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Predicting Cycles in Economic Activity

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Abstract:

Predicting cycles in economic activity is one of the more challenging but important aspects of economic forecasting. This paper reports the results from estimation of binary probit models that predict the probability of an economy being in a recession using a variety of financial and real activity indicators. The models are estimated for eight countries, both individually and using a panel regression. Although the success of the models varies, they are all able to identify a significant number of recessionary periods correctly.

Keywords: forecasting, turning points, business cycles, economic indicators

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I. Introduction

Accurate prediction of cycles in economic activity is one of the more challenging aspects of economic forecasting. At the same time, it is of key importance for policymaking. Expansionary policy may be appropriate when an economy is contracting, but once a turning point has been reached, the authorities may want to begin to shift to a more neutral stance fairly quickly. Similarly, policymakers do not want to allow an economy to overheat, but if a peak has been reached, they may want to switch early to stimulus to prevent a downward spiral. However, because business cycles are often highly influenced by forces that are hard to model, such as consumer and business confidence, structural models often have difficulty capturing cyclical turning points.

An alternative approach for predicting turning points is the estimation of binary probit models, which calculate the probability that an economy is in either an expansion or a contraction. When the estimated probability crosses a specified threshold, a turning point is predicted. This type of approach has been applied to prediction of recessions in U.S. GDP by Estrella and Mishkin (1998), using financial indicators as explanatory variables. Chin, Geweke, and Miller (2000) apply a similar methodology to the prediction of turning points in monthly unemployment rates. These techniques are also similar in some respects to models that assess the probability of financial crises within a specific time period in developing economies.[1]

This paper uses monthly data from eight countries (the United States, Canada, Japan, Germany, the United Kingdom, Mexico, Korea, and Taiwan) to estimate the

[1] See Edison (2000), Kaminsky and Reinhart (1999), and Kaminsky, Lizondo, and Reinhart (1998).

probability that these economies will be in either an expansion or contraction in a specific month, with both real and financial indicators as explanatory variables. Specifically, binary probit models in which the dependent variable takes on the value 0 during an expansion and 1 during a recession are estimated using lags of the explanatory variables that range from one to three months, depending on their relative timeliness. The time horizon has been deliberately kept short because the relationships become much less reliable further out. However, the indicators are generally available on a much more timely basis than is GDP; partial monthly data for financial indicators are available nearly in real time. Using indicators that are all lagged by at least one month, it is, for example, possible in October to make an assessment of the probability that an economy is currently in a recession, while fourth-quarter GDP for many regions will not be available until February or March.

As noted above, the model is applied to eight countries, which were chosen mainly because of availability of long time series for the explanatory variables. All of the countries except Mexico have data available back to the 1970s, and Mexico's is available beginning in 1980.

The models were estimated both for the individual countries and using a panel regression. The results vary widely, but overall suggest that this type of model can play a useful role in forecasting cyclical activity. The paper is organized as follows: section 2 describes the data in general terms, with more detail provided in Appendix 1. Section 3 describes and evaluates the individual country models, and section 4 does the same for the panel regression. Section 5 concludes.

II. Data

The recessionary and expansionary periods used in the model are based on monthly business cycle peaks and troughs identified by the NBER for the United States, by Statistics Canada for Canada,[2] and by Economic Cycle Research Institute (ECRI) for the other countries. The peaks and troughs for each country are shown in table 1. There are three recessionary periods each for the United Kingdom, South Korea, and Taiwan, four for Japan and Germany, five for the United States and Canada, and six for Mexico. As noted earlier, the dependent variable in the binary probit regressions takes on the value 1 during the recessionary periods and 0 during expansions.

The country-specific explanatory variables fall into five categories: exchange rates (both real and nominal trade-weighted exchange rates were used in alterative versions, as they are too collinear to use in the same regression); the change in a stock price index; the spread between short-term and long-term interest rates, if available, and the change in a short-term interest rate if no long-term rate is available for most of the period; a confidence or other leading indicator; and the change in an activity indicator (industrial production for most countries, employment for Canada because it is available on a more timely basis than industrial production). The change in oil prices (the U.S. spot price of West Texas Intermediate oil, which is available back to 1946) was also used in each initial equation. Most of the data were drawn from the Haver Analytics database, which includes data from the source countries. More details are provided in Appendix 1.

[2] These dates, which are unofficial, were published by Statistics Canada in the Canadian Economic Observer in December 2001 and were obtained from the Haver Analytics database. The recessionary period December 2000 to September 2001 was not included in this publication and was added based on the behavior of Canadian monthly GDP over that period.

As indicated in table 2, the expected signs for stock prices, leading indicators, and activity variables are unambiguously negative, as improvement in any of these variables should reduce the probability of a recession and vice versa. Interest rate spreads are available back to the 1970s for all of the industrialized countries (the United States, Canada, Japan, the United Kingdom, and Germany), as well as for Taiwan. A decline in this variable (a flattening of the yield curve) should be associated with an increased probability of a recession, so the expected sign is negative. Long-term interest rates were not available for Korea and Mexico for a long period, so the change in a short-term rate was used instead of a spread. The sign on this variable should be positive—a rise in short-term interest rates should be associated with an increased probability of a recession.

The expected signs on both oil prices and exchange rates are ambiguous. Increases in oil prices should increase the probability of a recession for oil-importing countries (resulting in an expected positive sign), but might reduce the probability for an oil exporter (such as Mexico). Declines in nominal exchange rates, particularly for developing countries, often precede a period of negative growth, especially for developing countries, as they may reflect a loss of confidence and may have adverse balance-sheet effects if currency mismatches are widespread. On the other hand, if the real exchange rate also declines, exports would become more competitive, potentially having a stimulative effect on output. However, if prices react quickly to upward pressure from the falling currency, real exchange rates may be little changed in such an episode. Versions of the model were estimated using both real and nominal exchange rates separately and the better version was used.

III. Country Models

A. Estimation

Binary probit models were estimated for each of the eight countries, with the recession-expansion indicator as the dependent variable and each of the variables described in the previous section as explanatory variables. The particular lags used for each variable were chosen based on their relative timeliness, which varied by country. For instance, financial variables (exchange rates and interest rates) are generally available one or two months sooner than other variables. Thus, lags from one to six months were included for these variables in the equation. Variables such as industrial production were lagged from two or three months to six months, depending on their timeliness for each country. The final model for each country was obtained by progressively eliminating the lags of the variables that were insignificant or incorrectly signed. This was done twice, once using the nominal exchange rate and again using the real rate. The better-fitting final equation was used in the evaluation. The models were estimated from the earliest available date, which was usually sometime in the mid-1970s, through the end of 2005.

Full estimation results for the final model for each country are shown in Appendix 2. Table 3 is a summary table that shows the level of significance of each coefficient, thus allowing for comparison across countries of which variables are important. Oil prices are important for the United States, the United Kingdom, Korea, and Taiwan. At least one lag of the leading indicator is significant for all of the countries except Canada and Mexico. The yield spread (the change in the short-term interest rate for Korea) is significant all of the countries except Mexico and Taiwan. Stock prices are significant for all of the countries except Korea. Real activity indicators are important for Canada, the United Kingdom, Mexico, and Korea. Exchange rates played a variety of roles. For the United Kingdom and Taiwan, the real exchange rate is positive and significant, indicating that an appreciation increases the probability of a recession, consistent with an important effect of trade on output. The real exchange rate for Mexico, and the nominal rate for Korea are negative and significant, suggesting that for those countries a currency depreciation is associated with a weakening of output.

The fit of the models varies considerably across countries, but is generally better for the advanced economies. McFadden R^2s range from around .4 for Mexico and Taiwan to about .5 for Korea and Japan, .6 for the United States and Germany, to a high of nearly .8 for the United Kingdom.

Charts 1 through 8 show the actual and fitted values from each of the eight equations. Two general observations may be made:

(1) the value of the indicator does appear to increase notably during most of the recessionary periods for most of the countries, but the timing is not usually exact. However, even though the indicator sometimes does not spike in advance, it can still be useful in identifying a recessionary period before it is evident in the data.

(2) there are numerous "false positives".

The next section provides a more rigorous evaluation of the models' performance.

B. Evaluation

In order to evaluate the success of the binary probit models in predicting turning points, it is necessary to choose a "threshold" above which the predicted probability is said to be signaling a recession. The choice of the threshold depends largely on the preferences of the policymaker. The higher the threshold the greater is the probability of making a Type I error (not predicting a recession that actually occurs), but the lower the probability of making a Type II error (predicting a recession that does not occur). The choice of a threshold will thus depend on the relative weights placed on avoiding the two types of errors.

The methodology used here to choose a threshold follows that used in Bussiere and Fratscher (2006). If the policymaker's loss function is written as:

$$L = \alpha \text{ x } \pi_1 (T) + (1-\alpha) \text{ x } \pi_2 (T)$$

where π_1 (T) and π_2 (T) are the probabilities of making Type I and Type 2 errors, respectively, for each threshold T, then the threshold T that is chosen should be the one that minimizes the loss function for a given α. However, the choice of α is judgemental.

In order to derive some empirical guidance for the choice of a threshold, the value of the loss function was calculated using the estimated error probabilities from each of the country equations for thresholds for the values from .1 to .9 (increasing by .1) for three values of α: .25, .5, and .75. The results are shown in table 4. For each country and value of α, the minimum value of the loss function is shown in bold. The last column shows the average value for the 8 countries.

These results suggest that the optimal threshold is relatively low, certainly less than .5. When the policymaker puts equal weights on avoiding the two types of errors (α= .5), the optimal threshold ranges from .1 for the United Kingdom, Canada, Korea, and Taiwan, to .3 for Japan. It is .2 for the other four countries. The average optimal threshold for the eight countries also is .2. When the weight on Type I errors (missing an actual recession) rises to .75, the optimal threshold is .1 for six of the countries, .2 for the other two, and .1 for the average. When the weight on Type I errors falls to .25, the optimal threshold ranges from .2 to .5, with the average at .4. In the analysis that follows a threshold of .2 is used on the assumption that the weight placed on avoiding a missed recession should be at least as large as the weight on a false signal.

In-sample Evaluation

Table 5 provides an indication of how well the model does at correctly categorizing recessions and expansions. The percentage of total observations that are successfully categorized (column 1) is generally quite high, around 90 percent for the United States, Canada, the United Kingdom, Germany, Korea, and Taiwan, and close to 80 percent for Japan and Mexico. The percentage of recessions correctly called (column 2) is usually lower, although there are a couple of exceptions. However, this percentage is over 80 percent for the United States, Canada, the United Kingdom, Japan, Germany, and Mexico. It is lower for Korea and Taiwan, which have the fewest recessions.

The percentage of expansionary periods that are correctly categorized is likely to be high, given that the vast majority of both the actual and predicted observations will be expansions. A more telling statistic is "false alarms" (the percentage of predicted recessionary periods that occur during expansions), shown in column 3 vs. the corresponding percentage of predicted recessionary periods which do occur in actual recessions, column 4 (these two sum to 1). The value in column 4 is the in-sample probability of being in a recession when the predicted value is above the critical value. The probability of a false alarm is lowest for Germany and the United Kingdom (around 20 percent), and is around 30-40 percent for most of the other countries. It is highest for Taiwan at 59 percent. The probability of a recession when the indicator is less than .2 (column 5) is quite small for most countries.

Out-of-sample Evaluation

The models were first re-estimated through 1999, and these equations were then used to derive out-of-sample forecasts for the period 2000-2006. Strictly speaking, this is not really an out-of-sample forecast, since the same form of the equation was used as in the full sample period. Thus, it is possible that some variables (at some lags) that were included in the models evaluated in the previous section might not be significant for the shorter period and vice versa. However, the exercise was done using the same equations in order to be able to compare these results with those obtained in-sample. The re-estimated equations, also shown in appendix 2, are generally fairly similar to the original equations.

Table 6 shows the same set of results as shown in table 5 for the full period. The total percentage of observations that are correctly categorized is similar for most countries to the in-sample results. The percentage of recessionary periods correctly categorized is higher for some countries, notably for the U.S. and Japan, where it is 100 percent. The percentage of false alarms when the indicator is above the critical value is higher for some, but lower for others. (Taiwan shows no predictions above the critical value during the out-of-sample period.) The probability of missing a recessionary period is still low for most countries, but is quite high at 27.5 percent for Mexico. However, it might be noted that this actually refers to one long recessionary period, and the indicator does categorize a substantial part of it correctly.

Charts 9-16 give a more qualitative impression of how the indicators perform. One interesting result is that only one recession (Taiwan, 2003) is missed entirely. Another is that many false alarms are a result of inexact timing (i.e., they occur either just before a recession begins or just after it ends), rather than occurring in the middle of an expansionary period. However, Korea provides a dramatic exception, as the indicator suggests four recessions during the out-of-sample period, compared with just one official recession.

IV. Panel Estimation

A panel regression with fixed effects was also estimated. Although the panel regression may be assuming a degree of conformity across countries that is not in fact the case, it has the advantage of having many more observations relative to the number of parameters being estimated. The results are shown in table 7. The equation is similar to the separate country equations: each of the independent variables was lagged between one and six months, depending on timeliness, in the initial estimation, and insignificant and/or incorrectly signed variables were progressively eliminated.[3] All of the explanatory variables except oil prices were significant for at least one lag. The R^2 is .43.

Charts 17 through 24 compare the fitted values from the panel equation with both the actual values and the fitted values from the separate equations. A visual inspection suggests that the fitted indicators from the panel equation do tend to rise during recessionary periods, but often not as much as the fitted values from the separate equations. (However, this may not affect the ability of the indicator to signal a recession depending on the critical value.) As shown in table 8, the loss function is minimized at a critical value of .2 when equal weights are placed on avoiding the two types of errors, similar to the result from the single-equation estimation. Thus, .2 is used as the critical value in the evaluation.

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[3] Mexico and Korea did not have enough long-term interest rate data to calculate yield curves for a long period of time. As a proxy, the negative of the short-term interest rate was used, and a dummy was included for those countries.

Table 9 evaluates the success of the panel equation in predicting recessions in-sample for both the total and for each country. The percentage of observations correctly categorized is lower than for the individual equations (table 5) in all cases, although the size of the difference is generally fairly small. For the full regression, the percent of total observations correctly categorized is 85 percent, compared with a total of 89 percent for the individual equations taken together.

The out-of-sample results are shown in table 10. These forecasts are better than those from the individual country models for six of the eight countries, although the Korean model does not register the recession that occurred during that period. The overall percentage of periods correctly categorized is 86 percent for the panel regression, compared with a composite of 82 percent for the individual regressions.

Conclusion

This paper reports the results of an estimation of binary probit models for eight countries, both individually and as part of a panel, in an effort to forecast cycles in economic activity. The results vary widely, but several of the explanatory variables are significant in each of the country equations and all of them are significant in the panel regression. A loss function that places equal weights on errors in the two types of periods suggests that the optimal critical value signaling a recession is relatively low at .2 for both the individual country equations and the panel regressions. Using this critical value the individual models correctly identify nearly 90 percent of both the total and the recessionary periods on average in-sample, although these percentages differ substantially across countries. The percentage of total periods correctly identified is a little lower for the panel regression on average, although the percentage of recessionary periods correctly identified is about the same. The low critical value results in a relatively high percentage of false alarms, with 37 percent of fitted values above .2 occurring during expansionary periods for the individual equations on average, and 45 percent for the panel regression.

Nevertheless, the overall results suggest that models such as these can provide some general guidance to policymakers interested in gauging early signs of a weakening economy during an expansion or a strengthening economy during a contraction.

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Table 1 Business Cycle Peaks and Troughs								
	United States	Canada	Japan	United Kingdom	Germany	South Korea	Taiwan	Mexico
peak	1973:11	1974:12	1973:11	1974:9	1973:8	1979:3	1973:12	1982:3
trough	1975:3	1975:3	1975:2	1974:8	1975:7	1980:10	1975:1	1983:7
peak	1980:1	1980:1	1992:4	1979:6	1980:1	1997:8	2000:8	1985:10
trough	1980:7	1980:6	1994:2	1981:5	1982:10	1998:7	2001:9	1986:11
peak	1981:7	1981:6	1997:3	1990:5	1991:1	2002:12	2003:2	1992:10
trough	1982:11	1982:10	1999:7	1992:3	1994:4	2003:9	2003:5	1993:10
peak	1990:7	1990:3	2000:12		2001:1			1994:11
trough	1991:3	1992:4	2003:7		2003:8			1995:7
peak	2001:3	2000:12						2000:8
trough	2001:11	2001:9						2003:8
peak								2004:12
trough								2005:6

Table 2 Expected Signs for the Explanatory Variables		
Variable	**Expected sign**	**explanation**
Oil prices	Ambiguous	+ for oil importers, - for oil exporters
Exchange rate* Real Nominal	Ambiguous	Increase might either reduce net exports or increase confidence
Stock price	-	Improvement in any of these indicators reduces the probability of a recession
Leading Indicator	-	
Activity	-	
Interest Rates (spread or change in short-term rate)	- for spread, + for change in short-term rates	Narrowing of the spread between long-term and short-term rates is associated with an increased probability of a recession

* assumes an increase in the exchange rate signals an appreciation.

Table 3 **Estimated Coefficients (lags in parentheses)**								
Region Coeff.	U.S.	Canada	Japan	U.K.	Germany	Mexico	Korea	Taiwan
Oil Price	.033(2)[b] .025(4)[c] .028(2)[b]			.051(2)[c]			.042(2)[b]	.035(3)[a]
Leading Indicator	-.127(6)[a]		-.061(1)	-.064(3)[a] -.097(6)[b]	-.088(2)[a]		-.964(3)[a] -.559(4)[b] -.943(6)[a]	-.305(3)[b] -.360(5)[a] -.251(6)[b]
Yield Spread	-.332(3)[a] -.313(6)[a]	-.616(6)[a]	-.705(1)[a]	-.626(1)[a]	-1.08(6)[a]		.339(2)[a+]	
Stock Price	-.040(1)[c] -.087(2)[a] -.110(4)[a] -.110(6)[a]	-.040(2)[c] -.060(3)[b] -.053(4)[b] -052(5)[b] -.038(6)[c]	-.044(1)[a] -.064(2)[a] -.063(3)[a] -.043(6)[a]	-.079(2)[b]	-.034(2)[b] -.038(5)[b] -.040(6)[a]	-.023(1)[a] -.020(2)[b] -.023(3)[b] -.022(5)[b]		-.035(1)[a]
Real Activity		-1.95(2)[a] -1.30(3)[a] -.865(4)[b]		-.281(3)[c]		-.475(3)[a] -.587(4)[a] -.419(5)[b] -.152(6)[c]	-.124(8)[b] -.186(9)[a]	
Nominal Exchange Rate							-.120(4)[b] -.173(6)[a]	
Real Exchange Rate				.297(1)[a] .277(2)[b] .364(3)[a] .296(4)[b] .317(5)[a] .385(6)[b]		-.064(2)[c] -.103(3)[b] -.123(4)[a] -.063(5)[c] -.083(6)[b]		.151(4)[b] .139(5)[b]
McFadden R^2	.66	.58	.46	.78	.62	.43	.46	.37

[a] significant at the 1 % level [b] significant at the 5% level. [c] significant at the 10 percent level.
+ change in short-term interest rate.

Table 4 **Value of Loss Function for given α and threshold**									
	25	UK	CA	JA	GE	KO	TA	MX	Avg.
Threshold	$\alpha = .75$								
.1	**6.93**	**1.80**	**7.74**	**13.59**	7.07	**13.80**	**16.90**	13.92	**8.63**
.2	7.47	7.10	13.78	14.64	**7.03**	19.48	32.71	**13.60**	11.72
.3	9.89	11.28	24.85	17.35	10.13	28.21	44.59	19.16	17.20
.4	15.02	14.21	26.72	21.42	12.67	35.42	54.66	27.29	22.00
.5	17.37	16.97	30.32	26.87	19.28	48.64	54.45	27.54	26.47
.6	25.42	16.89	34.20	33.25	21.99	48.48	54.31	35.90	30.86
.7	35.08	19.81	35.27	43.31	25.80	50.24	54.31	40.38	35.74
.8	39.03	30.00	40.23	47.31	33.18	57.77	62.07	47.92	42.36
.9	55.62	40.25	46.55	59.84	40.14	59.62	64.66	54.40	50.79
Threshold	$\alpha = .50$								
.1	8.29	**3.61**	**10.30**	20.37	13.34	**14.77**	**16.56**	24.55	12.39
.2	**7.52**	6.20	12.05	15.65	**9.30**	15.88	24.04	**18.42**	**11.47**
.3	8.66	8.57	18.66	**15.37**	9.95	20.52	30.57	18.54	13.83
.4	11.52	10.41	18.96	16.71	11.05	24.69	36.90	22.71	16.33
.5	12.52	11.94	20.98	19.64	14.74	33.18	36.49	21.01	18.74
.6	17.51	11.79	23.56	23.32	16.20	32.86	36.21	25.65	21.36
.7	23.86	13.63	23.99	29.80	18.26	33.82	36.21	28.01	24.38
.8	26.21	20.00	27.01	32.12	22.71	38.62	41.38	32.11	28.45
.9	37.18	26.94	31.04	40.12	27.12	39.75	43.11	36.27	33.95
Threshold	$\alpha = .75$								
.1	**9.66**	**5.41**	**12.87**	**27.14**	19.62	**15.75**	16.22	35.17	16.16
.2	7.58	5.29	10.31	16.65	**11.56**	12.28	**15.36**	**23.23**	11.22
.3	7.44	5.85	12.48	13.40	9.76	12.83	16.54	17.91	**10.46**
.4	8.02	6.62	11.19	11.99	9.42	13.95	19.15	18.13	10.67
.5	7.67	6.91	11.63	12.42	10.21	17.71	18.52	14.47	11.00
.6	9.60	6.68	12.93	13.39	10.40	17.23	18.10	15.39	11.85
.7	12.63	7.44	12.71	16.28	10.73	17.39	18.10	15.64	13.02
.8	13.38	10.00	13.79	16.92	12.24	19.47	20.69	16.29	14.55
.9	18.73	13.62	15.52	20.41	14.09	19.87	21.55	18.13	17.12

Table 5 **Model Evaluation (in-sample)**					
	% of total observations correctly categorized	% of recessionary periods correctly categorized	% of false alarms when p.v. > .2	prob of recession when p.v. > .2	prob of recession when p.v. < .2
U.S.	92.4	92.6	35.1	64.9	1.2
Canada	90.4	84.5	38.0	62.0	2.7
U.K.	95.1	92.0	23.3	76.7	1.3
Japan	83.3	86.4	40.2	59.8	4.8
Germany	89.0	95.2	24.5	75.5	2.4
Korea	89.7	76.9	47.4	52.6	3.1
Taiwan	90.7	58.6	58.5	41.5	3.5
Mexico	75.4	83.5	44.1	55.9	8.9
Total	88.6	86.7	37.0	63.0	3.1

p.v. = predicted value

Table 6 **Model Evaluation (out-of-sample)**					
	% of total observations correctly categorized	% of recessionary periods correctly categorized	% of false alarms when p.v. > .2	prob of recession when p.v. > .2	prob of recession when p.v. < .2
U.S.	84.5	100.0	61.9	38.1	0.0
Canada	94.0	55.6	16.7	83.3	5.1
U.K.	94.0	NA*	100.0	0.0	0.0
Japan	75.0	100.0	40.4	59.6	0.0
Germany	83.3	54.8	0.0	100.0	20.9
Korea	69.0	88.9	75.8	24.2	2.0
Taiwan	81.0	0.0	NA**	NA**	19.0
Mexico	73.8	66.7	22.2	77.8	29.2
Total	81.8	66.4	42.9	57.1	9.8

p.v. = predicted value
*there were no recessions in the U.K. during the out-of-sample period.
**the predicted value never exceeded the critical value during the out-of-sample period for Taiwan.

Table 7 **Results of Panel Regression (Preferred Equation)**				
Sample: 1973:08 to 2005:12				
Variable	Coefficient	Std. Error	Z-Statistic	Prob.
C	0.952710	0.254163	3.748415	0.0002
Exchange rate(-1)	-4.118604	1.597582	-2.578024	0.0099
Exchange rate(-3)	-3.471046	1.705465	-2.035249	0.0418
Exchange rate(-6)	-5.806483	1.758986	-3.301039	0.0010
Stock price (-1)	-2.122200	0.484139	-4.383453	0.0000
Stock price (-2)	-2.404494	0.488647	-4.920722	0.0000
Stock price (-3)	-2.199412	0.482461	-4.558735	0.0000
Stock price (-4)	-1.227985	0.489297	-2.509691	0.0121
Stock price (-5)	-1.512747	0.497441	-3.041060	0.0024
Stock price (-6)	-1.439765	0.489552	-2.940987	0.0033
Leading Ind. (-4)	-0.017743	0.010174	-1.744001	0.0812
Leading Ind. (-6)	-0.021621	0.009745	-2.218574	0.0265
Yield (-3)	-0.247681	0.046183	-5.362998	0.0000
Yield -6)	-0.294310	0.047251	-6.228588	0.0000
Yield(-3)*DUMK	0.159851	0.071256	2.243311	0.0249
Yield(-6)*DUMK	0.339984	0.070709	4.808242	0.0000
Yield(-3)*DUMM	0.189228	0.051366	3.683948	0.0002
Yield(-6)*DUMM	0.372996	0.053624	6.955807	0.0000
Activity (-3)	-17.47433	2.314219	-7.550852	0.0000
Activity (-4)	-21.76745	2.640760	-8.242875	0.0000
Activity (-5)	-16.67411	2.502781	-6.662233	0.0000
Activity (-6)	-9.079876	2.252303	-4.031374	0.0001
McFadden R-squared	0.427685		Mean dependent var	0.178632
S.D. dependent var	0.383109		S.E. of regression	0.282809
Akaike info criterion	0.556924		Sum squared resid	232.7446
Schwarz criterion	0.615988		Log likelihood	-789.3998
Hannan-Quinn criter.	0.578191		Restr. log likelihood	-1379.311
LR statistic	1179.823		Avg. log likelihood	-0.268595
Prob(LR statistic)	0.000000			
Obs with Dep=0	2414		Total obs	2939
Obs with Dep=1	525			

Table 8 Value of Loss Function for panel regression for given α and threshold			
Threshold	α = .25	α = .5	α = .75
.1	24.09	18.73	**13.36**
.2	15.49	**15.03**	14.56
.3	12.72	16.29	19.86
.4	**12.45**	19.48	26.50
.5	13.98	24.56	35.13
.6	15.74	29.42	43.09
.7	17.52	33.72	49.91
.8	19.94	39.01	58.07
.9	20.99	41.80	62.62

Table 9 Panel Equation Evaluation (In-Sample)					
	% of total observations correctly categorized	% of recessionary periods correctly categorized	% of false alarms when p.v*. > .2	prob of recession when p.v. > .2	prob of recession when p.v. < .2
United States	91.5	90.7	36.4	63.6	1.6
Canada	85.8	77.6	48.3	51.7	4.3
U.K.	89.6	82.6	44.1	55.9	2.7
Japan	81.2	86.7	45.0	55.0	4.6
Germany	83.2	97.6	33.7	66.3	1.5
Korea	86.0	64.1	57.6	42.4	4.9
Taiwan	82.7	55.2	70.4	29.6	3.9
Mexico	72.1	95.6	48.2	51.8	2.9
Full Regression	84.8	86.5	45.2	54.8	3.4

* p.v. = predicted value

Table 10 Panel Equation Evaluation (Out-of-Sample)					
	% of total observations correctly categorized	% of recessionary periods correctly categorized	% of false alarms when p.v.* > .2	prob of recession when p.v. > .2	prob of recession when p.v. < .2
United States	94.0	87.5	36.4	63.6	1.4
Canada	95.2	66.7	14.3	85.7	3.9
U.K.	98.8	NA#	100.0	0.0	0.0
Japan	64.3	100.0	49.2	50.8	0.0
Germany	89.3	87.1	15.6	84.4	7.7
Korea	89.3	0.0	NA+	NA+	10.7
Taiwan	79.8	18.8	25.0	75.0	16.3
Mexico	76.2	71.4	21.1	78.9	26.1
Full Regression	86.3	71.2	32.5	67.5	8.1

* p.v. = predicted value. # there were no UK recessions in the out-of-sample period. +the Korean indicator did not rise above the critical value in the out-of-sample period.

In-sample fitted values

Chart 1
United States

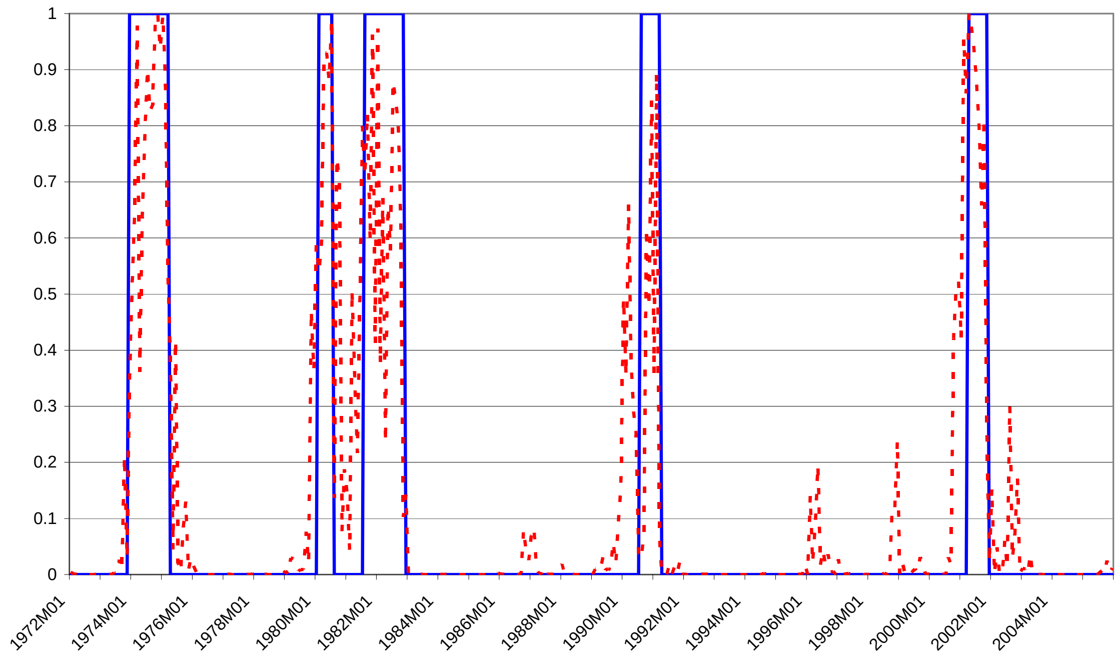


Chart 2
Canada

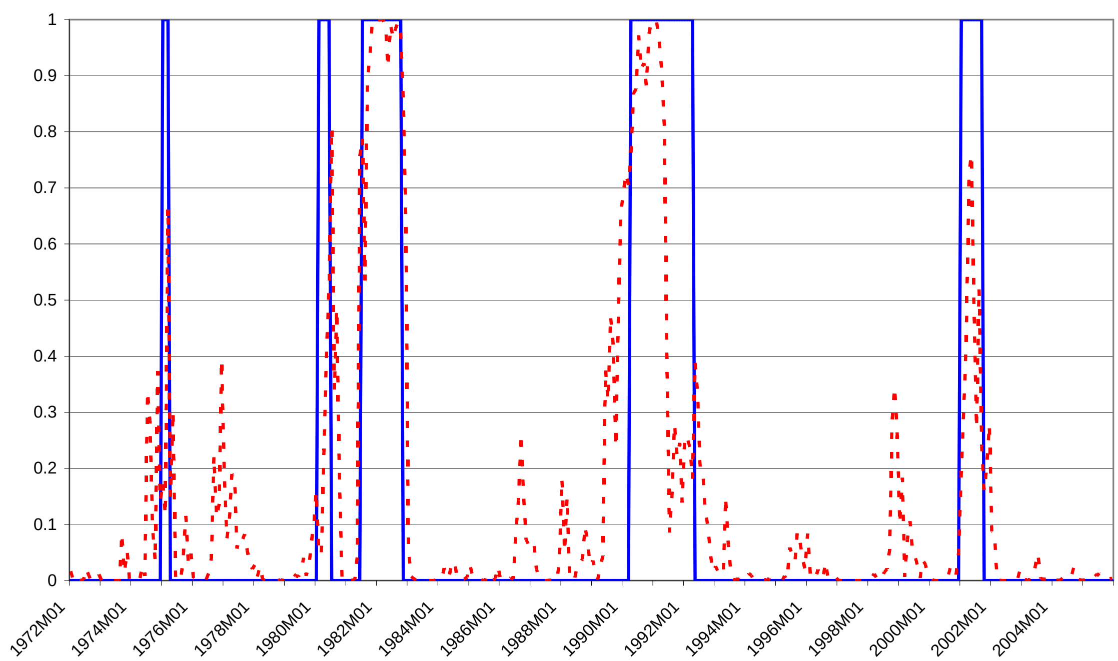


Chart 3
Japan

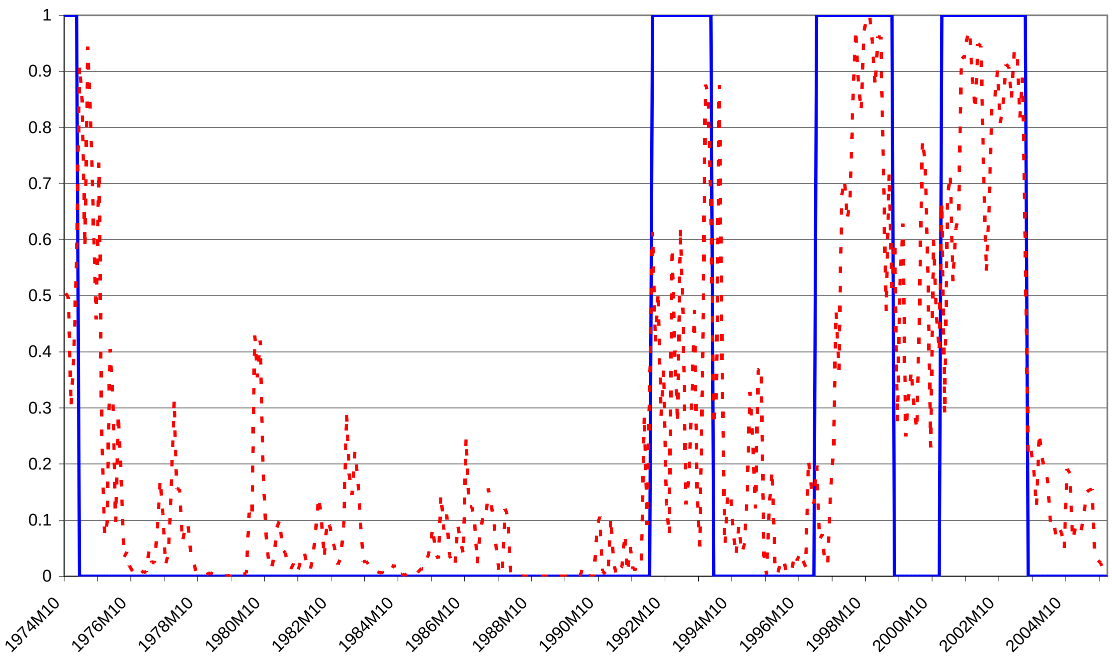


Chart 4
Germany

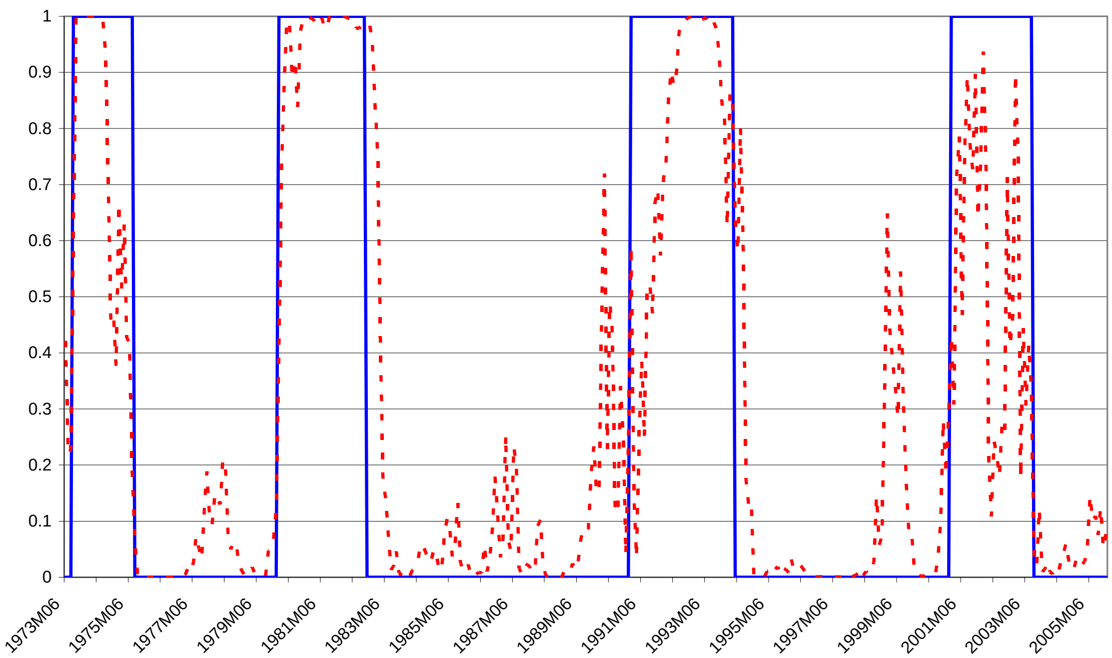


Chart 5
United Kingdom

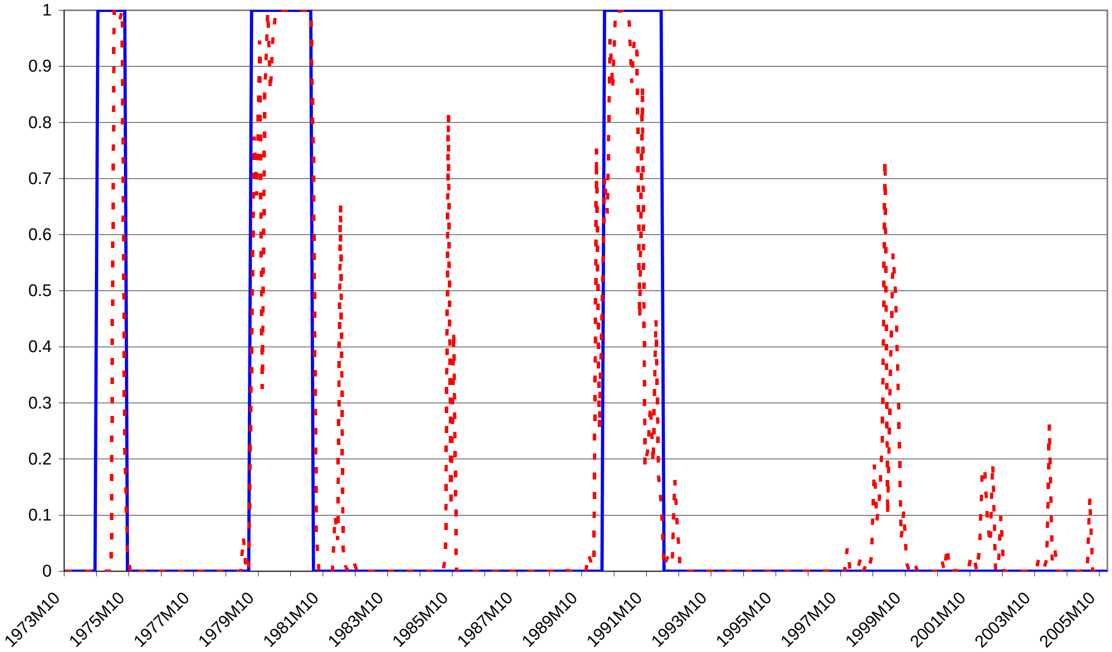


Chart 6
Mexico

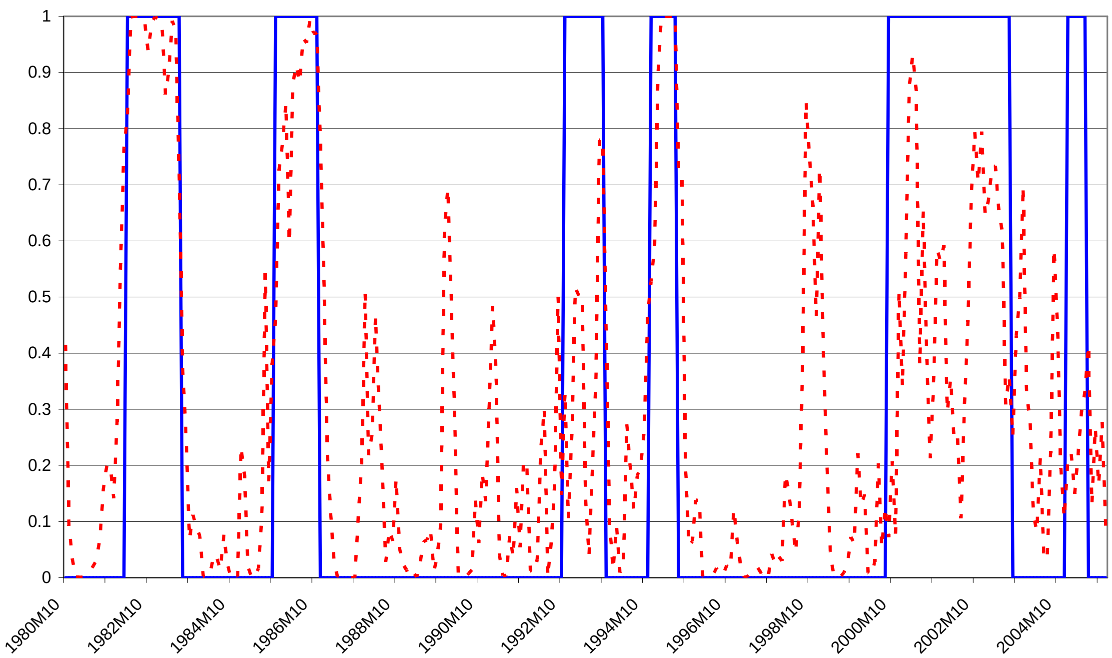


Chart 7
Korea

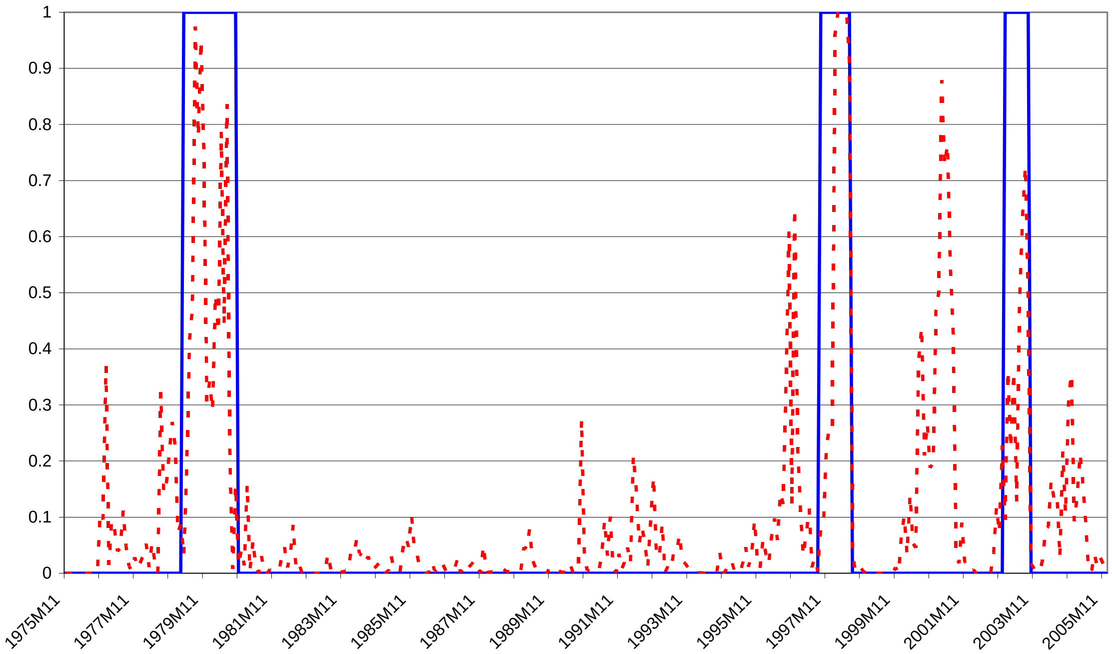
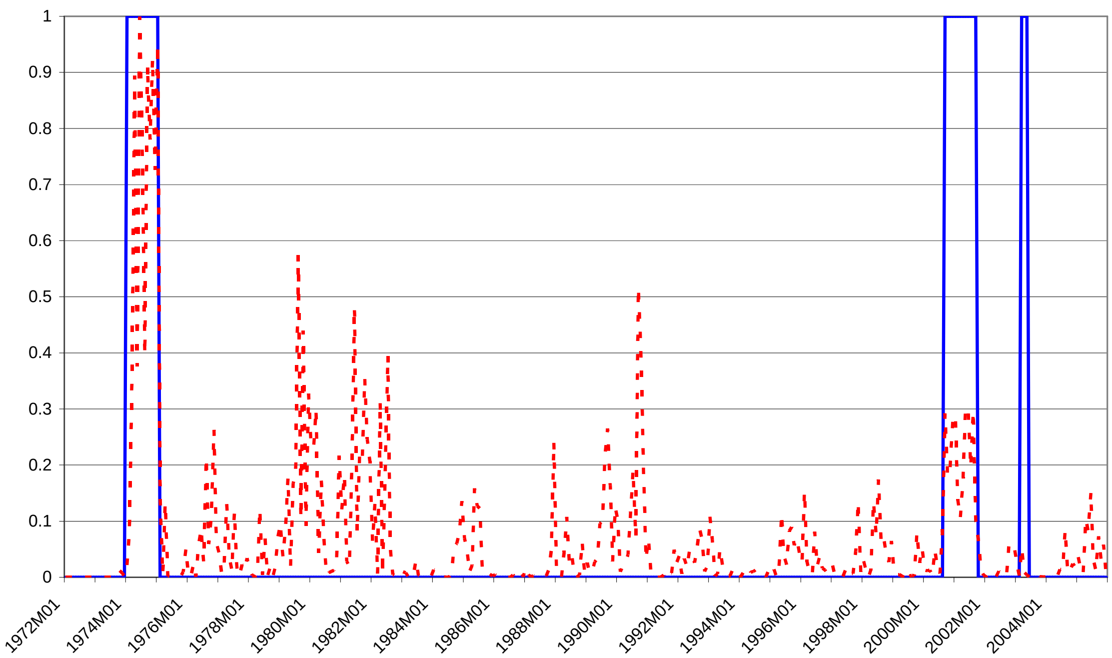


Chart 8
Taiwan



Out-of-Sample Forecasts

Chart 9
United States

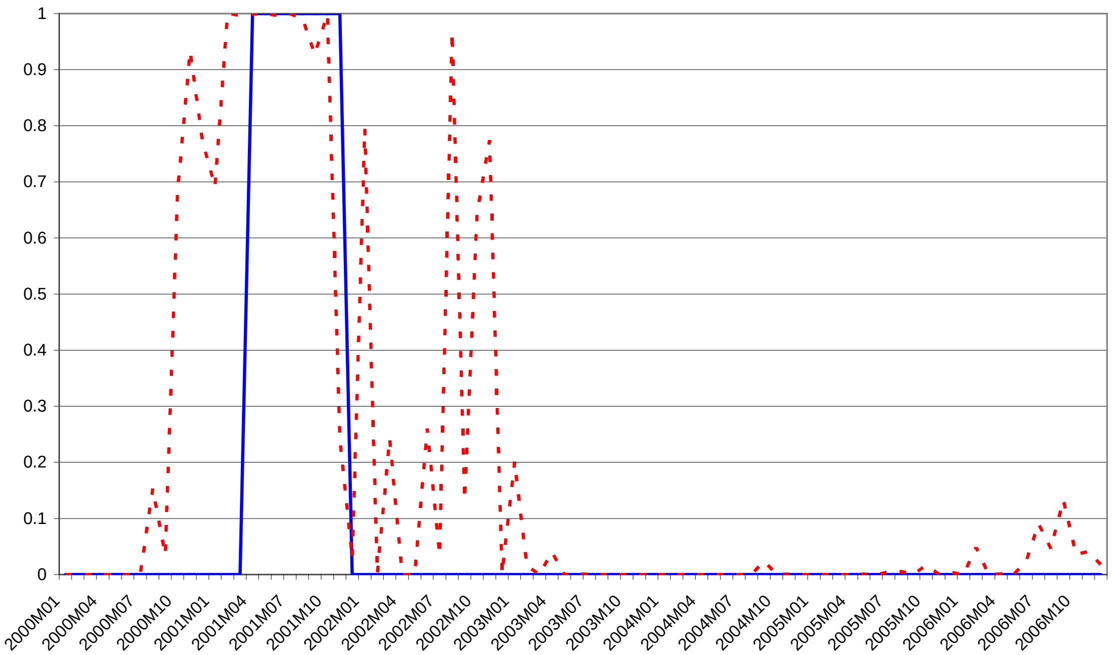


Chart 10
Canada

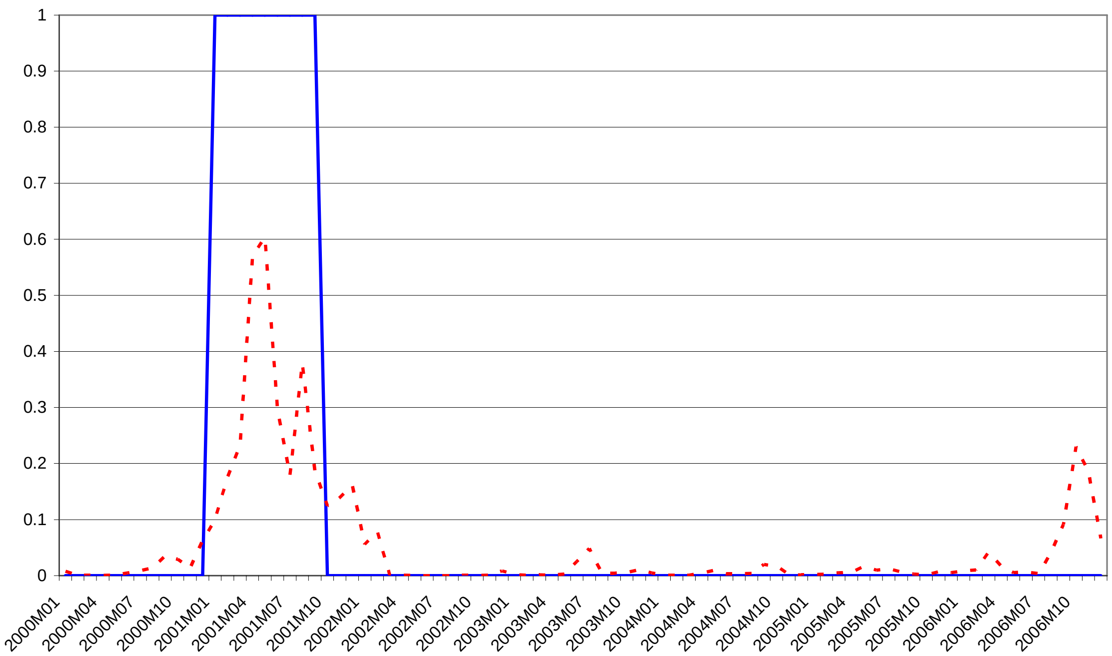


Chart 11
Japan

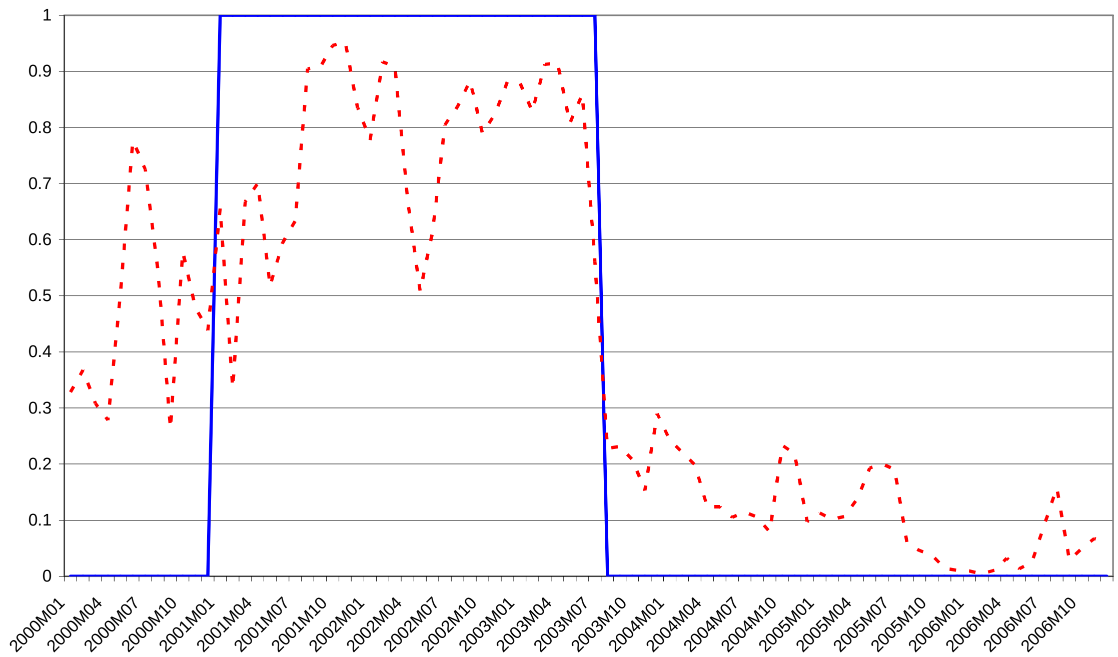


Chart 12
Germany

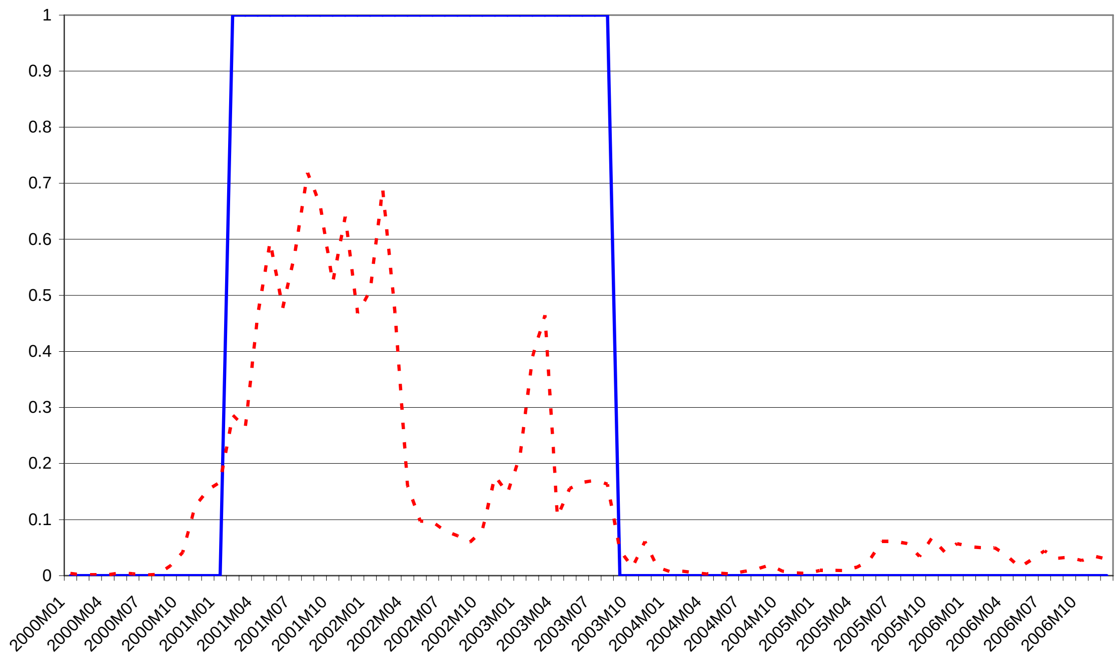


Chart 13
United Kingdom

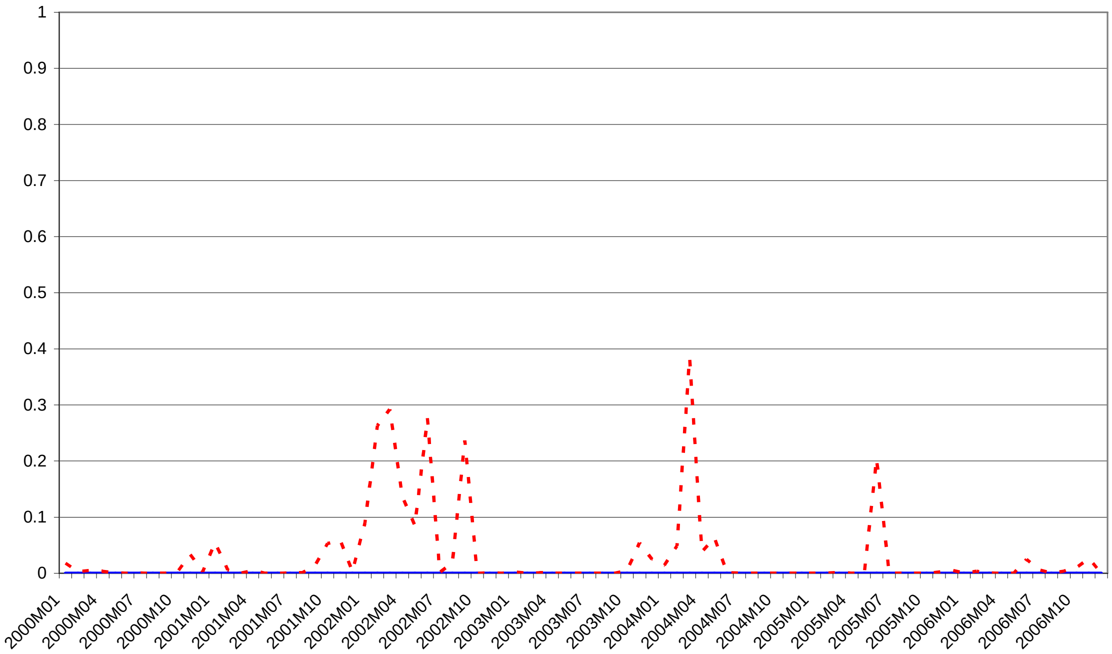


Chart 14
Mexico

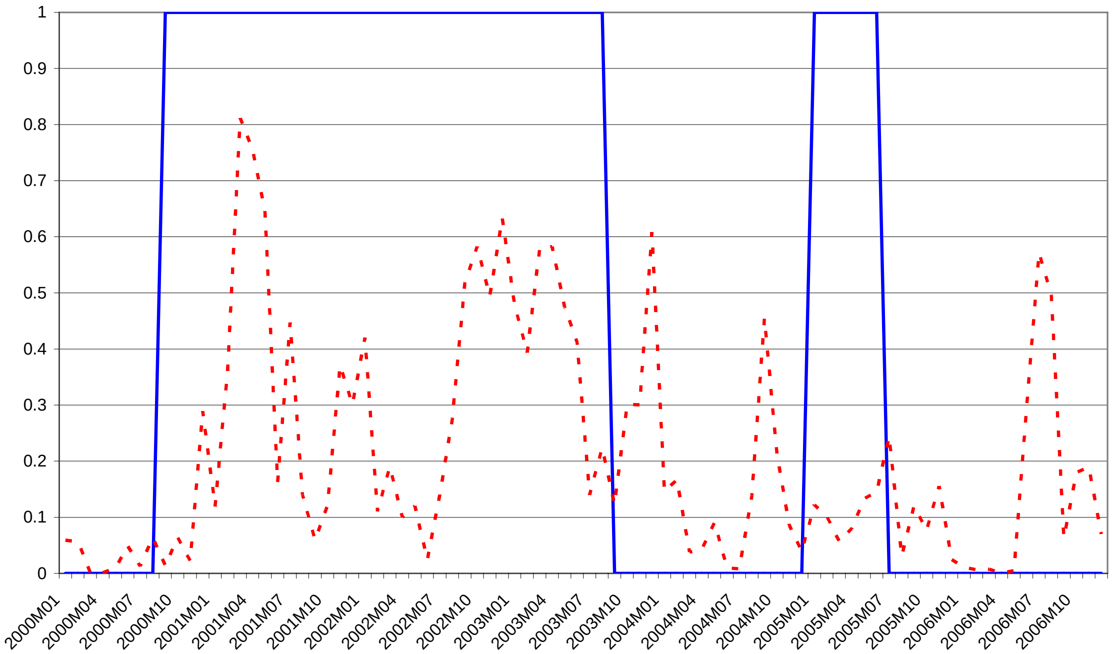


Chart 15
Korea

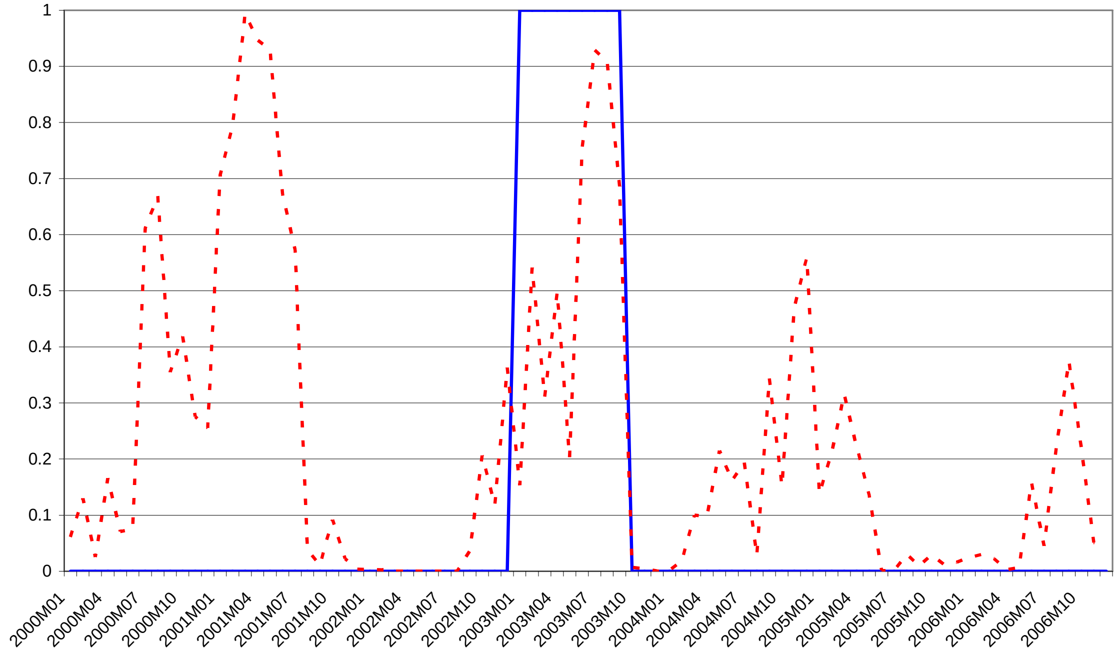
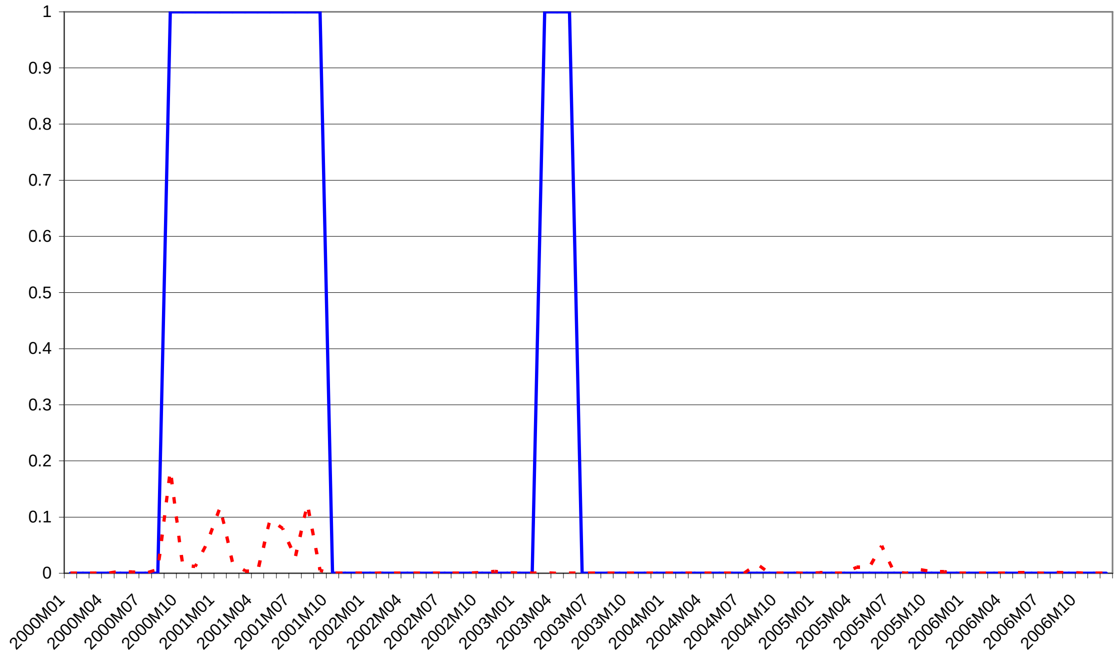


Chart 16
Taiwan



In-sample fitted values

Chart 17
United States

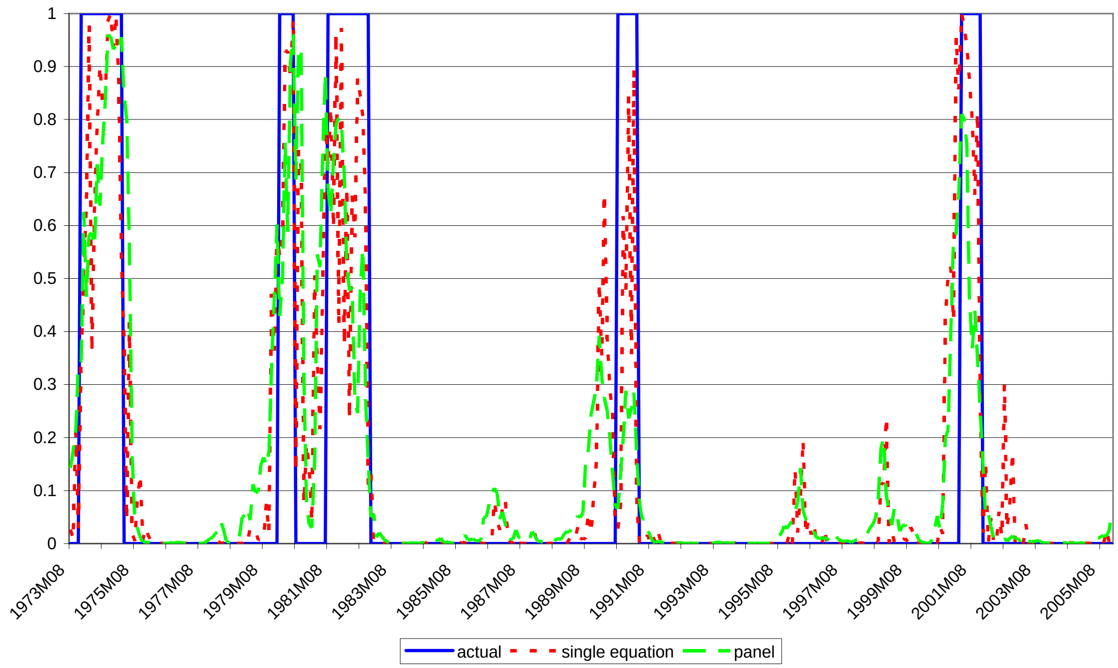


Chart 18
Canada

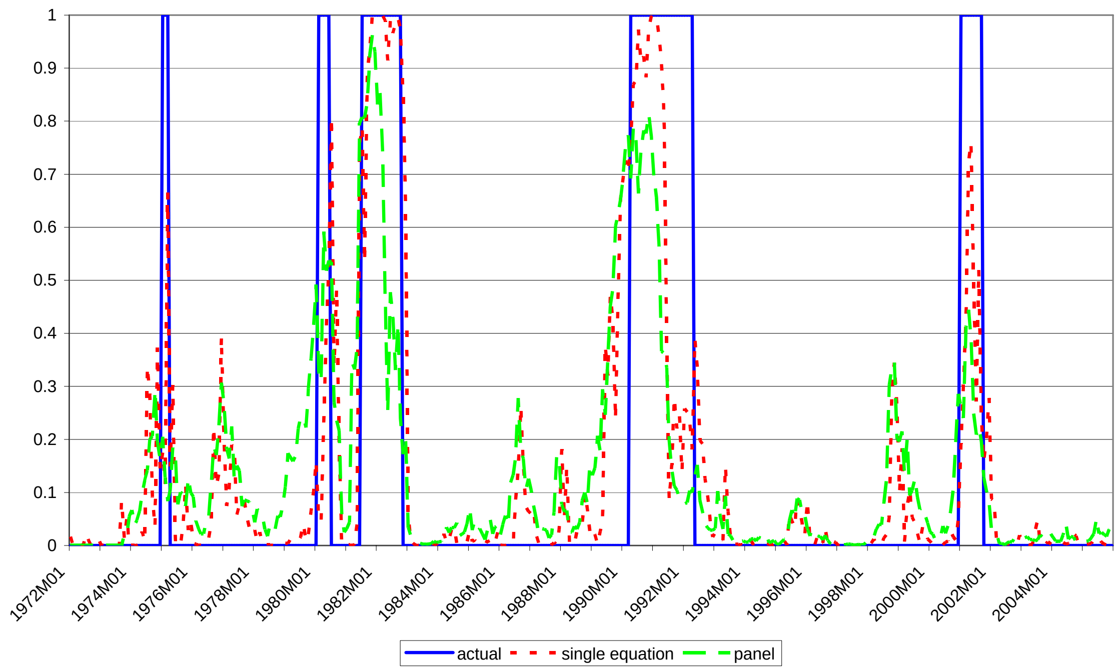


Chart 19
Japan

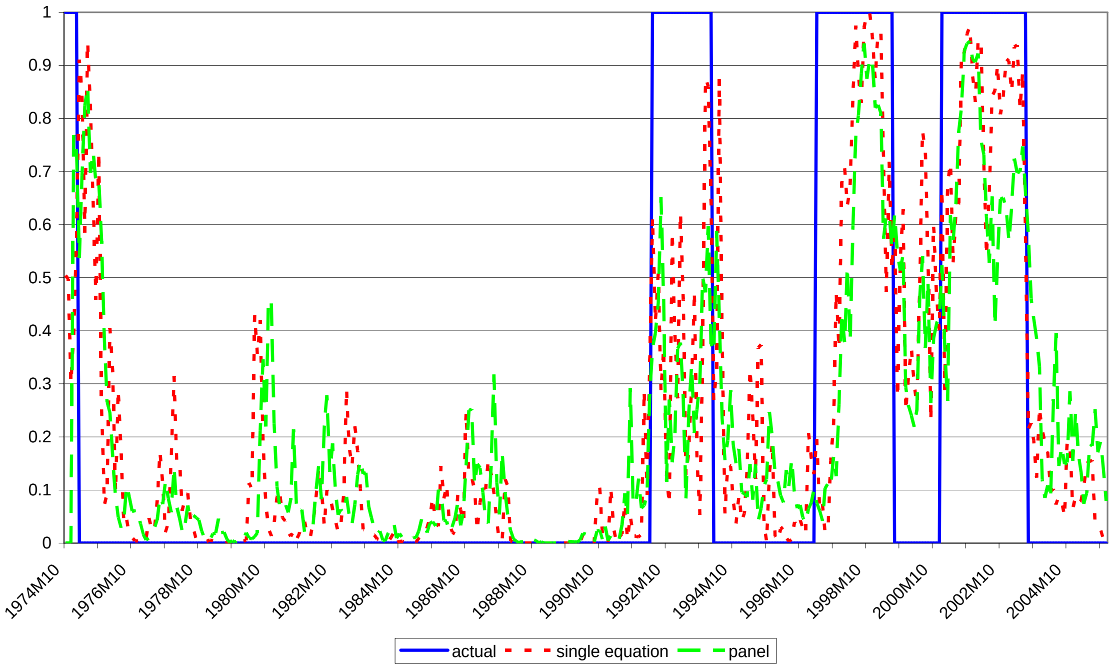


Chart 20
Germany

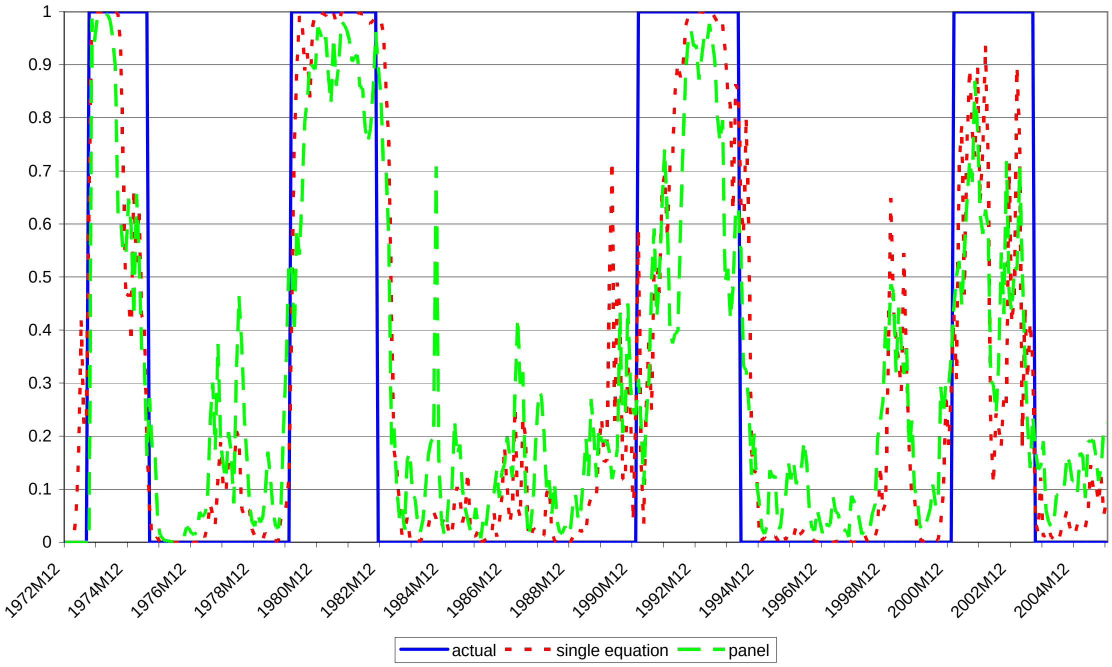


Chart 21
United Kingdom

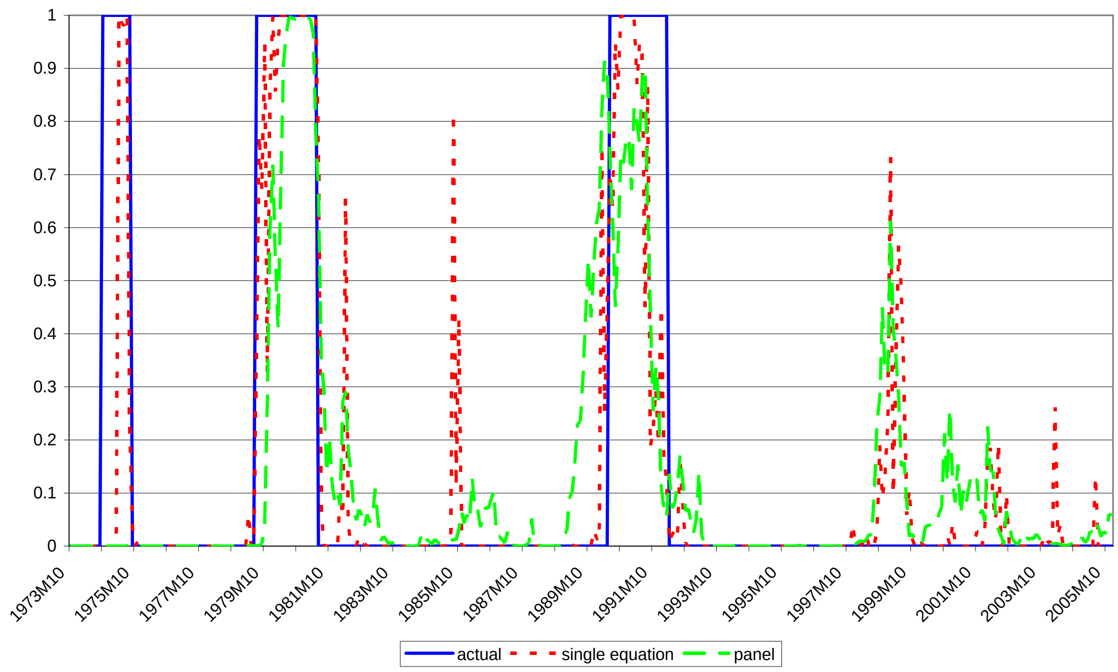


Chart 22
Mexico

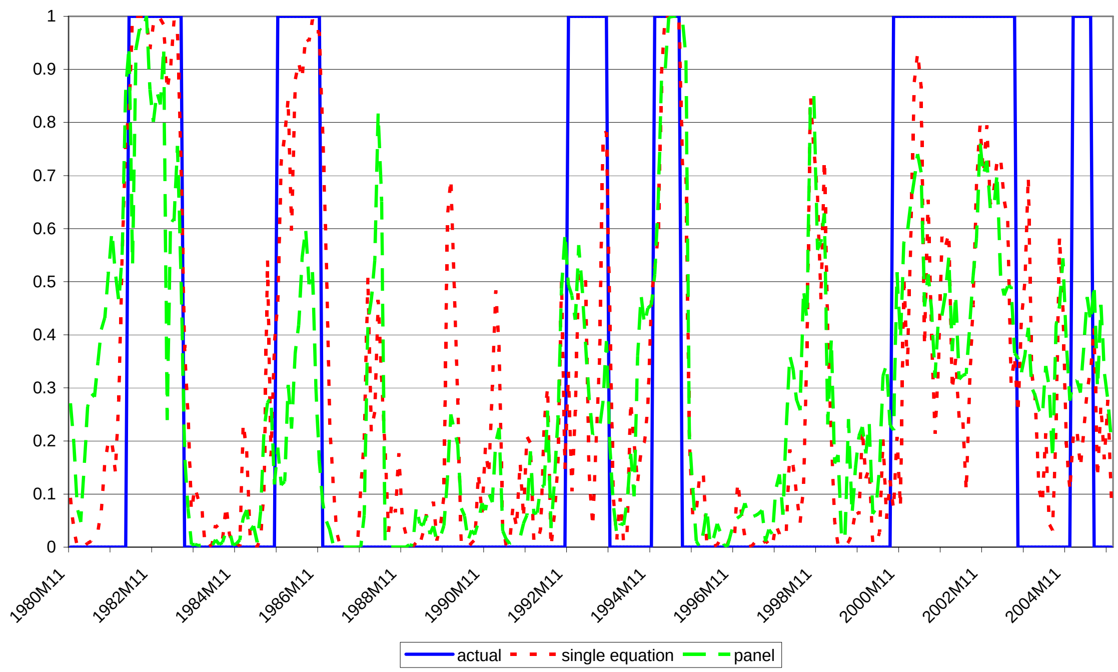


Chart 23
Korea

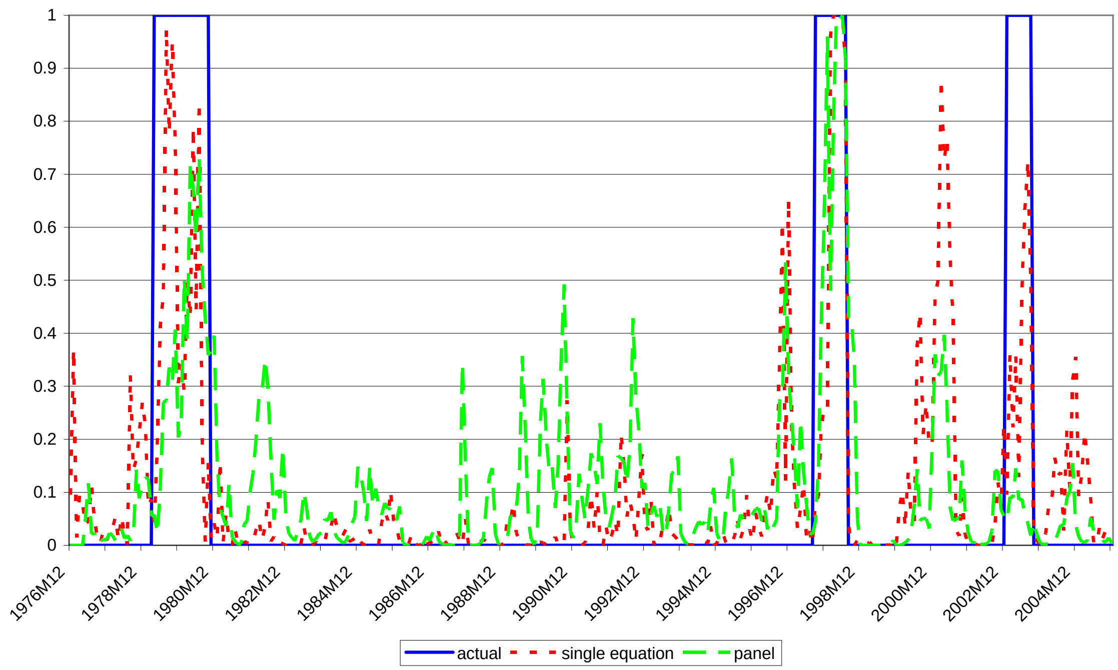
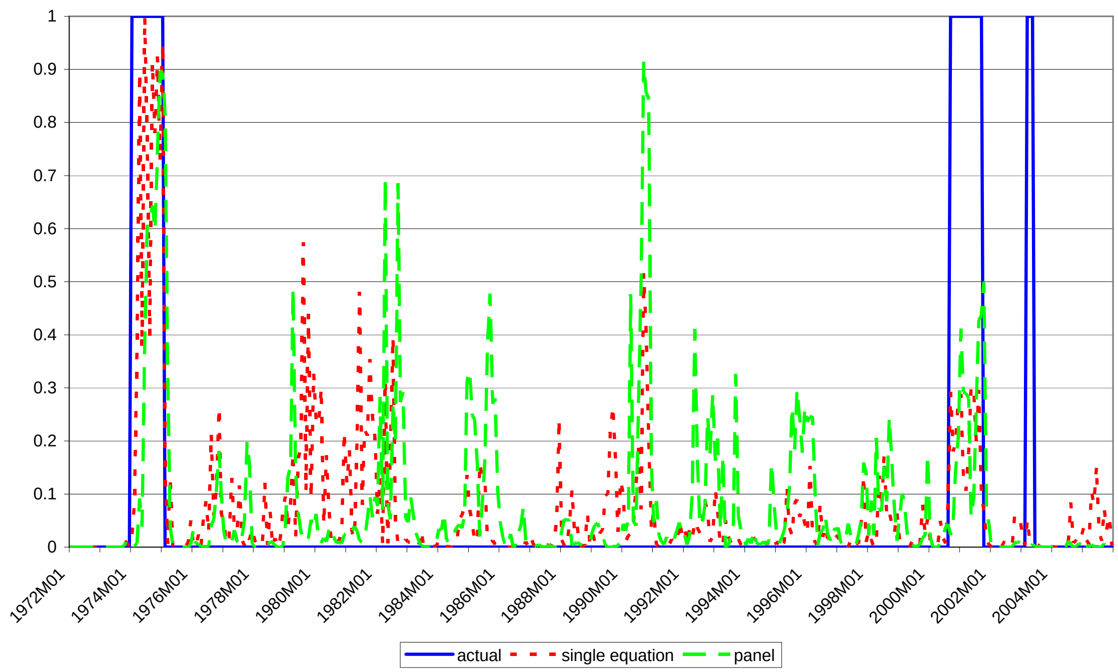


Chart 24
Taiwan



Appendix 1: Data

General

Oil prices:	U.S. spot price of West Texas Intermediate (prior to 1982, the posted price), $/barrel
Exchange rates:	trade-weighted average exchanges rates, nominal and price-adjusted

United States

Leading indicator:	manufacturing PMI composite index
Yield curve:	market yield on U.S. Treasury securities at 10-year constant maturity less the fed funds effective rate
Activity:	industrial production
Stock market:	Nasdaq composite index

Canada

Leading Indicator:	composite index of 10 leading indicators
Yield curve:	5 to 10 year bond yield average less the 3-month Treasury bill yield
Activity:	employment
Stock market:	Toronto stock exchange composite index

Japan

Leading indicator:	Tankan survey: all enterprises forecast of business conditions
Yield curve:	yield on newly-issued 10-year government bonds less the official discount rate
Activity:	industrial production
Stock market:	Nikkei index of common share prices

Germany

Leading Indicator:	IFO business climate index
Yield curve:	Estimated 10-year government debt yield less the 3-month interbank offered rate
Activity:	industrial production
Stock market:	DAX index

United Kingdom

Leading indicator:	survey of industrial trends, optimism regarding business situation compared to three months earlier
Yield curve:	government war loan yield less the daily 3-month interbank rate
Activity:	industrial production
Stock market:	FTSE share price index

Mexico

Leading Indicator:	composite index of leading indicators
Yield curve:	U.S. yield curve (defined above)
Activity:	industrial production
Stock market:	IPC stock price index

Korea

Leading indicator:	leading composite index
Yield curve:	U.S. yield curve (defined above)
Activity:	industrial production
Stock market:	KOSPI composite index

Taiwan

Leading Indicator:	Composite leading index
Yield curve:	Base lending rate less the official rediscount rate
Activity:	industrial production
Stock market:	Taiwan stock price index

Appendix 2: Estimation results for Final Model Equations

Table A2.1
United States

Sample: 1972M01 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	4.952632	1.144010	4.329185	0.0000
DOIL(-2)	0.032756	0.016939	1.933771	0.0531
DOIL(-4)	0.024560	0.012980	1.892114	0.0585
DOIL(-6)	0.028298	0.014639	1.933027	0.0532
USLI(-6)	-0.127421	0.024671	-5.164772	0.0000
USYC(-3)	-0.332561	0.090599	-3.670708	0.0002
USYC(-6)	-0.313051	0.081703	-3.831560	0.0001
DUSSTKN(-1)	-0.039853	0.022357	-1.782551	0.0747
DUSSTKN(-2)	-0.087180	0.024165	-3.607744	0.0003
DUSSTKN(-4)	-0.110286	0.025762	-4.280940	0.0000

McFadden R-squared	0.657685	Mean dependent var	0.132353
S.D. dependent var	0.339290	S.E. of regression	0.206623
Akaike info criterion	0.321499	Sum squared resid	16.94912
Schwarz criterion	0.429646	Log likelihood	-54.58579
Hannan-Quinn criter.	0.364293	Restr. log likelihood	-159.4608
LR statistic	209.7499	Avg. log likelihood	-0.133789
Prob(LR statistic)	0.000000		

Obs with Dep=0	354	Total obs	408
Obs with Dep=1	54		

Table A2.2
Japan

Sample: 1974M08 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.40877	0.299149	-1.36644	0.1718
JALI(-1)	-0.06096	0.007498	-8.12905	0.0000
JAYC(-1)	-0.70548	0.154951	-4.55293	0.0000
DJASTK(-1)	-0.04448	0.016923	-2.62807	0.0086
DJASTK(-2)	-0.06371	0.017347	-3.67271	0.0002
DJASTK(-3)	-0.06269	0.017431	-3.59631	0.0003
DJASTK(-6)	-0.04329	0.016672	-2.59674	0.0094

McFadden R-squared	0.460589	Mean dependent var	0.233422
S.D. dependent var	0.42357	S.E. of regression	0.302223
Akaike info criterion	0.623343	Sum squared resid	33.79539
Schwarz criterion	0.696356	Log likelihood	-110.5
Hannan-Quinn criter.	0.652324	Restr. log likelihood	-204.854
LR statistic	188.7065	Avg. log likelihood	-0.2931
Prob(LR statistic)	0.000000		
Obs with Dep=0	289	Total obs	377
Obs with Dep=1	88		

Table A2.3
Canada

Sample: 1972M01 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.682859	0.135067	-5.055703	0.0000
CAYC(-6)	-0.616426	0.085131	-7.240948	0.0000
DCAEMP(-2)	-1.951527	0.500282	-3.900851	0.0001
DCAEMP(-3)	-1.299095	0.450365	-2.884540	0.0039
DCAEMP(-4)	-0.865168	0.436657	-1.981345	0.0476
DCASTK(-2)	-0.040201	0.022255	-1.806411	0.0709
DCASTK(-3)	-0.060068	0.021564	-2.785619	0.0053
DCASTK(-4)	-0.052912	0.022142	-2.389657	0.0169
DCASTK(-5)	-0.051988	0.022342	-2.326880	0.0200
DCASTK(-6)	-0.038192	0.023625	-1.616636	0.1060

McFadden R-squared	0.580765	Mean dependent var	0.142157
S.D. dependent var	0.349640	S.E. of regression	0.238403
Akaike info criterion	0.391836	Sum squared resid	22.62066
Schwarz criterion	0.490151	Log likelihood	-69.93455
Hannan-Quinn criter.	0.430740	Restr. log likelihood	-166.8147
LR statistic	193.7603	Avg. log likelihood	-0.171408
Prob(LR statistic)	0.000000		

Obs with Dep=0	350	Total obs	408
Obs with Dep=1	58		

Table A2.4
United Kingdom

Sample: 1975M04 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.796258	0.452664	-6.177337	0.0000
DOIL(-5)	0.050923	0.028678	1.775667	0.0758
UKLI(-3)	-0.064419	0.022320	-2.886184	0.0039
UKLI(-6)	-0.097229	0.022904	-4.244980	0.0000
UKYC(-1)	-0.626173	0.131496	-4.761924	0.0000
DUKIP(-3)	-0.281261	0.160027	-1.757584	0.0788
DUKSTK(-2)	-0.078702	0.039652	-1.984836	0.0472
DUKEXW(-1)	0.296612	0.120174	2.468183	0.0136
DUKEXW(-2)	0.277223	0.128866	2.151256	0.0315
DUKEXW(-3)	0.363771	0.146954	2.475404	0.0133
DUKEXW(-4)	0.295629	0.117450	2.517055	0.0118
DUKEXW(-5)	0.317239	0.120917	2.623624	0.0087
DUKEXW(-6)	0.385345	0.140052	2.751447	0.0059

McFadden R-squared	0.781619	Mean dependent var	0.135501
S.D. dependent var	0.342723	S.E. of regression	0.174453
Akaike info criterion	0.243730	Sum squared resid	10.83447
Schwarz criterion	0.381508	Log likelihood	-31.96813
Hannan-Quinn criter.	0.298462	Restr. log likelihood	-146.3868
LR statistic	228.8374	Avg. log likelihood	-0.086635
Prob(LR statistic)	0.781619		

Obs with Dep=0	319	Total obs	369
Obs with Dep=1	50		

Table A2.5
Germany

Sample: 1972M01 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	8.715571	1.352739	6.442904	0.0000
GELI(-2)	-0.088014	0.014072	-6.254779	0.0000
GEYC(-6)	-1.086703	0.111377	-9.756989	0.0000
DGESTK(-2)	-0.034200	0.015707	-2.177429	0.0294
DGESTK(-5)	-0.037927	0.016318	-2.324208	0.0201
DGESTK(-6)	-0.039561	0.015742	-2.513115	0.0120

McFadden R-squared	0.617676	Mean dependent var	0.308824
S.D. dependent var	0.462575	S.E. of regression	0.272929
Akaike info criterion	0.502084	Sum squared resid	29.94500
Schwarz criterion	0.561073	Log likelihood	-96.42517
Hannan-Quinn criter.	0.525426	Restr. log likelihood	-252.2077
LR statistic	311.5650	Avg. log likelihood	-0.236336
Prob(LR statistic)	0.617676		

Obs with Dep=0	282	Total obs	408
Obs with Dep=1	126		

Table A2.6
Mexico

Sample: 1980M08 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.169952	0.110653	-1.535909	0.1246
DMXIP(-3)	-0.475197	0.106440	-4.464458	0.0000
DMXIP(-4)	-0.586875	0.112055	-5.237366	0.0000
DMXIP(-5)	-0.419026	0.098153	-4.269100	0.0000
DMXIP(-6)	-0.151991	0.086973	-1.747570	0.0805
DMXSTK(-1)	-0.025591	0.010087	-2.537056	0.0112
DMXSTK(-2)	-0.020007	0.009617	-2.080441	0.0375
DMXSTK(-3)	-0.022618	0.009880	-2.289308	0.0221
DMXSTK(-5)	-0.021711	0.009037	-2.402409	0.0163
DMXEXW(-2)	-0.064050	0.035699	-1.794150	0.0728
DMXEXW(-3)	-0.102847	0.042923	-2.396065	0.0166
DMXEXW(-4)	-0.122755	0.042992	-2.855273	0.0043
DMXEXW(-5)	-0.062575	0.036142	-1.731389	0.0834
DMXEXW(-6)	-0.083132	0.035796	-2.322374	0.0202

McFadden R-squared	0.431561	Mean dependent var	0.298361
S.D. dependent var	0.458291	S.E. of regression	0.345125
Akaike info criterion	0.784695	Sum squared resid	34.66143
Schwarz criterion	0.955463	Log likelihood	-105.6659
Hannan-Quinn criter.	0.852998	Restr. log likelihood	-185.8880
LR statistic	160.4442	Avg. log likelihood	-0.346446
Prob(LR statistic)	0.000000		

Obs with Dep=0	214	Total obs	305
Obs with Dep=1	91		

Table A2.7
Korea

Sample: 1976M11 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.55222	0.153915	-3.58781	0.0003
DOIL(-2)	0.041523	0.017324	2.396846	0.0165
DOIL(-3)	-0.96416	0.257436	-3.74522	0.0002
DKOLI(-3)	-0.55904	0.26935	-2.07552	0.0379
DKOLI(-4)	-0.94321	0.242563	-3.8885	0.0001
DKOLI(-6)	0.339092	0.136872	2.477444	0.0132
DKOSR(-2)	-0.12034	0.061974	-1.94177	0.0522
DKOEXN(-4)	-0.17304	0.067649	-2.5579	0.0105
DKOEXN(-6)	-0.55222	0.153915	-3.58781	0.0003

McFadden R-squared	0.459481	Mean dependent var	0.111429
S.D. dependent var	0.315113	S.E. of regression	0.242286
Akaike info criterion	0.423528	Sum squared resid	20.0763
Schwarz criterion	0.51171	Log likelihood	-66.1174
Hannan-Quinn criter.	0.458627	Restr. log likelihood	-122.322
LR statistic	112.4093	Avg. log likelihood	-0.18891
Prob(LR statistic)	0.000000		

Obs with Dep=0	311	Total obs	350
Obs with Dep=1	39		

Table A2.8
Taiwan

Sample: 1973M09 2005M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.751060	0.151228	-11.57896	0.0000
DOIL(-3)	0.035328	0.014206	2.486879	0.0129
DTALI(-3)	-0.305428	0.127583	-2.393966	0.0167
DTALI(-5)	-0.360367	0.130109	-2.769728	0.0056
DTALI(-6)	-0.250712	0.126296	-1.985118	0.0471
DTASTK(-1)	-0.034905	0.012834	-2.719728	0.0065
DTAEXW(-4)	0.150859	0.064824	2.327193	0.0200
DTAEXW(-5)	0.139373	0.067476	2.065516	0.0389

McFadden R-squared	0.370233	Mean dependent var	0.074742
S.D. dependent var	0.263315	S.E. of regression	0.214692
Akaike info criterion	0.375941	Sum squared resid	17.51525
Schwarz criterion	0.457611	Log likelihood	-64.93261
Hannan-Quinn criter.	0.408322	Restr. log likelihood	-103.1058
LR statistic	76.34630	Avg. log likelihood	-0.167352
Prob(LR statistic)	0.000000		

Obs with Dep=0	359	Total obs	388
Obs with Dep=1	29		

Table A2.9
United States

Sample: 1972M01 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	6.435547	1.509281	4.263982	0.0000
DOIL(-2)	0.025732	0.017446	1.474996	0.1402
DOIL(-4)	0.025575	0.014564	1.75612	0.0791
DOIL(-6)	0.048283	0.023151	2.085595	0.0370
USLI(-6)	-0.15624	0.032292	-4.83823	0.0000
USYC(-3)	-0.38152	0.107047	-3.56408	0.0004
USYC(-6)	-0.30818	0.094461	-3.26251	0.0011
DUSSTKN(-1)	-0.10188	0.035109	-2.9017	0.0037
DUSSTKN(-2)	-0.11312	0.035914	-3.1497	0.0016
DUSSTKN(-4)	-0.21103	0.049825	-4.2355	0.0000
DUSSTKN(-6)	-0.19571	0.050501	-3.87542	0.0001

McFadden R-squared	0.711316	Mean dependent var	0.136905
S.D. dependent var	0.344259	S.E. of regression	0.192309
Akaike info criterion	0.296022	Sum squared resid	12.01939
Schwarz criterion	0.420987	Log likelihood	-38.7317
Hannan-Quinn criter.	0.345837	Restr. log likelihood	-134.166
LR statistic	190.8693	Avg. log likelihood	-0.11527
Prob(LR statistic)	0.000000		

Obs with Dep=0	290	Total obs	336
Obs with Dep=1	46		

Table A2.10
Japan

Sample: 1974M08 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.25256	0.32282	-0.78236	0.4340
JALI(-1)	-0.05203	0.007676	-6.77859	0.0000
JAYC(-1)	-0.68727	0.163523	-4.20287	0.0000
DJASTK(-1)	-0.04278	0.018744	-2.28257	0.0225
DJASTK(-2)	-0.06002	0.019355	-3.10105	0.0019
DJASTK(-3)	-0.05661	0.019483	-2.90536	0.0037
DJASTK(-6)	-0.03523	0.018117	-1.94476	0.0518

McFadden R-squared	0.389278	Mean dependent var	0.186885
S.D. dependent var	0.39046	S.E. of regression	0.306949
Akaike info criterion	0.634241	Sum squared resid	28.07686
Schwarz criterion	0.719625	Log likelihood	-89.7217
Hannan-Quinn criter.	0.668393	Restr. log likelihood	-146.911
LR statistic	114.3782	Avg. log likelihood	-0.29417
Prob(LR statistic)	0.000000		

Obs with Dep=0	248	Total obs	305
Obs with Dep=1	57		

Table A2.11
Canada

Sample: 1972M01 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.77981	0.144067	-5.41285	0.0000
CAYC(-6)	-0.57687	0.08698	-6.63222	0.0000
DCAEMP(-2)	-2.06606	0.530446	-3.89494	0.0001
DCAEMP(-3)	-1.30049	0.458622	-2.83563	0.0046
DCAEMP(-4)	-0.85409	0.455406	-1.87545	0.0607
DCASTK(-2)	-0.02893	0.025495	-1.13463	0.2565
DCASTK(-3)	-0.04466	0.024362	-1.8332	0.0668
DCASTK(-4)	-0.02528	0.026079	-0.96944	0.3323
DCASTK(-5)	-0.0379	0.025713	-1.4741	0.1405
DCASTK(-6)	-0.01829	0.026964	-0.67818	0.4977

McFadden R-squared	0.578636	Mean dependent var	0.145833
S.D. dependent var	0.353465	S.E. of regression	0.237754
Akaike info criterion	0.409604	Sum squared resid	18.42785
Schwarz criterion	0.523208	Log likelihood	-58.8134
Hannan-Quinn criter.	0.454889	Restr. log likelihood	-139.579
LR statistic	161.5307	Avg. log likelihood	-0.17504
Prob(LR statistic)	0.000000		
Obs with Dep=0	287	Total obs	336
Obs with Dep=1	49		

Table A2.12
United Kingdom

Sample: 1975M04 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.47021	0.463374	-5.33091	0.0000
DOIL(-5)	0.050074	0.029881	1.675791	0.0938
UKLI(-3)	-0.06309	0.024201	-2.6068	0.0091
UKLI(-6)	-0.09063	0.024243	-3.73845	0.0002
UKYC(-1)	-0.52791	0.135246	-3.90332	0.0001
DUKIP(-3)	-0.2931	0.174844	-1.67633	0.0937
DUKSTK(-2)	-0.0779	0.038985	-1.99813	0.0457
DUKEXW(-1)	0.299492	0.123517	2.424707	0.0153
DUKEXW(-2)	0.299713	0.139487	2.148681	0.0317
DUKEXW(-3)	0.331681	0.144771	2.291077	0.0220
DUKEXW(-4)	0.275745	0.118103	2.334779	0.0196
DUKEXW(-5)	0.286123	0.121838	2.348386	0.0189
DUKEXW(-6)	0.372607	0.14205	2.623064	0.0087

McFadden R-squared	0.778081	Mean dependent var	0.16835
S.D. dependent var	0.374808	S.E. of regression	0.190251
Akaike info criterion	0.288717	Sum squared resid	10.2795
Schwarz criterion	0.450395	Log likelihood	-29.8744
Hannan-Quinn criter.	0.353442	Restr. log likelihood	-134.618
LR statistic	209.4879	Avg. log likelihood	-0.10059
Prob(LR statistic)	0.000000		
Obs with Dep=0	247	Total obs	297
Obs with Dep=1	50		

Table A2.13
Germany

Sample: 1972M01 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	6.670281	1.380097	4.833196	0.0000
GELI(-2)	-0.0694	0.014387	-4.82346	0.0000
GEYC(-6)	-1.18085	0.134898	-8.75362	0.0000
DGESTK(-2)	-0.01255	0.02355	-0.53278	0.5942
DGESTK(-5)	-0.01344	0.022761	-0.59031	0.5550
DGESTK(-6)	-0.02336	0.021856	-1.06888	0.2851

McFadden R-squared	0.682478	Mean dependent var	0.282738
S.D. dependent var	0.451002	S.E. of regression	0.248086
Akaike info criterion	0.413896	Sum squared resid	20.31032
Schwarz criterion	0.482059	Log likelihood	-63.5345
Hannan-Quinn criter.	0.441067	Restr. log likelihood	-200.095
LR statistic	273.121	Avg. log likelihood	-0.18909
Prob(LR statistic)	0.000000		
Obs with Dep=0	241	Total obs	336
Obs with Dep=1	95		

Table A2.14
Mexico

Sample: 1980M11 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.75586	0.162415	-4.65388	0.0000
DMXIP(-3)	-0.5478	0.148074	-3.69946	0.0002
DMXIP(-4)	-0.60023	0.150115	-3.99849	0.0001
DMXIP(-5)	-0.36793	0.126535	-2.90773	0.0036
DMXIP(-6)	-0.08565	0.112899	-0.75867	0.4481
DMXSTK(-1)	-0.01854	0.012991	-1.42738	0.1535
DMXSTK(-2)	-0.00958	0.012675	-0.75608	0.4496
DMXSTK(-3)	-0.01994	0.012878	-1.54809	0.1216
DMXSTK(-5)	-0.01654	0.01128	-1.46625	0.1426
DMXEXW(-2)	-0.1031	0.043535	-2.36817	0.0179
DMXEXW(-3)	-0.11178	0.051955	-2.15154	0.0314
DMXEXW(-4)	-0.14198	0.056069	-2.53231	0.0113
DMXEXW(-5)	-0.0545	0.039841	-1.36793	0.1713
DMXEXW(-6)	-0.09514	0.040938	-2.32408	0.0201

McFadden R-squared	0.589762	Mean dependent var	0.2103
S.D. dependent var	0.408399	S.E. of regression	0.252765
Akaike info criterion	0.542187	Sum squared resid	13.99194
Schwarz criterion	0.749546	Log likelihood	-49.1648
Hannan-Quinn criter.	0.625803	Restr. log likelihood	-119.845
LR statistic	141.3596	Avg. log likelihood	-0.21101
Prob(LR statistic)	0.000000		

Obs with Dep=0	184	Total obs	233
Obs with Dep=1	49		

Table A2.15
Korea

Sample: 1976M11 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.10711	0.259366	-0.41299	0.6796
DOIL(-2)	0.051578	0.023845	2.16302	0.0305
DOIL(-3)	-1.24182	0.334256	-3.71517	0.0002
DKOLI(-3)	-0.93739	0.373217	-2.51165	0.012
DKOLI(-4)	-1.19601	0.360173	-3.32066	0.0009
DKOLI(-6)	0.319373	0.143444	2.226467	0.026
DKOSR(-2)	-0.17654	0.094234	-1.87346	0.061
DKOEXN(-4)	-0.1896	0.092255	-2.05522	0.0399
DKOEXN(-6)	-0.10711	0.259366	-0.41299	0.6796
C	0.051578	0.023845	2.16302	0.0305

McFadden R-squared	0.575992	Mean dependent var	0.107914
S.D. dependent var	0.310831	S.E. of regression	0.205762
Akaike info criterion	0.347686	Sum squared resid	11.43121
Schwarz criterion	0.452078	Log likelihood	-40.3284
Hannan-Quinn criter.	0.389567	Restr. log likelihood	-95.1124
LR statistic	109.5681	Avg. log likelihood	-0.14507
Prob(LR statistic)	0.000000		

Obs with Dep=0	248	Total obs	278
Obs with Dep=1	30		

Table A2.16
Taiwan

Sample: 1973M09 1999M12

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-3.112393	0.474242	-6.562874	0.0000
DOIL(-3)	0.046968	0.018933	2.480779	0.0131
DTALI(-3)	-0.370344	0.197194	-1.878068	0.0604
DTALI(-5)	-0.642545	0.211431	-3.039027	0.0024
DTALI(-6)	-0.280629	0.187902	-1.493484	0.1353
DTASTK(-1)	-0.041857	0.023825	-1.756831	0.0789
DTAEXW(-4)	0.432796	0.124400	3.479062	0.0005
DTAEXW(-5)	0.292244	0.111369	2.624110	0.0087

McFadden R-squared	0.654620	Mean dependent var	0.041139
S.D. dependent var	0.198927	S.E. of regression	0.121407
Akaike info criterion	0.169132	Sum squared resid	4.539833
Schwarz criterion	0.264214	Log likelihood	-18.72278
Hannan-Quinn criter.	0.207116	Restr. log likelihood	-54.20916
LR statistic	70.97276	Avg. log likelihood	-0.059249
Prob(LR statistic)	0.000000		

Obs with Dep=0	303	Total obs	316
Obs with Dep=1	13		