule, this assumption provides a good approximation of the interplay between business-cycle fluctuations and financial integration.

Our results also reveal that, in the case of the G7 countries, there are a few exceptions from this rule. This result and the result that the effect of a shock on financial integration is in general highly persistent indicate that there are cases in which economists and policy makers alike should take into consideration that shocks that hit a G7 economy may bring about changes in the degree of financial integration.

Furthermore, from the viewpoint of economy theory, it is interesting to note that we find that both an aggregate real demand shock and a monetary policy shock tends to result in the majority of countries in a decrease in the degree of financial integration. If one uses the popular basic textbook version of the canonical Mundell-Fleming model as a reference model for the analysis of the propagation of such shocks, then this finding implies that, in a flexible exchange rate system, a real demand shock (e.g., a fiscal policy shock) should have a stronger impact on aggregate output than implied by the Mundell-Fleming model. In contrast, a monetary policy shock should have a smaller impact on aggregate output than implied by the Mundell-Fleming model. The reason for this is that the basic textbook Mundell-Fleming model implies that, in a flexible exchange rate system, the output effect of a real demand (monetary policy) shock is a decreasing (an increasing) function of the degree of financial integration of an open economy.

Of course, one should not stretch this interpretation too far. More advanced models than the simple textbook version of the Mundell-Fleming model have different implications for the impact of changes in the degree of financial integration for the dynamic macroeconomic effects of real and monetary policy shocks. Also, before definitive policy conclusions can be drawn from the type of analysis we have done in this paper, more empirical research needs to be done. In future empirical research, alternative measures of financial integration and more complex VAR models could be use to study the link between the determinants of business-cycle fluctuations and financial integration. Given that the degree of financial integration plays such a central role in many macroeconomic theories, our results indicate that such research on the link between business-cycle fluctuations and financial integration can deepen our understanding of how shocks propagate through an open economy.

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Table 1 — Summary Statistics of Returns of MSCI Stock Market Indexes

This table summarizes a number of summary statistics of the continuously compounded returns of the MSCI stock market indexes we use in our empirical analysis.

Country	*Germany*	*Canada*	*France*	*Italy*	*USA*	*UK*	*Japan*	*Europe*	*World*
Mean	0.007033	0.005560	0.007170	0.003932	0.006720	0.006486	0.008675	0.006946	0.006651
Median	0.008340	0.007346	0.007480	0.004897	0.006983	0.003068	0.005510	0.008662	0.006484
Maximum	0.189353	0.147958	0.222997	0.270161	0.159578	0.445217	0.225173	0.207766	0.133356
Minimum	-0.233562	-0.189538	-0.310973	-0.308910	-0.181103	-0.204974	-0.226830	-0.166586	-0.140998
Std. Dev.	0.057031	0.054301	0.066062	0.076373	0.042758	0.064341	0.063277	0.045803	0.039905
Skewness	-0.392965	-0.412693	-0.470194	-0.142971	-0.289637	0.703569	0.068537	-0.305225	-0.280981
Kurtosis	4.256294	4.104624	5.183722	3.907980	4.463822	8.784025	3.768577	4.927772	4.148977
Jarque-Bera	33.94589	29.39334	87.38550	14.00819	38.31089	547.7657	9.421839	63.20840	25.28904
Observations	371	371	371	371	371	371	371	371	371

Table 2A — Estimated Parameters of the Kalman-Filter Model. Financial Integration vis-à-vis Europe

Country	*Germany*	*Canada*	*France*	*Italy*	*USA*	*UK*	*Japan*
$\overline{\hat{\beta}}_0$	0.198764	0.236567	-0.109144	-0.598866	0.245028	-0.030046	0.699971
$\overline{\hat{\beta}}_1$	-0.111789	0.058229	-0.028393	-0.000498	-0.021441	-0.024134	0.019955
$\overline{\hat{\beta}}_2$	0.863881	0.599358	0.971918	0.846761	0.506339	1.123576	0.584754
$\overline{\hat{\sigma}}^2_{\hat{\beta}_0}$	0.356289	0.406181	0.423338	0.569363	0.357798	0.319745	0.801947
$\overline{\hat{\sigma}}^2_{\hat{\beta}_1}$	0.081482	0.080185	0.070085	0.121894	0.069765	0.046369	0.090004
$\overline{\hat{\sigma}}^2_{\hat{\beta}_2}$	0.180304	0.250821	0.096716	0.306562	0.070109	0.290253	0.117760
$\hat{\sigma}^2_u$	15.89856	20.24010	22.96614	40.01195	12.22761	11.98683	33.22024
$\hat{\sigma}^2_{0,v}$	0.000000	0.000000	0.000000	0.000000	0.000467	0.000000	0.009044
$\hat{\sigma}^2_{1,v}$	0.000041	0.000000	0.000000	0.000117	0.000000	0.000000	0.000000
$\hat{\sigma}^2_{2,v}$	0.001096	0.003352	0.000000	0.000630	0.000000	0.010020	0.000000
LogL	-1011.9108	-1057.3958	-1072.0315	-1177.5237	-958.9748	-975.9990	-1139.408

Table 2B — Estimated Parameters of the Kalman-Filter Model. Financial Integration vis-à-vis World

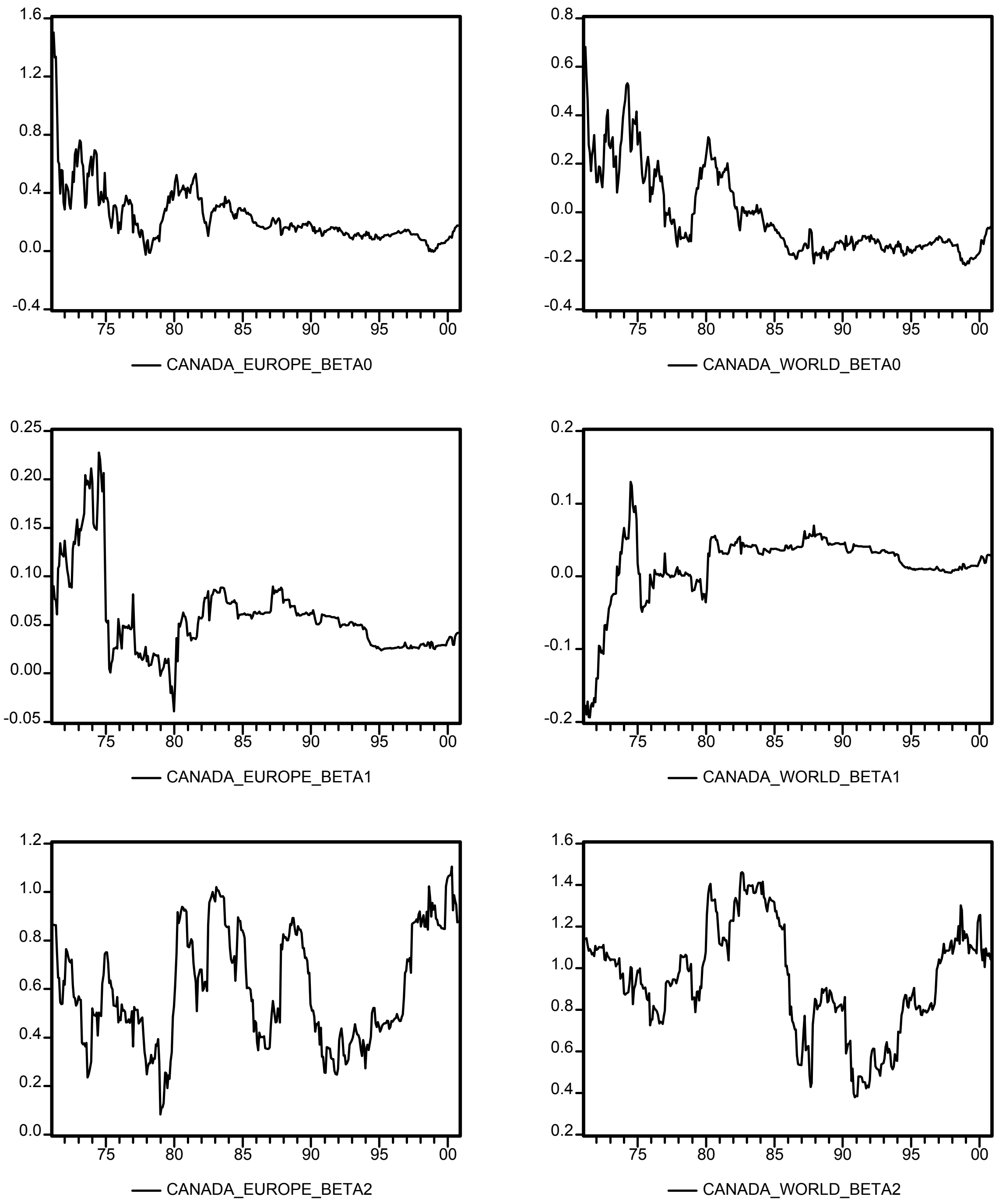
Country	*Germany*	*Canada*	*France*	*Italy*	*USA*	*UK*	*Japan*
$\bar{\hat{\beta}}_0$	0.191880	-0.015275	-0.122931	-0.577572	0.071308	-0.054062	0.226484
$\bar{\hat{\beta}}_1$	-0.040055	0.015457	0.018138	0.011720	-0.062253	0.012609	0.035673
$\bar{\hat{\beta}}_2$	0.691189	0.945443	0.825342	0.676249	0.893888	1.003019	1.113111
$\bar{\hat{\sigma}}^2_{\hat{\beta}_0}$	0.432896	0.346655	0.492613	0.630013	0.308805	0.439820	0.709039
$\bar{\hat{\sigma}}^2_{\hat{\beta}_1}$	0.088202	0.069336	0.113574	0.140298	0.049678	0.066259	0.069650
$\bar{\hat{\sigma}}^2_{\hat{\beta}_2}$	0.163045	0.239096	0.124435	0.194741	0.141313	0.267491	0.278410
$\hat{\sigma}^2_u$	23.59919	14.66124	30.80916	49.06302	4.391120	24.01000	20.03010
$\hat{\sigma}^2_{0,v}$	0.000000	0.000000	0.000000	0.000000	0.001340	0.000000	0.009584
$\hat{\sigma}^2_{1,v}$	0.000026	0.000000	0.000098	0.000193	0.000014	0.000002	0.000000
$\hat{\sigma}^2_{2,v}$	0.000303	0.002894	0.000000	0.000219	0.001296	0.002767	0.003552
LogL	-1080.9565	-1001.9281	-1128.3394	-1212.4699	-790.2377	-1088.1201	-1060.1583

Figure 1 — Kalman-Filter Estimates of Time-Varying Financial Integration

This figure depicts Kalman-filter estimates (see equations (6)-(10) in section 2.3) of the time-varying parameters $\beta_{0,t}$, $\beta_{1,t}$ and $\beta_{2,t}$ for the G7 countries (Canada, France, Germany, Italy, Japan, UK and US). $\beta_{0,t}$ denotes the time-varying intercept, $\beta_{1,t}$ denotes the time-varying predictability (efficiency) of a given G7 market, and $\beta_{2,t}$ denotes the time-varying degree of financial integration. The left (right) column of the panels depicts the estimates for the model in which we use the European (World) market as a benchmark.

PANEL A: Canada

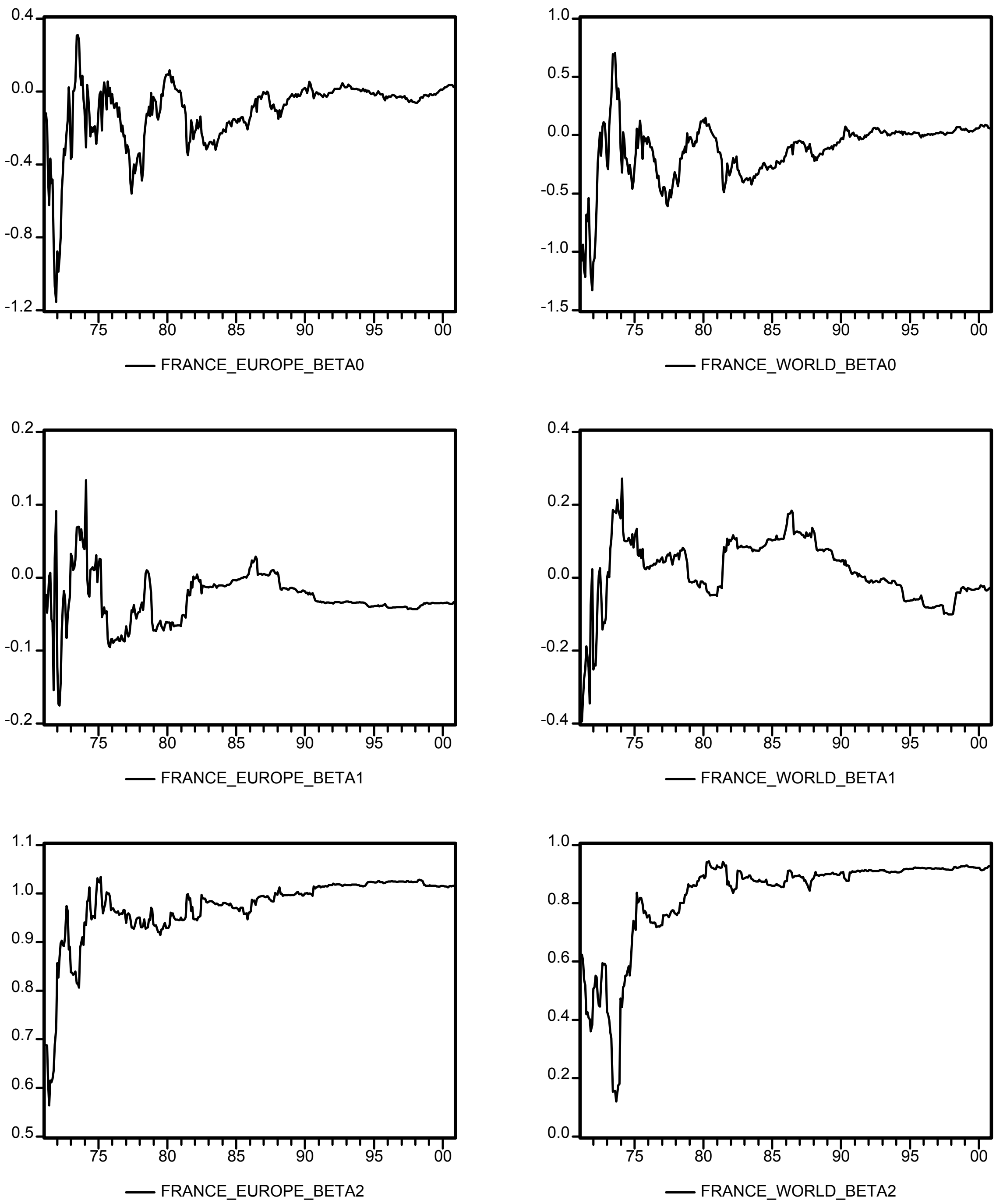
EU **WORLD**



(Figure 1 cont.)

PANEL B: France

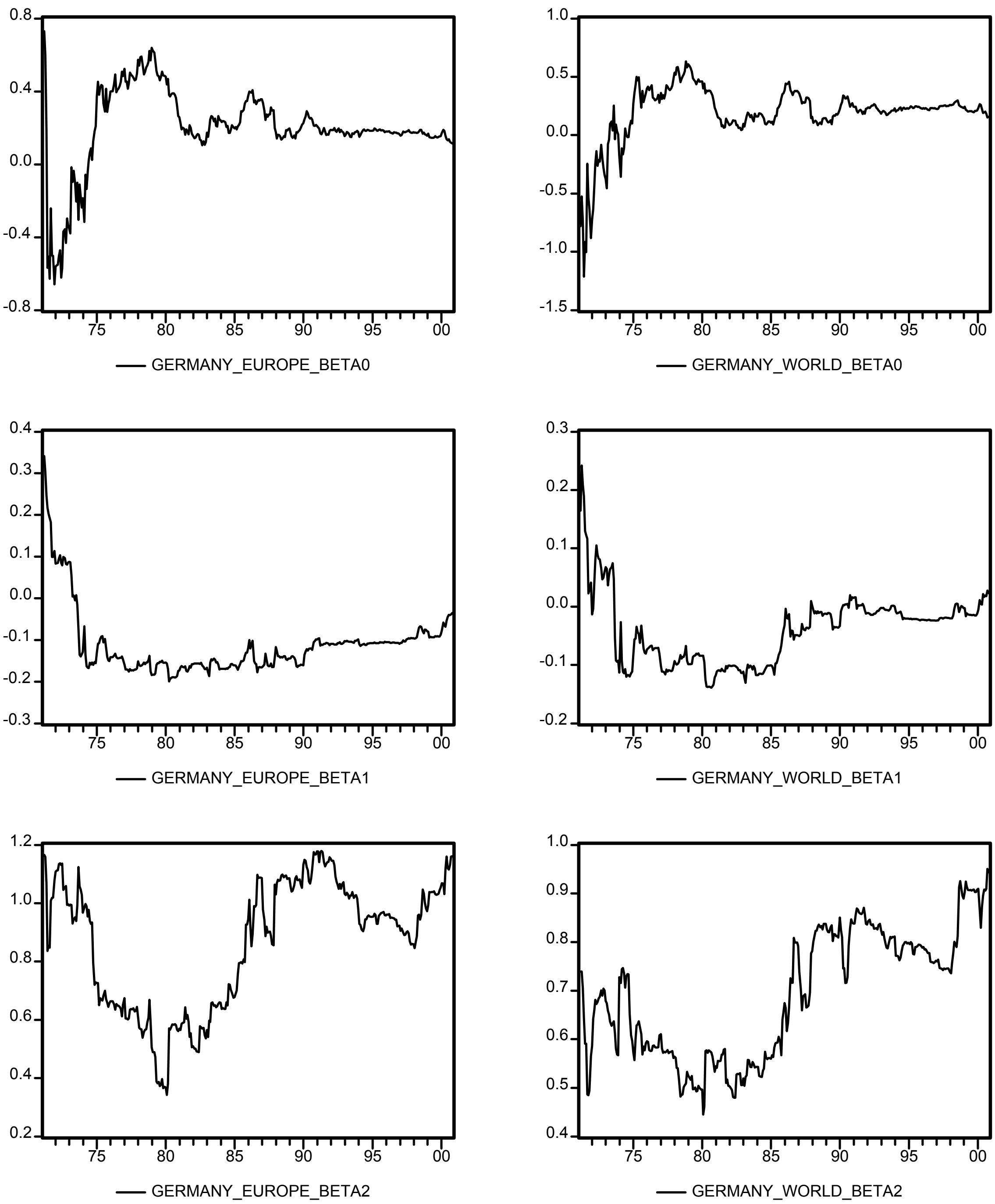
EU **WORLD**



(Figure 1 cont.)

PANEL C: Germany

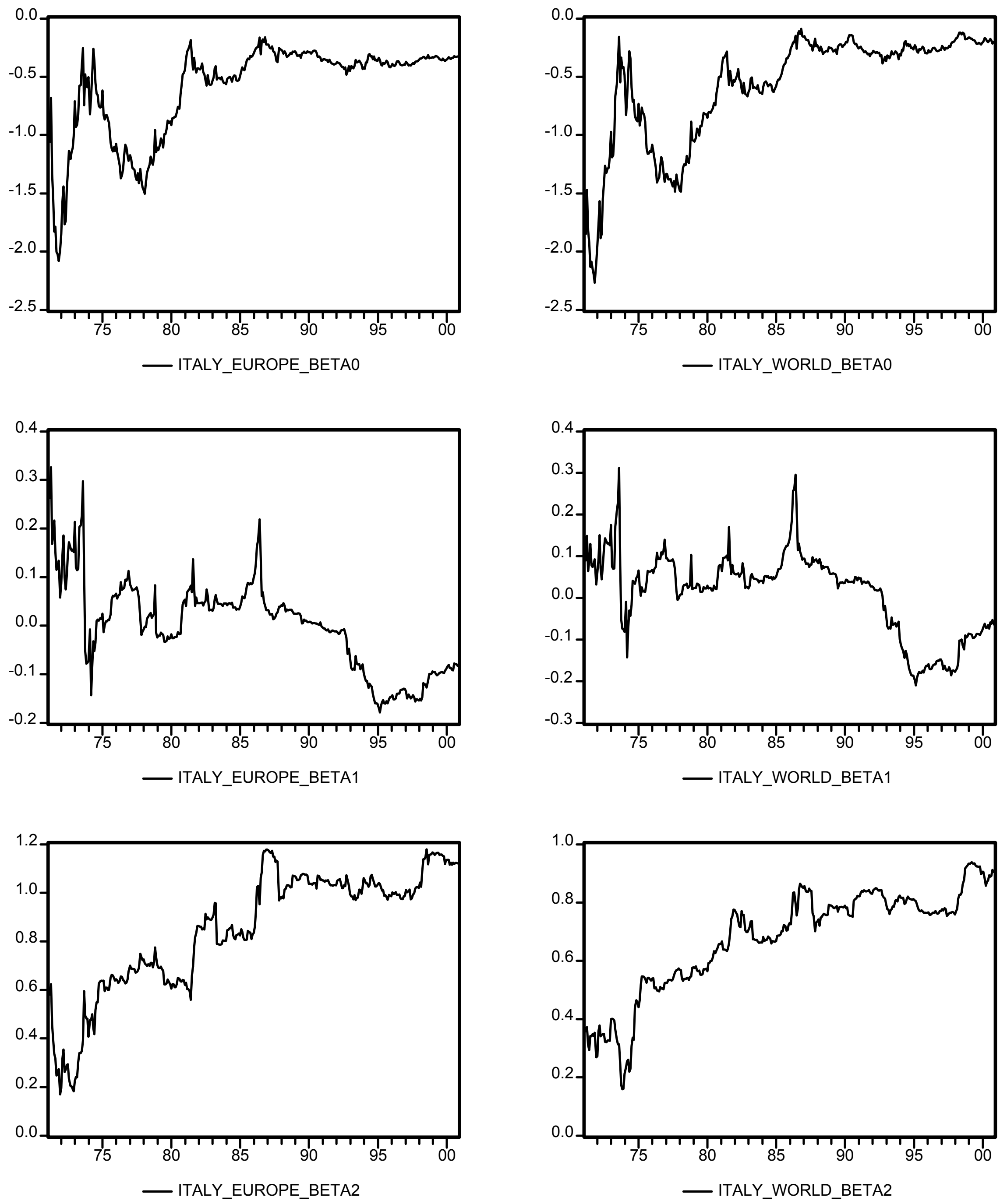
EU **WORLD**



(Figure 1 cont.)

PANEL D: Italy

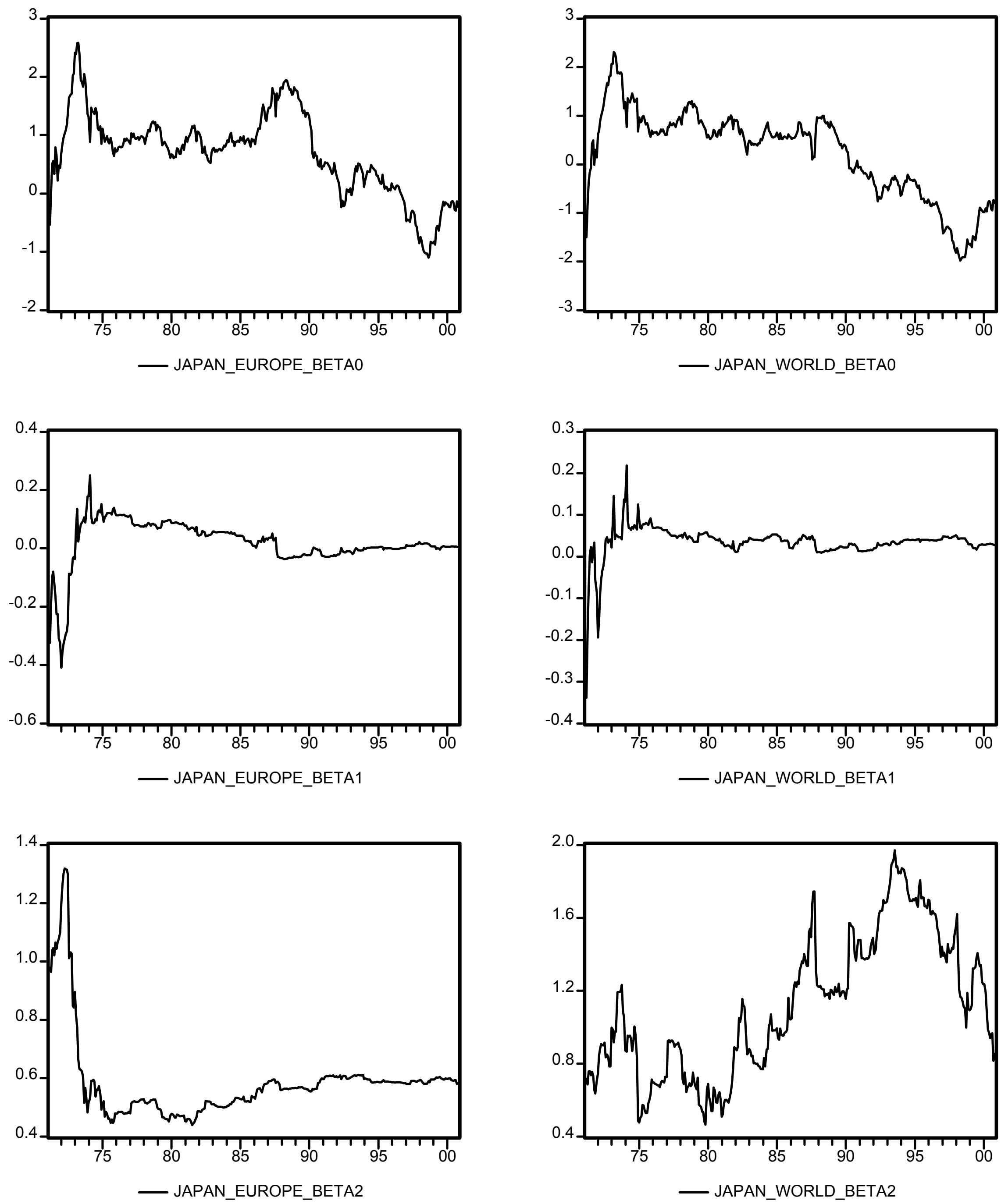
EU **WORLD**



(Figure 1 cont.)

PANEL E: Japan

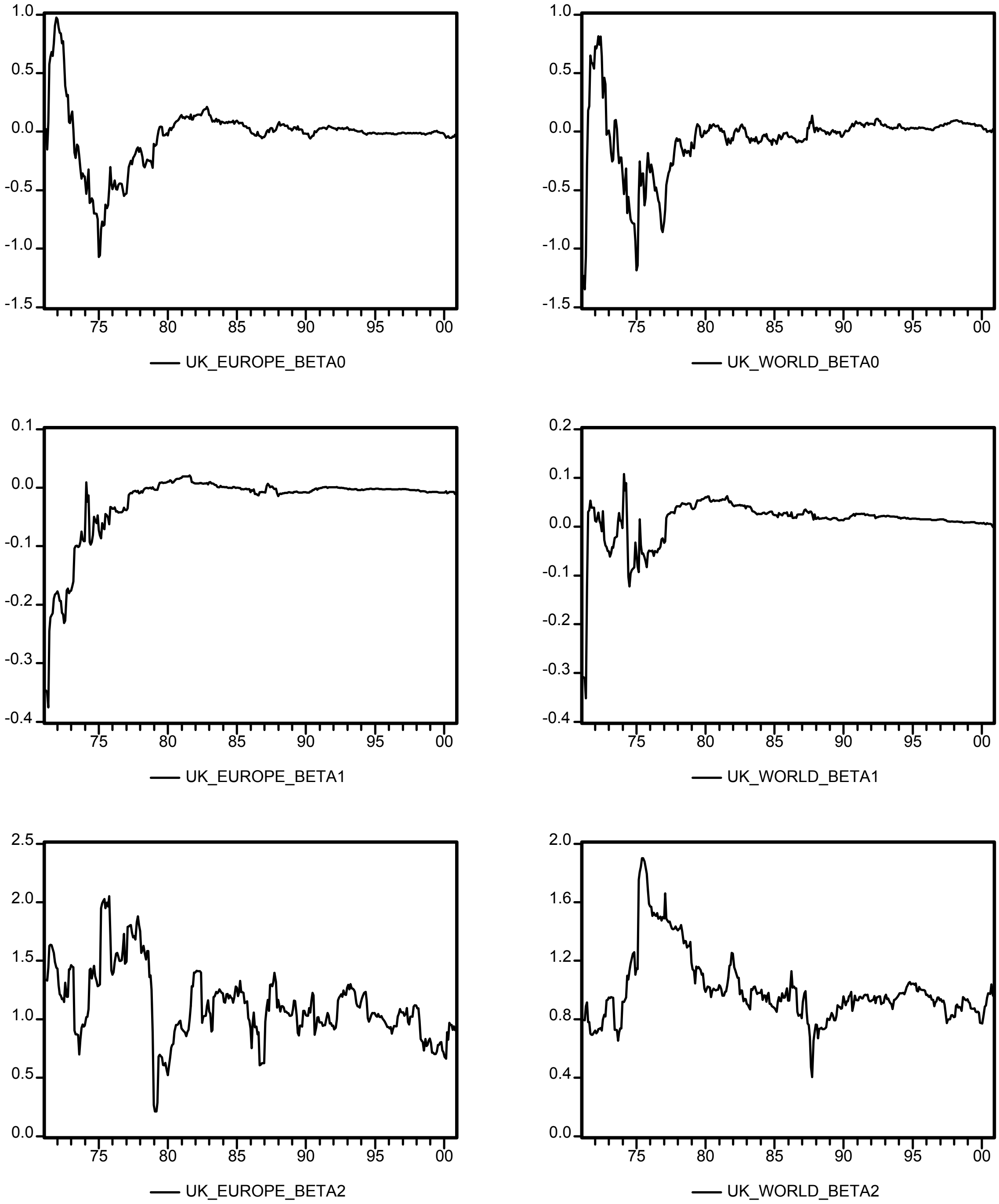
EU **WORLD**



(Figure 1 cont.)

PANEL F: United Kingdom

EU **WORLD**



(Figure 1 cont.)

PANEL G: United Sates

EU **WORLD**

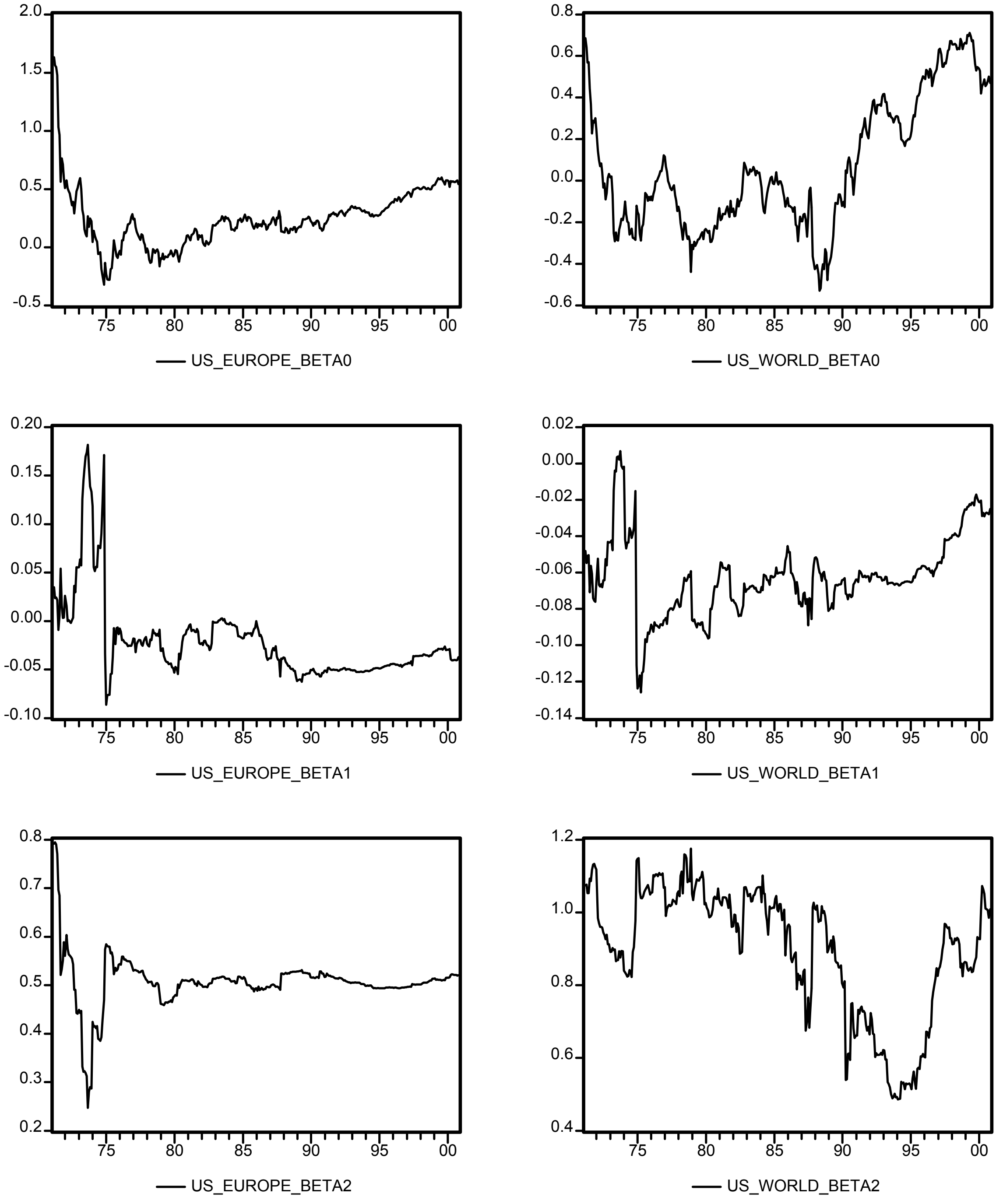
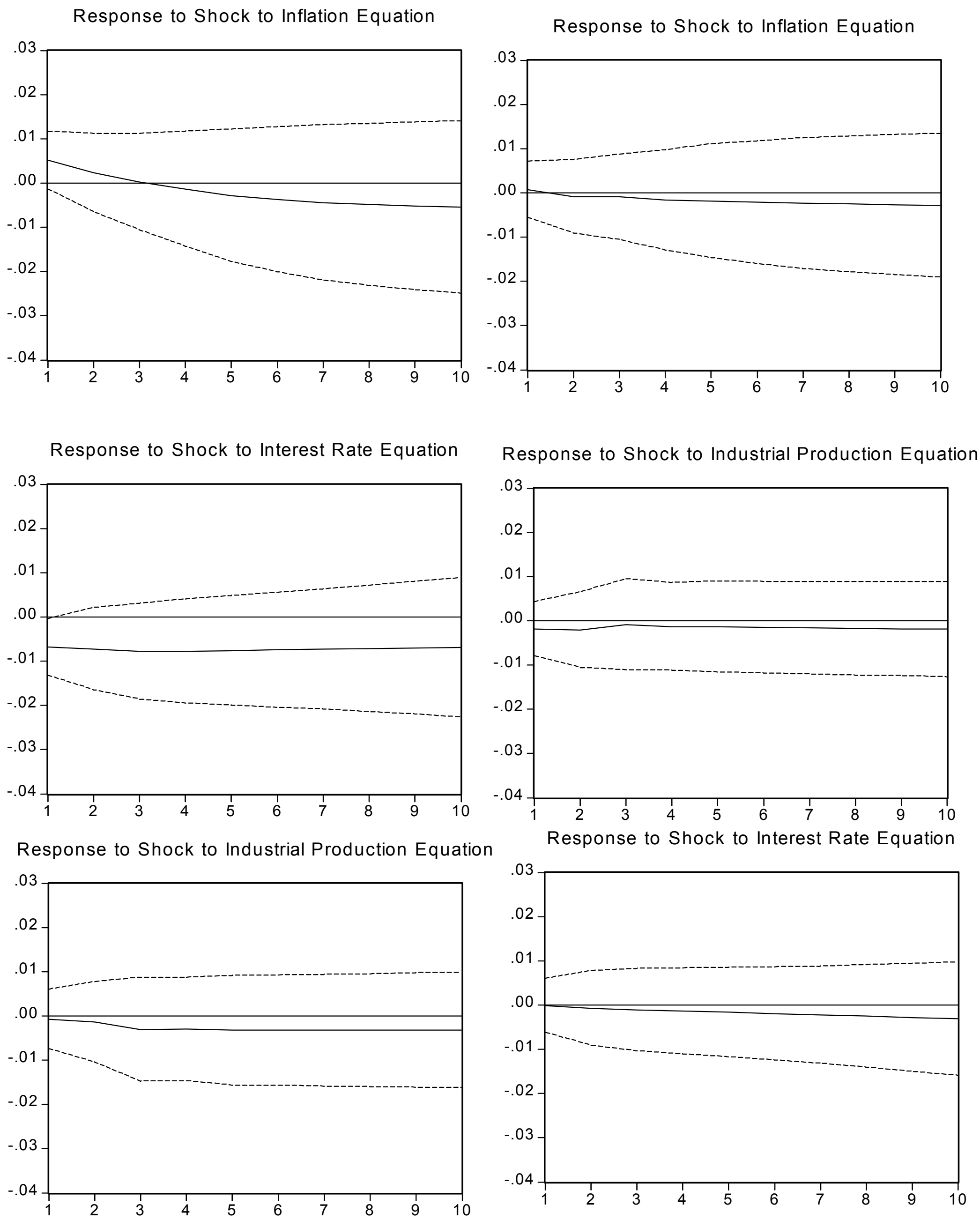


Figure 2 — Business-Cycle Fluctuations and Changes in the Degree of Financial Integration

This figure depicts accumulated impulse response functions for a VAR including a constant and the inflation rate of the natural logarithm of the consumer price index, the first difference of the natural logarithm of industrial production, the short-term interest rate, and the first-difference of our measure of financial integration as endogenous variables. We include two lags of the endogenous variables in the VAR. In order to identify the impulse response functions, we use a Choleski decomposition, where the order of the variables is: industrial production, inflation rate, short-term interest rate, financial integration. Dashed lines denote the boundaries of 95 percent confidence bands. In order to generate the confidence bands, we ran Monte Carlo simulations (1000 simulation runs). We estimate the VAR over the period 1970:1 – 2000:12. (For Italy, our data on the short-term interest rate start in 1977:3.)

PANEL A: Canada

EU **World**

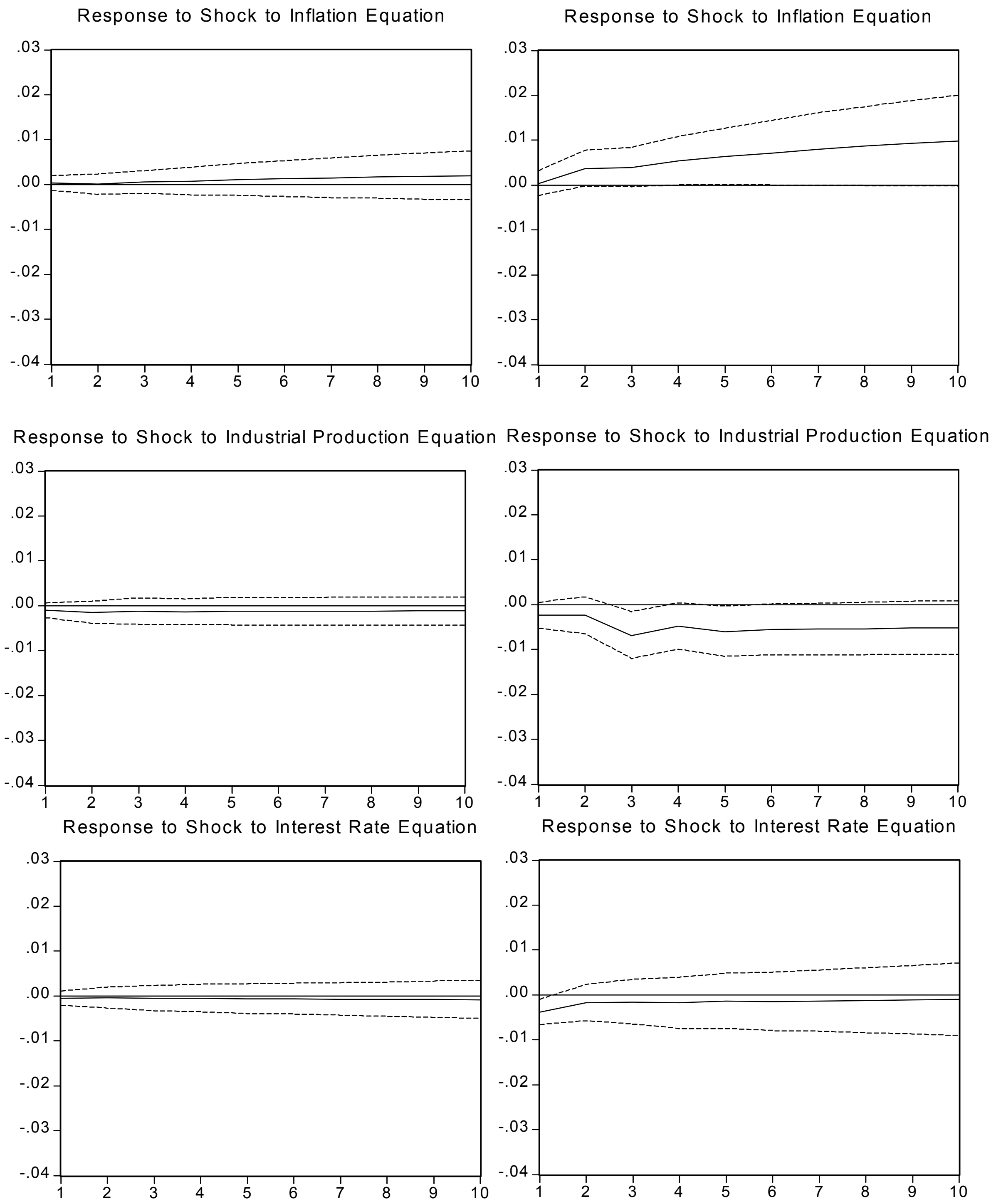


(to be cont.)

(Figure 2 cont.)

PANEL B: France

EU **World**

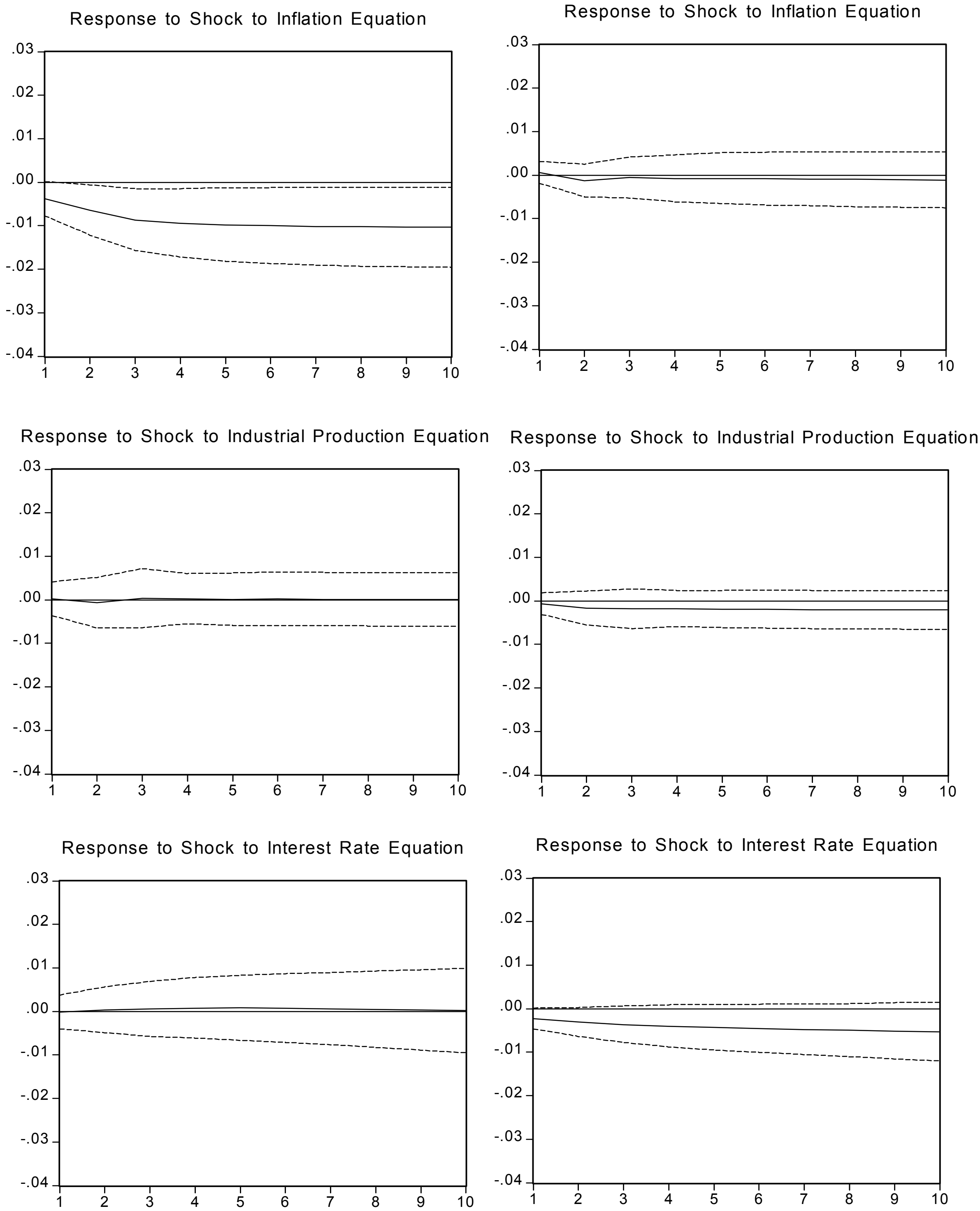


(to be cont.)

(Figure 2 cont.)

PANEL C: Germany

EU **World**

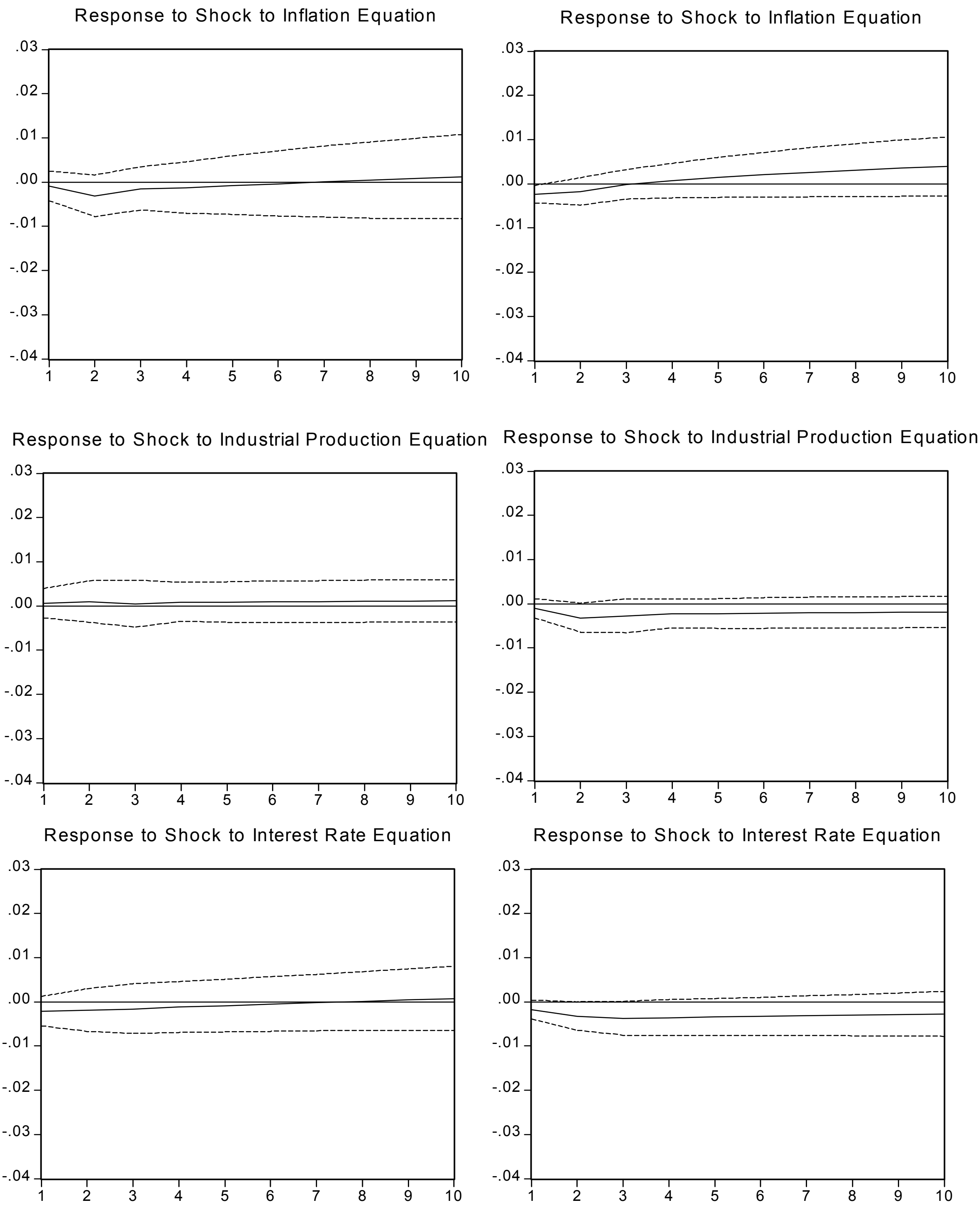


(to be cont.)

(Figure 2 cont.)

PANEL D: Italy

EU **World**

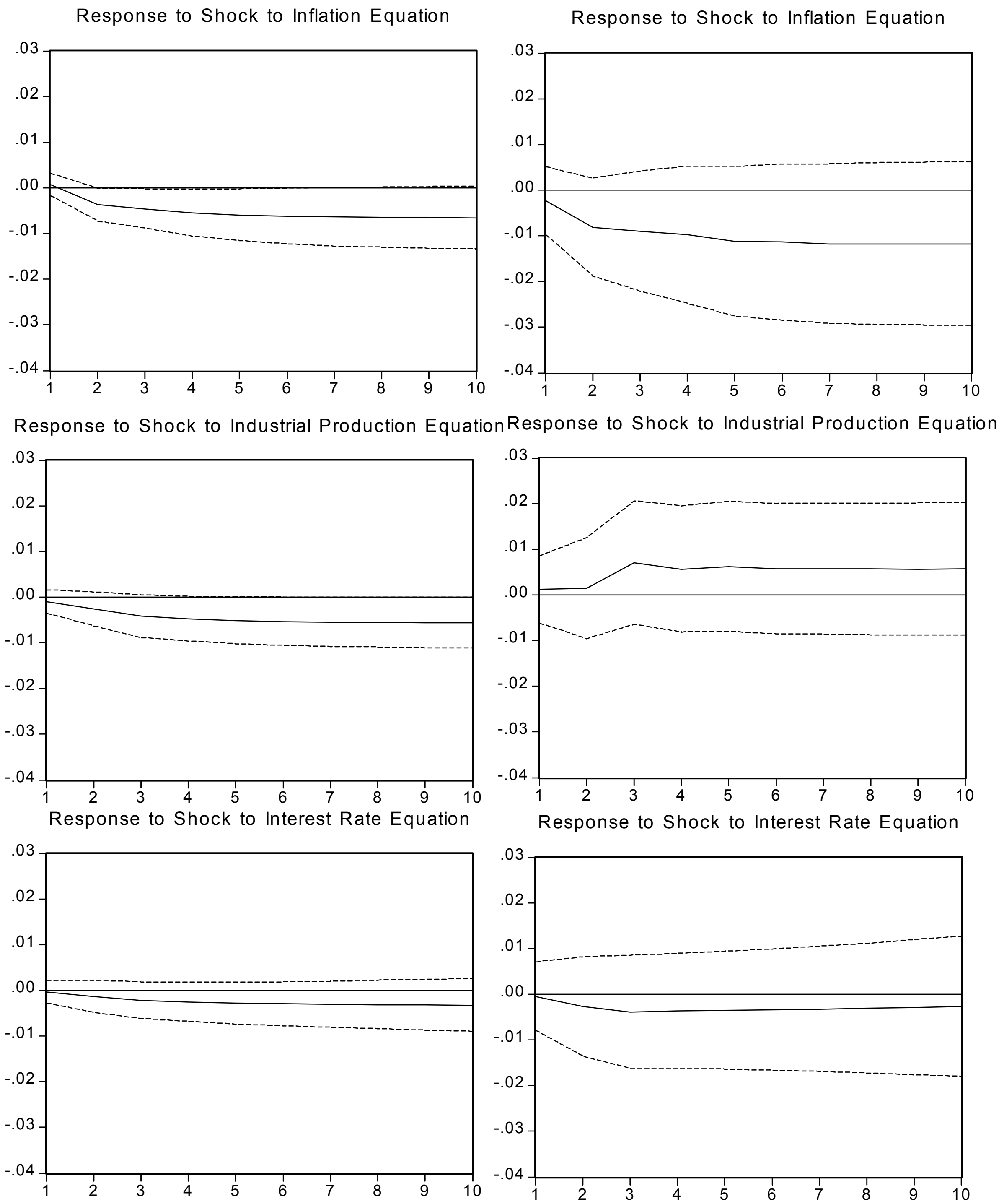


(to be cont.)

(Figure 2 cont.)

PANEL E: Japan

EU **World**

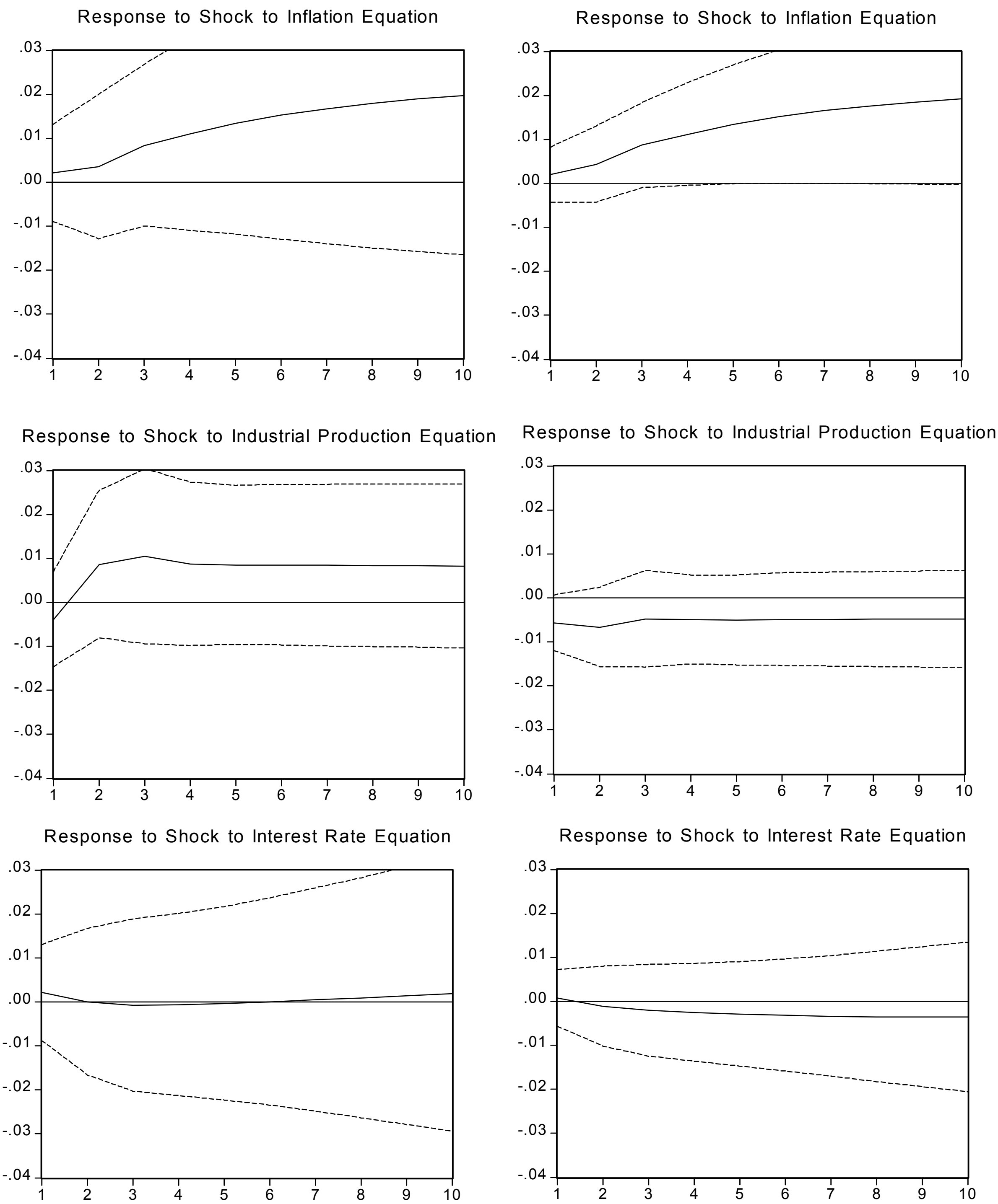


(to be cont.)

(Figure 2 cont.)

PANEL F: UK

EU **World**



(to be cont.)

(Figure 2 cont.)

PANEL G: USA

EU **World**