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 probability that these economies will be in either an expansion or contraction in a specific

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

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 six 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. For instance, in the current cycle, all of the models showed the indicator moving into recessionary territory at least by the first half of last year. The Mexican indicator was already signaling a recession in August of 2007, and the German and Japanese indicators crossed the threshold in December of 2007. Indicators for the United States, Canada, and Korea were signaling recessions by early 2008. Of perhaps even greater interest at the present time, indicators for five of the eight

countries have recently moved out of recessionary territory: Korea in April, Taiwan in May, the United States in June, and Canada and the United Kingdom in July. In contrast, the indicators for Japan, Germany, and Mexico remain very high, suggesting more prolonged stagnation there.

The paper is organized as follows: section 2 describes the data in general terms, with more detail provided in the Appendix. Section 3 describes and evaluates the individual country models, and section 4 does the same for the panel regression. Section 5 provides a brief discussion of the behavior of the models in the current recessionary period and section 6 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. Not counting the current recession, for which we do not yet have an identifiable trough, 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

[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.

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 the Appendix.

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 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 2006.

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. The only variable that is significant for all of the countries is changes in stock prices. The leading indicator variable is significant for all of the countries except Canada, and the yield spread (the change in the short-term interest rate for Korea) is significant all of the countries except Mexico and Taiwan. The real activity variable is significant for Canada, Japan, Mexico, and Taiwan, and oil prices are significant for the United States, Korea, and Taiwan. Exchange rates play different roles for different countries. 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 .3 for Taiwan to a high of .7 for United Kingdom.

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

$$L = \alpha \times \pi_1 (T) + (1-\alpha) \times \pi_2 (T)$$

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 is .1 for Canada, Korea, and Taiwan and .2 for the five other countries. When the weight on Type I errors (missing an actual recession) rises to .75, the optimal threshold is .1 for seven of the countries and .2 for other one. When the weight on Type I errors falls to .25, the optimal threshold ranges from .2 to .6. 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, 85 percent for Japan and 75 percent for Mexico. The percentage of recessions correctly called (column 2) is usually lower, although there are a couple of exceptions. Taiwan, which has the fewest number of formal recessions, stands out as having the smallest percentage of correctly identified recessions, along with the largest number of false positives, the next column. However, a number of these are likely to have been close calls.

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, and is around 30-40 percent for most of the other countries. It is highest for Taiwan. The probability of a recession when the indicator is less than .2 (column 5) is quite small for most countries, although it is higher for Mexico.

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 to 2008. 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 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 generally a little lower than for the in-sample results. The percentage of recessionary periods is also usually a lower, except for Japan, where all of the recessionary periods were correctly called. The percentage of false alarms when the indicator is above the critical value is higher for some, but lower for others. (Canada shows no false alarms during the out-of-sample

period.) The probability of missing a recessionary period is considerably higher for a number of countries, notably Mexico, Taiwan, and Germany. However, many of the missed observations occur during long recessionary periods where substantial parts are categorized correctly.

Charts 9-16 give a more qualitative impression of how the indicators perform. One interesting result is that only two recessions (Taiwan, 2003 and the current recession in the United Kingdom) are 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 five recessions during the out-of-sample period, compared with just two official recessions.

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 McFadden R^2 is .42.

[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.

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.

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 generally lower than for the individual equations (table 5), although the size of the difference is 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 four of the eight countries. The overall percentage of periods correctly categorized is 83 percent for the panel regression, similar to the composite of 82 percent for the individual regressions.

V. Performance of Models in Current Recession

Charts 25 through 32 show the forecasts from the models through 2006 for the period starting in January 2007. For the United States both the individual equation and the panel regression began to signal a recession in January of 2008, about a month later

than the official start of the recession (as defined by the NBER). The indicators then dropped back out of recessionary territory in the summer of 2008. The indicator from the panel regression began to signal a recession again in November of 2008 but the single-equation indicator did not exceed the critical value again until March 2009. Both indicators suggest that the economy moved back into expansionary territory in June of July.

The indicators for Canada were also a little late in identifying the Canadian recession, although the panel indicator was close. These indicators also moved below the critical value in June or July. In contrast, the single-equation indicators for Japan, Germany, Mexico, and Korea all moved above the critical value before the official start of the recessions in those countries (although the Mexican indicator then moved back down about the time the recession started before increasing again). Both the single-equation and panel indicators for Japan, Germany, and Mexico are all currently still in recessionary territory, although both indicators for Korea have dropped back below the critical value.

The single-equation indicator for the United Kingdom has been remarkably stable throughout the recessionary period until very recently, although the panel regression indicator moved above the critical value near the official start of the recession and dropped back in July. The indicators also reacted fairly late for Taiwan, although they have both moved below the critical value recently.

In sum, the indicators for most countries were signaling recessionary conditions before these were officially acknowledged, and thus could have provided useful information for policymakers. The main exceptions were the United Kingdom and

Taiwan, where the indicators moved up too late. Both of these equations include a prominent role for the real exchange rate, so that depreciation reduces the probability of a recession. However, it may be the case that the expansionary effect of a lower exchange rate is not as strong when most of the world is experiencing a recession. Future work will attempt to better account for the interactions among countries.

VI. 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 both the country equations and 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 both total and recessionary periods correctly identified is a little lower for the panel regression on average. The low critical value chosen for the evaluation 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 47 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. In

particular, the indicators were signaling the current recession before it was officially identified in most of the countries. The indicators also are currently suggesting that the recession is ending in many countries, although the economies of Japan and Germany are still lagging.

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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	2008:4	2001:1	2008:7	2008:2	1994:11
trough	1991:3	1992:4	2003:7	NA	2003:8	NA	NA	1995:7
peak	2001:3	2000:12	2008:2		2008:3			2000:8
trough	2001:11	2001:9	NA		NA			2003:8
peak	2007:11	2008:1						2004:12
trough	NA	NA						2005:6
peak								2008:4
trough								NA

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 (sum of lagged coefficients, t-statistics in parentheses)

Region / Coeff.	U.S.	Canada	Japan	U.K.	Germany	Mexico	Korea	Taiwan
Oil Price	.043 (1.91)						.082 (2.55)	
Leading Indicator	-1.28 (-5.26)		-.061 (-8.09)	-.107 (-6.60)	-.099 (-6.73)	-.164 (-1.62)	-2.89 (-6.82)	-.086 (-2.31)
Yield Spread	-.656 (-7.04)	-.601 (-7.58)	-.706 (-4.36)	-.609 (-5.87)	-1.15 (-9.56)		.246+ (1.58)	
Stock Price	-.37 (-6.34)	-.271 (-5.02)	-.359 (-7.37)	-.050 (-1.58)	-.177 (-4.47)	-.068 (-3.30)	-.053 (-2.12)	-.098 (-4.02)
Real Activity		-3.24 (-5.34)	-.130 (-1.96)			-1.48 (-7.21)		-.484 (-3.99)
Nominal Ex. Rate							-.538 (-3.85)	
Real Ex. Rate				1.40 (5.64)		-.33 (-4.21)		.440 (3.80)
McFadden R^2	.65	.54	.51	.73	.64	.41	.55	.33

+ change in short-term interest rate.

Table 4
Value of Loss Function for given α and threshold

	US	UK	CA	JA	GE	KO	TA	MX
Threshold	α = .25							
.1	9.12	8.30	13.93	20.93	17.69	12.98	17.84	34.14
.2	**7.18**	6.76	12.89	14.95	11.40	**9.81**	**15.72**	25.55
.3	7.55	5.99	12.95	13.16	9.52	10.53	16.07	20.91
.4	7.50	**5.82**	11.73	12.08	8.81	10.42	17.60	17.88
.5	7.20	6.08	**11.35**	**11.80**	**8.08**	12.75	20.64	15.56
.6	10.75	6.63	13.52	12.30	8.90	13.98	20.44	**15.45**
.7	12.14	6.68	13.97	13.62	9.92	15.67	19.83	16.76
.8	14.04	15.23	15.07	16.16	10.74	17.54	20.69	17.36
.9	19.19	13.50	17.24	18.32	14.06	18.59	24.14	17.86
Threshold	α = .50							
.1	7.32	7.53	**11.01**	16.28	12.59	**12.08**	**21.09**	24.23
.2	**7.26**	**7.17**	17.21	**14.62**	**9.19**	12.53	26.57	**20.70**
.3	9.35	8.66	19.56	15.37	9.52	16.42	30.26	22.00
.4	11.18	9.21	19.31	16.20	11.17	18.06	33.57	22.55
.5	12.21	10.06	20.21	17.94	11.74	23.03	40.20	23.20
.6	20.13	11.76	25.11	20.60	14.40	26.41	40.06	26.05
.7	22.91	12.46	26.55	24.59	17.46	30.10	39.66	31.32
.8	27.26	30.15	29.59	31.32	20.13	34.77	41.38	34.29
.9	38.10	27.00	34.49	36.63	27.10	37.18	48.28	35.72
Threshold	α = .75							
.1	**5.51**	**6.77**	**8.09**	**11.63**	7.48	**11.17**	**24.34**	**14.31**
.2	7.33	7.59	21.54	14.28	**6.97**	15.24	37.43	15.84
.3	11.16	11.33	26.16	17.57	9.52	22.32	44.44	23.09
.4	14.85	12.61	26.90	20.31	13.52	25.69	49.55	27.21
.5	17.21	14.03	29.07	24.09	15.39	33.31	59.75	30.83
.6	29.51	16.88	36.69	28.91	19.90	38.85	59.69	36.65
.7	33.67	18.23	39.14	35.55	25.00	44.54	59.48	45.88
.8	40.48	45.08	44.10	46.47	29.51	52.00	62.07	51.21
.9	57.02	40.50	51.73	54.95	40.13	55.77	72.41	53.57

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.	92.9	92.6	34.2	65.8	1.2
Canada	89.1	74.1	41.9	58.1	4.3
U.K.	93.4	92.0	31.3	68.7	1.3
Japan	85.0	86.1	38.3	61.7	4.5
Germany	89.1	95.2	25.0	75.0	2.3
Korea	91.7	82.1	41.8	58.2	2.3
Taiwan	92.0	51.7	54.5	45.5	3.8
Mexico	74.2	87.9	47.0	53.0	6.6
Total	88.8	86.3	37.5	62.5	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.	82.4	80.0	48.4	51.6	5.2
Canada	90.7	52.4	0.0	100.0	10.3
U.K.	87.0	0.0	100.0	0.0	7.8
Japan	80.6	100.0	33.9	66.1	0.0
Germany	85.2	67.5	10.0	90.0	16.7
Korea	75.0	78.6	68.6	31.4	4.1
Taiwan	79.6	15.4	0.0	100.0	21.2
Mexico	76.9	60.0	14.3	85.7	27.4
Total	82.2	63.6	34.6	65.4	12.3

p.v. = predicted value

Table 7 **Results of Panel Regression** **(sum of lagged coefficients)**				
Sample: 1973:08 to 2006:12				
Variable	Coefficient	Std. Error	Z-Statistic	Prob.
C	.633	.235	2.696	.007
Exchange rate	-17.024	3.228	-11.246	.000
Stock price	-11.344	1.102	-10.290	.000
Leading Ind.	-.034	.004	-8.180	.000
Yield	-0.520	0.031	-16.772	.000
Activity	-63.855	5.678	-11.246	.000
McFadden R-squared	0.415		Total observations	3035
Obs. with Dep. = 0	2510		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	24.70	19.20	**13.69**
.2	15.57	**15.71**	15.86
.3	**12.58**	16.83	21.08
.4	13.46	21.74	30.01
.5	13.92	25.09	36.26
.6	15.80	29.77	43.74
.7	18.09	34.98	51.87
.8	20.13	39.45	58.78
.9	21.26	42.24	63.21

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	92.3	88.9	34.2	65.8	1.8
Canada	86.7	77.6	47.1	52.9	4.1
U.K.	93.4	80.4	42.2	57.8	2.9
Japan	78.1	83.1	50.4	49.6	5.7
Germany	82.7	94.4	34.4	65.6	3.2
Korea	85.8	59.0	60.3	39.7	5.3
Taiwan	83.5	55.2	69.8	30.2	3.8
Mexico	72.1	93.4	51.7	48.3	4.3
Full Regression	85.2	84.0	46.7	53.3	3.8

* 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	88.0	70.0	33.3	66.7	6.9
Canada	95.4	80.0	5.9	94.1	4.4
U.K.	95.4	75.0	33.3	66.7	2.0
Japan	63.9	100.0	48.8	51.3	0.0
Germany	84.3	90.0	26.5	73.5	6.8
Korea	88.0	7.1	0.0	100.0	12.1
Taiwan	75.0	15.4	20.0	80.0	21.4
Mexico	72.2	62.0	26.2	73.8	28.8
Full Regression	83.2	68.0	33.5	66.5	10.9

* 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

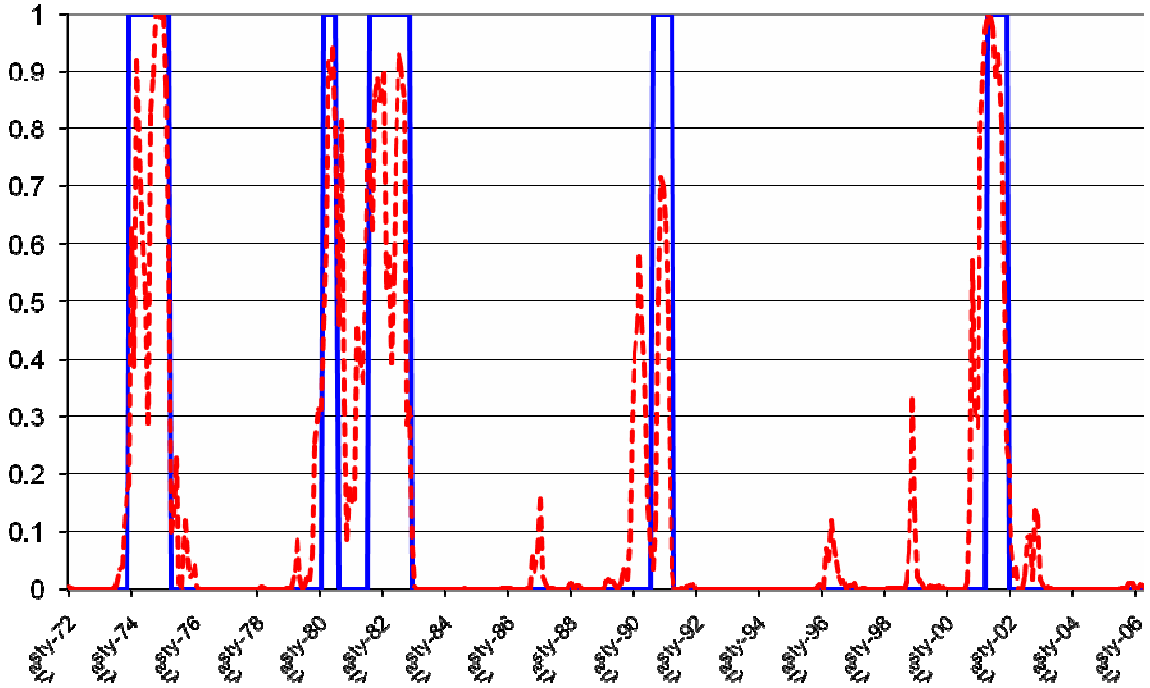


Chart 2
Canada

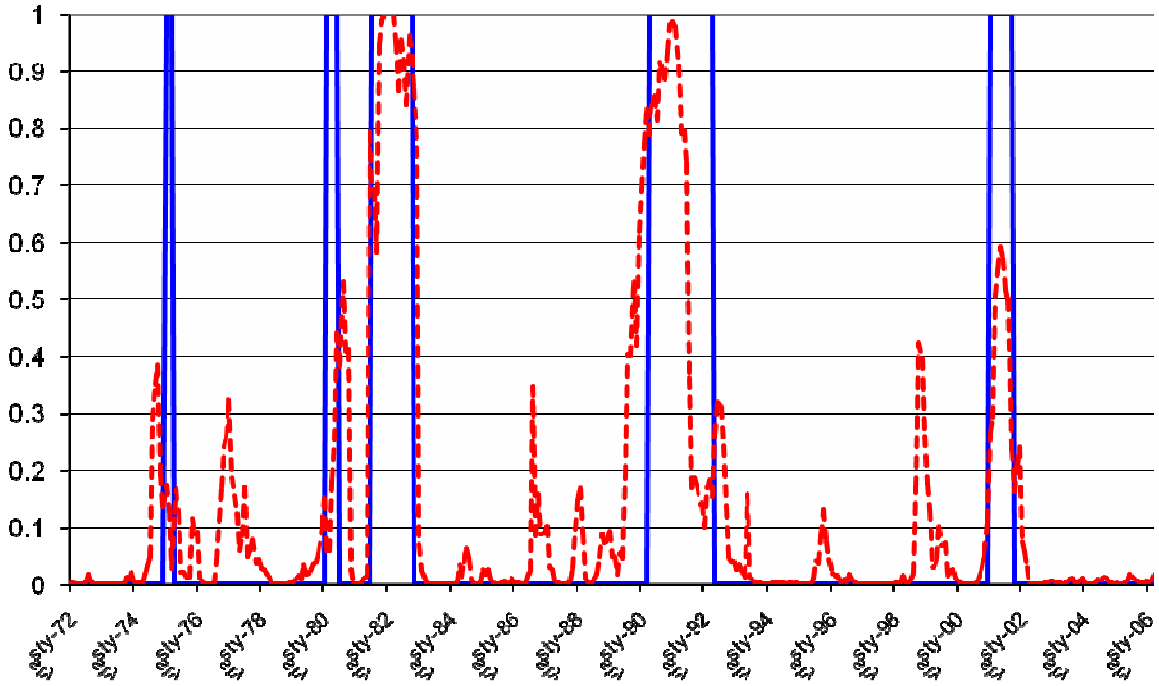


Chart 3
Japan

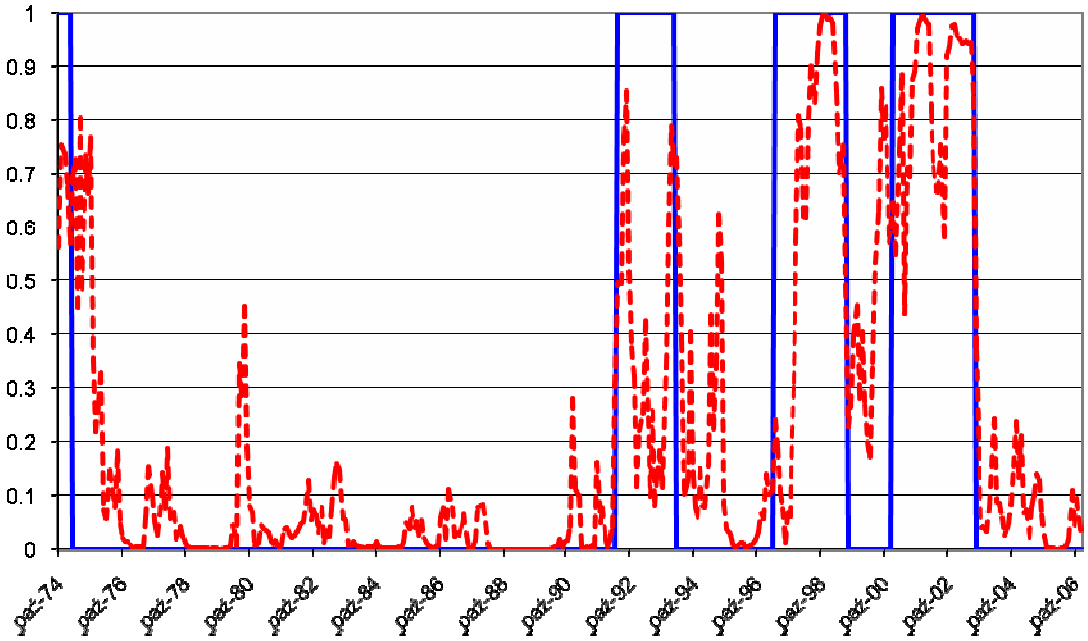


Chart 4
Germany

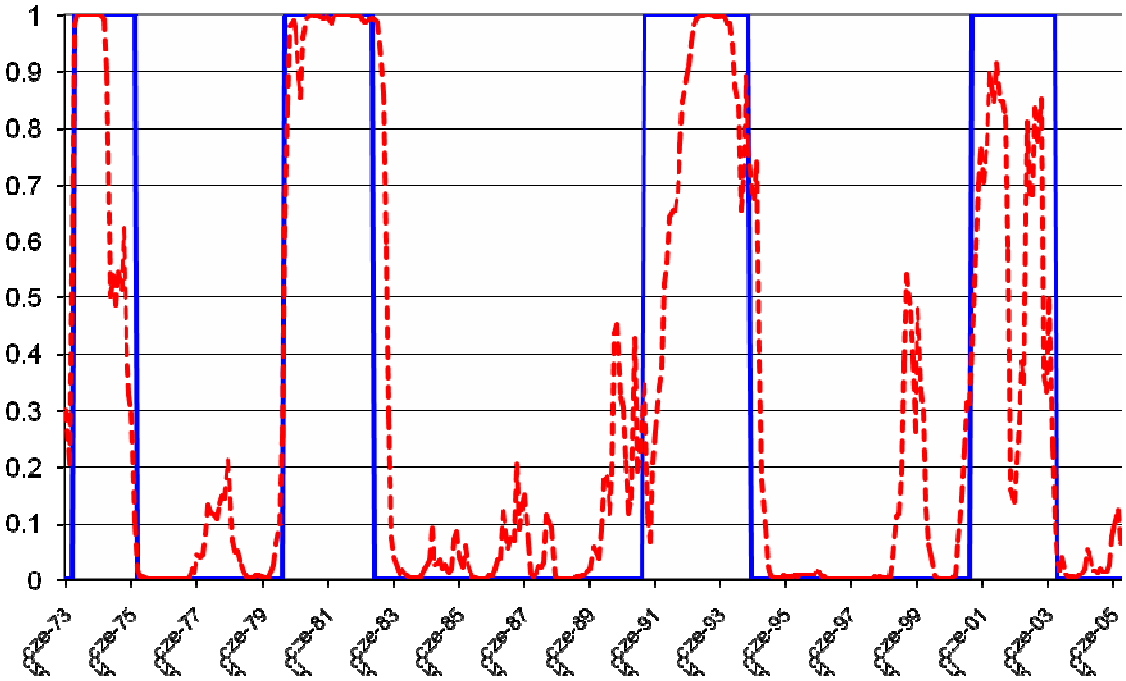


Chart 5
United Kingdom

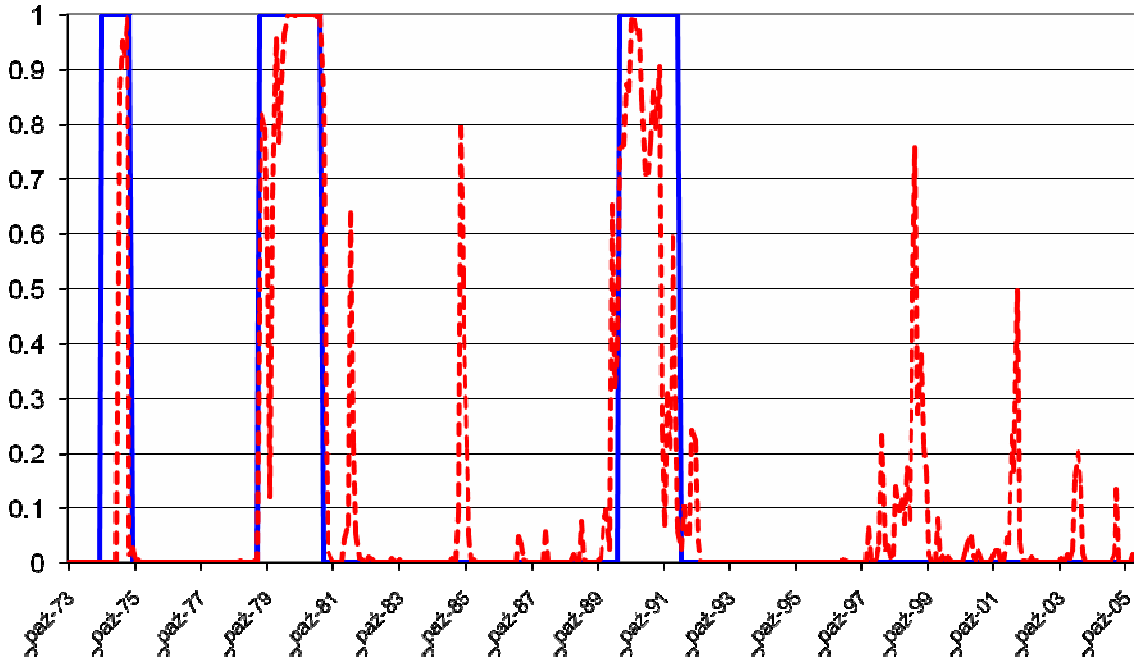


Chart 6
Mexico

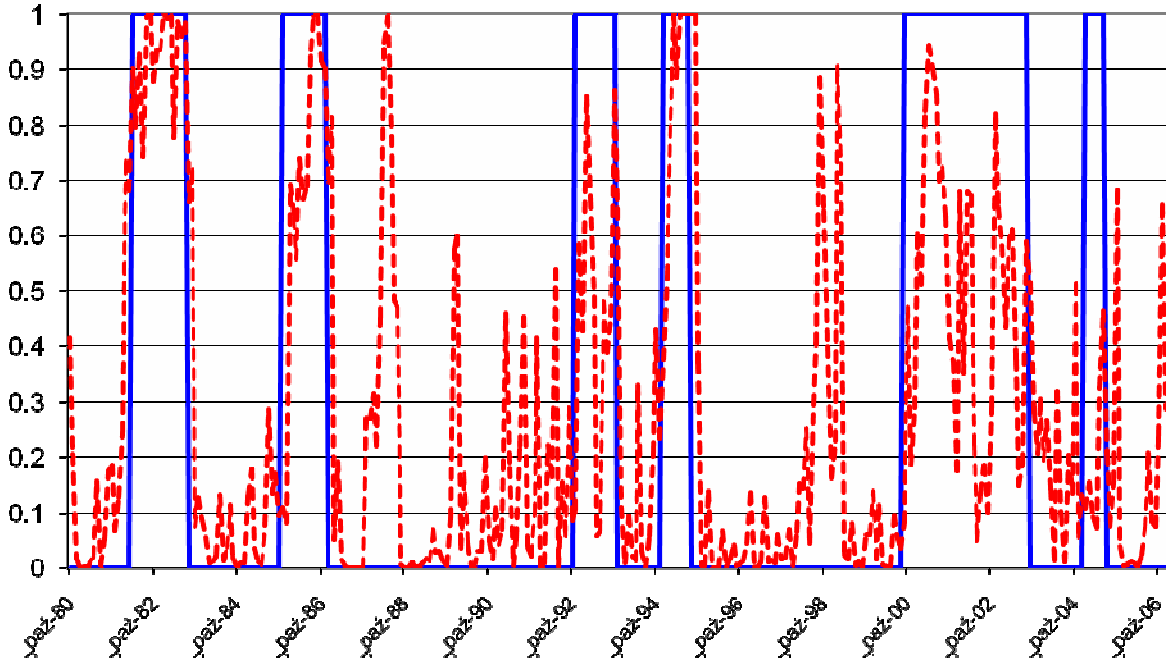


Chart 7
Korea

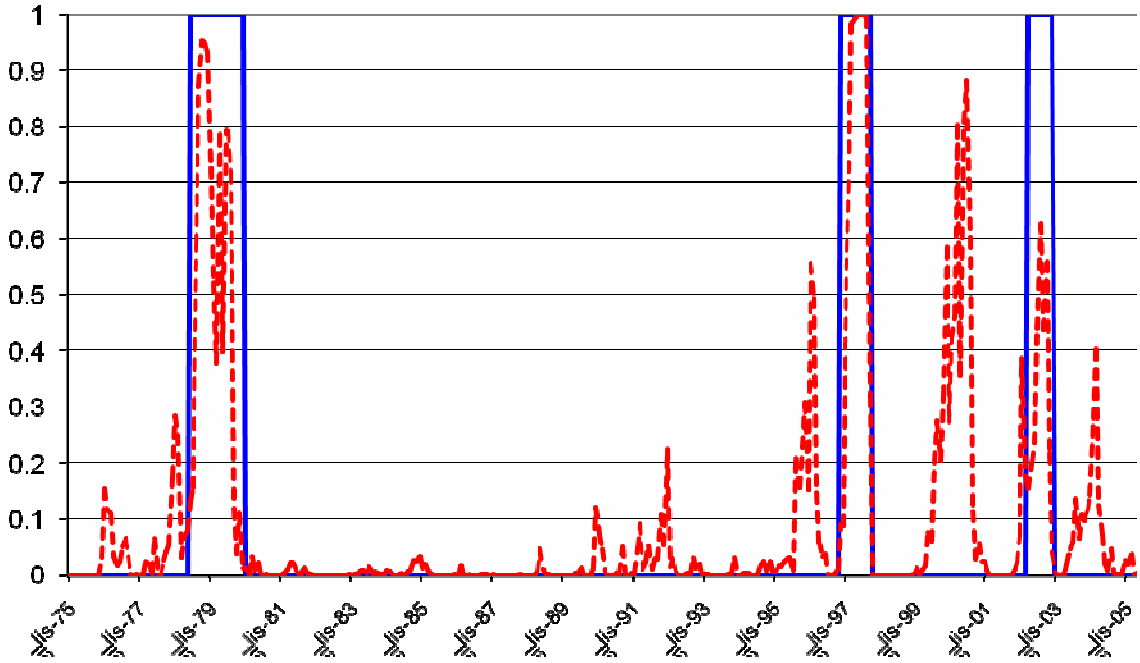
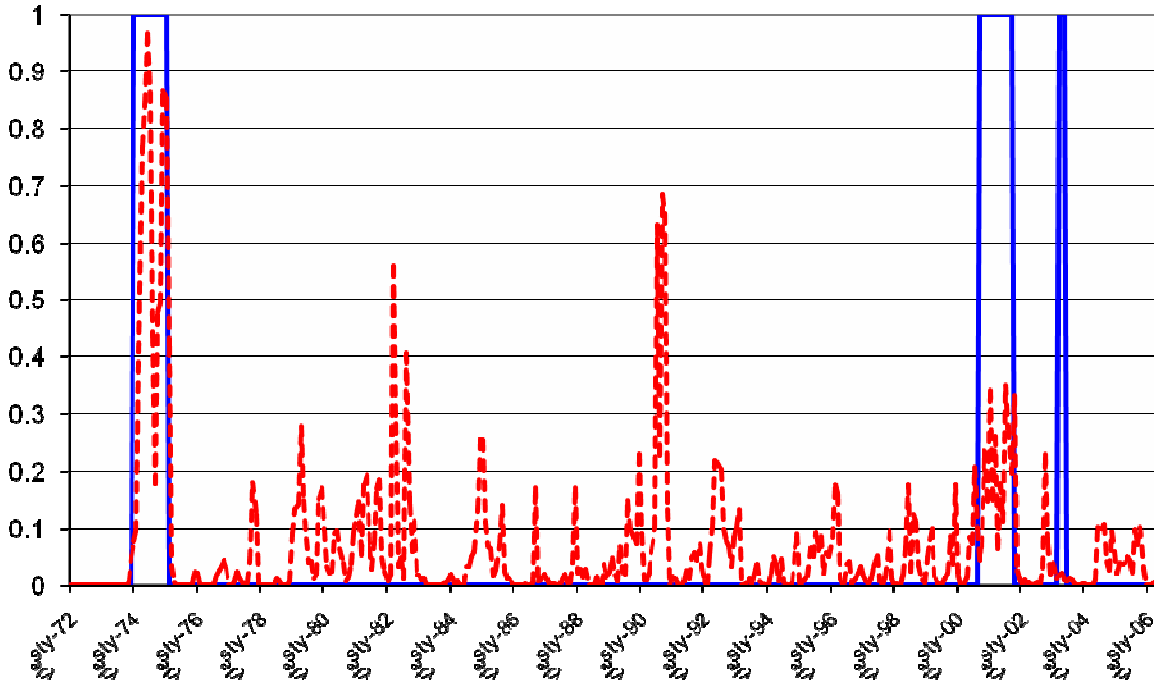


Chart 8
Taiwan



Out-of-Sample Forecasts

Chart 9
United States

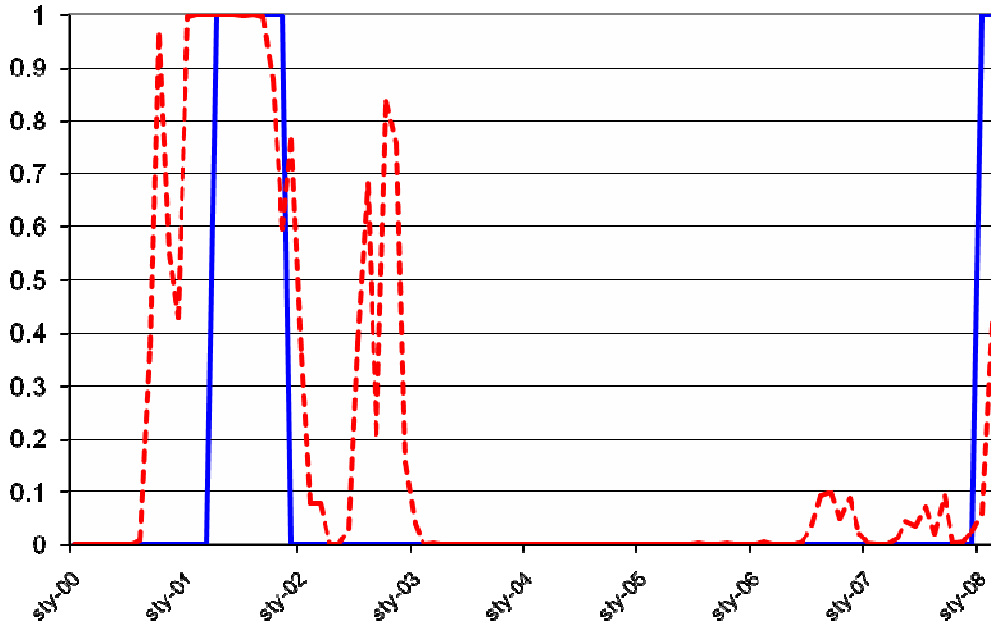


Chart 10
Canada

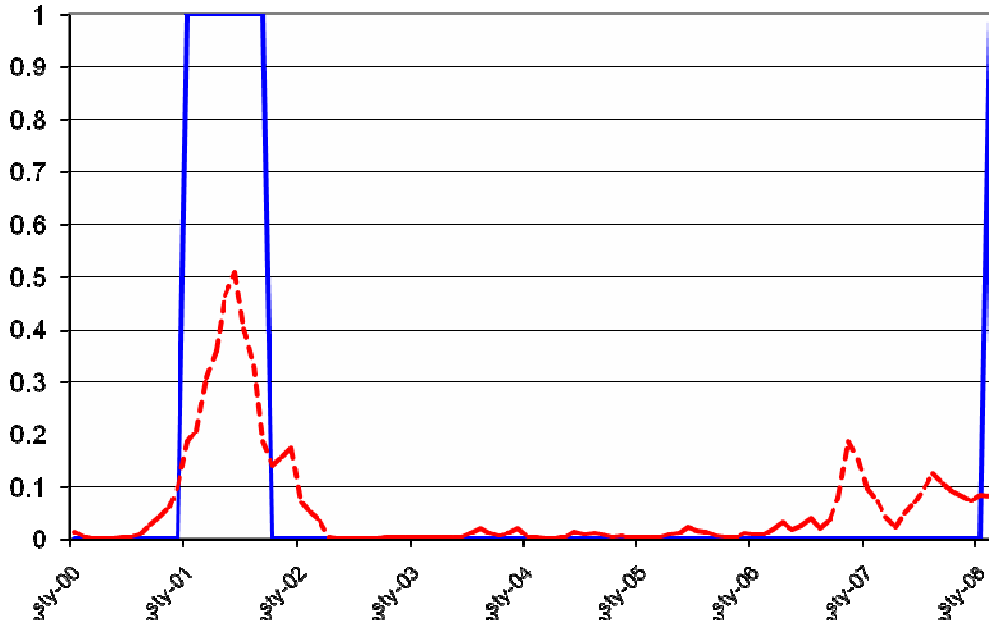


Chart 11
Japan

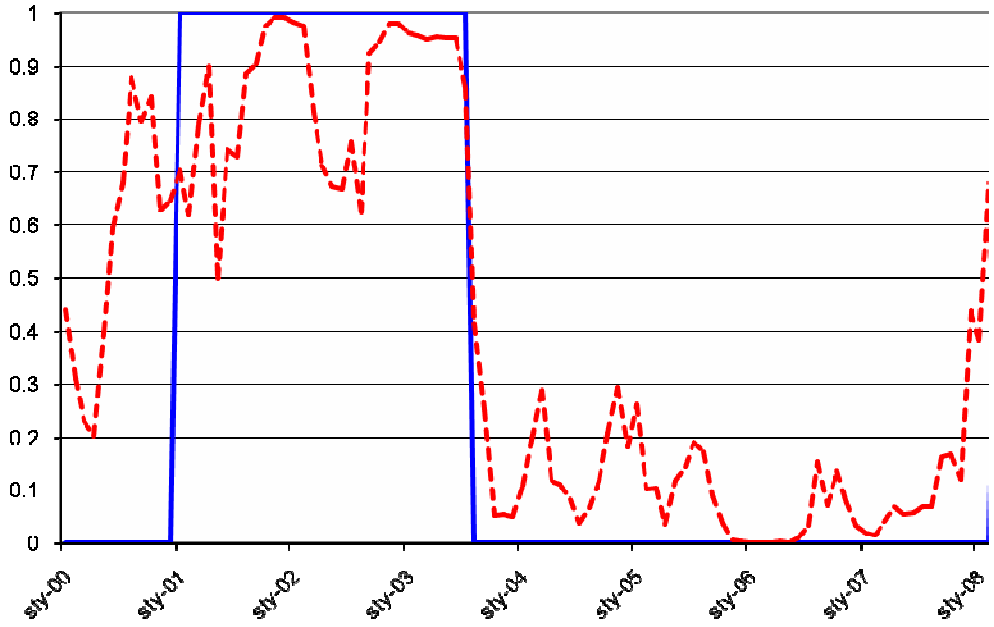


Chart 12
Germany

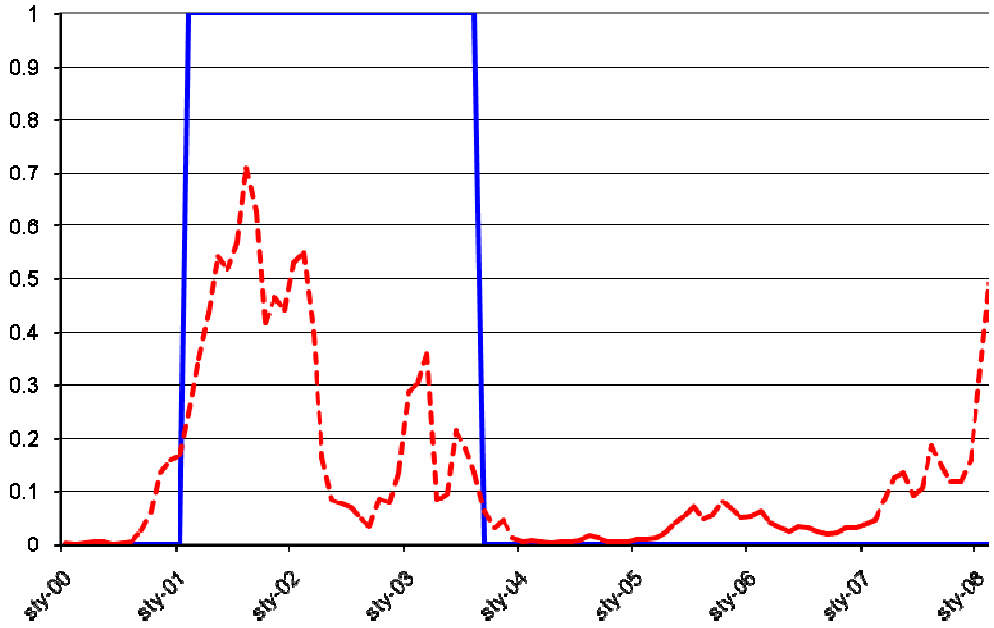


Chart 13
United Kingdom

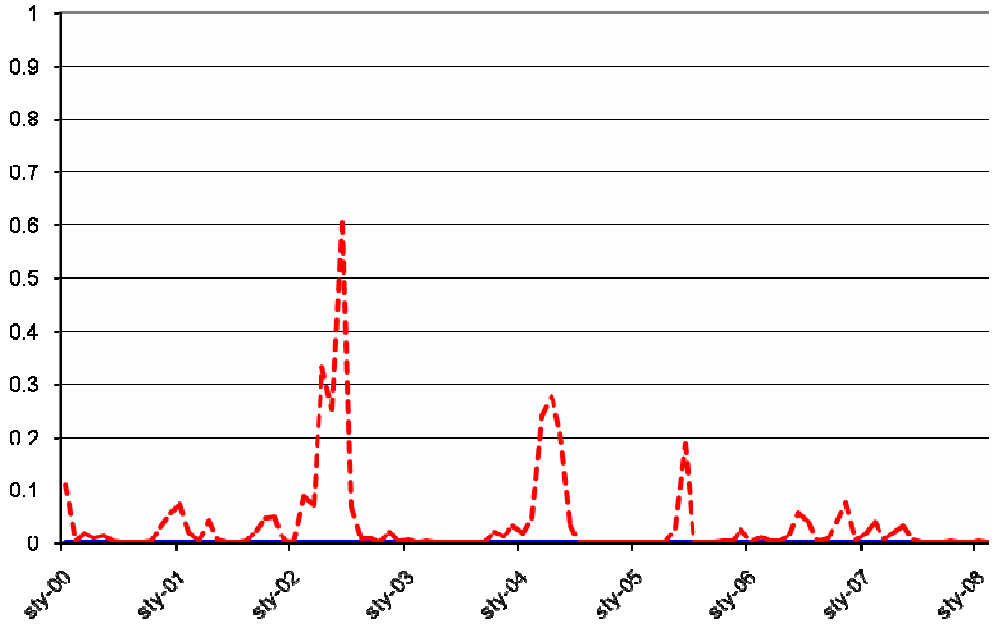


Chart 14
Mexico

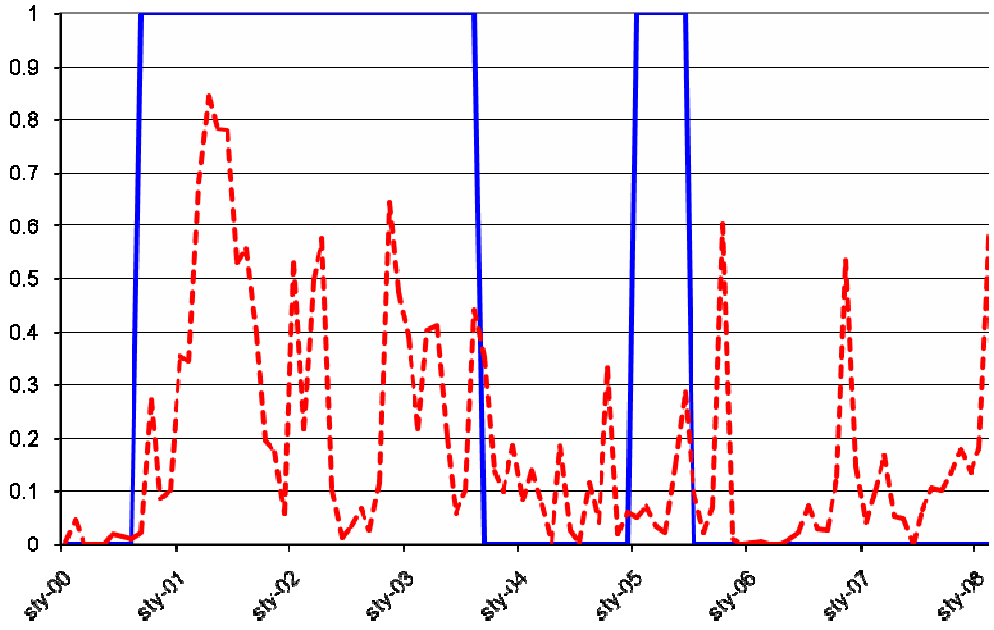


Chart 15
Korea

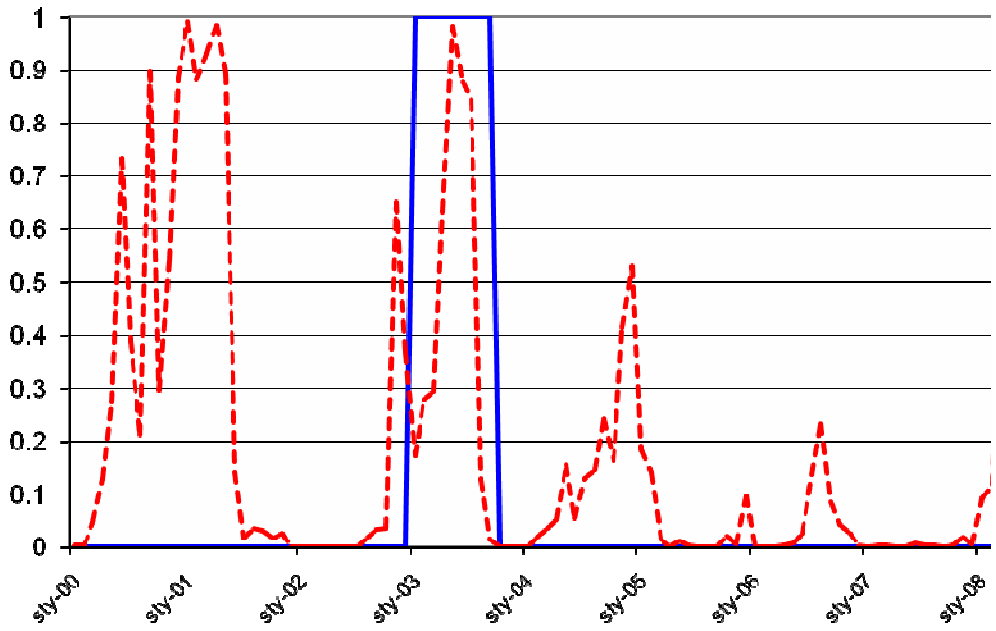
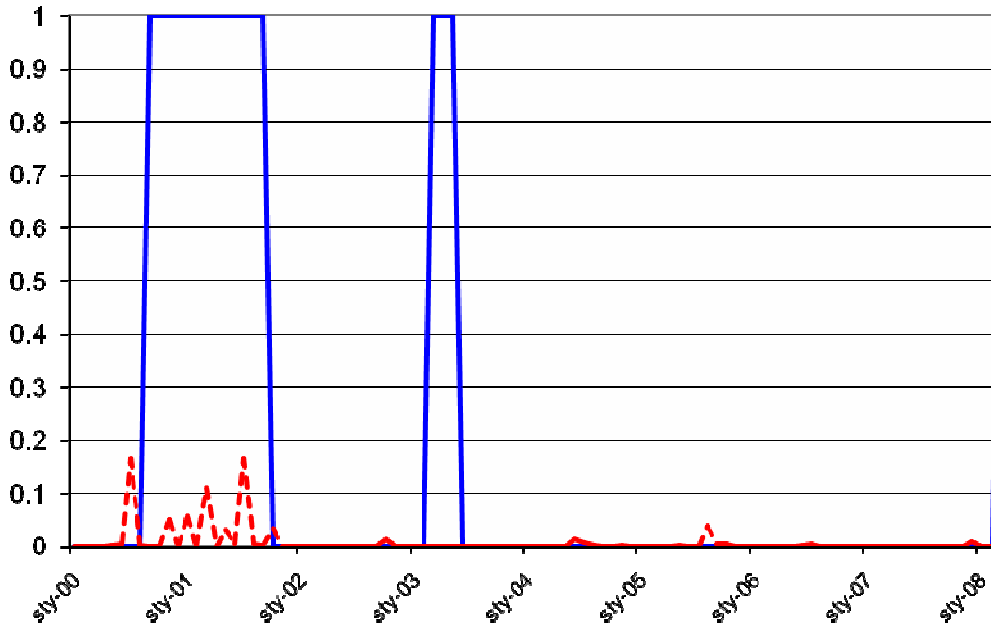


Chart 16
Taiwan



In-sample fitted values: Panel Regression

Chart 17
United States

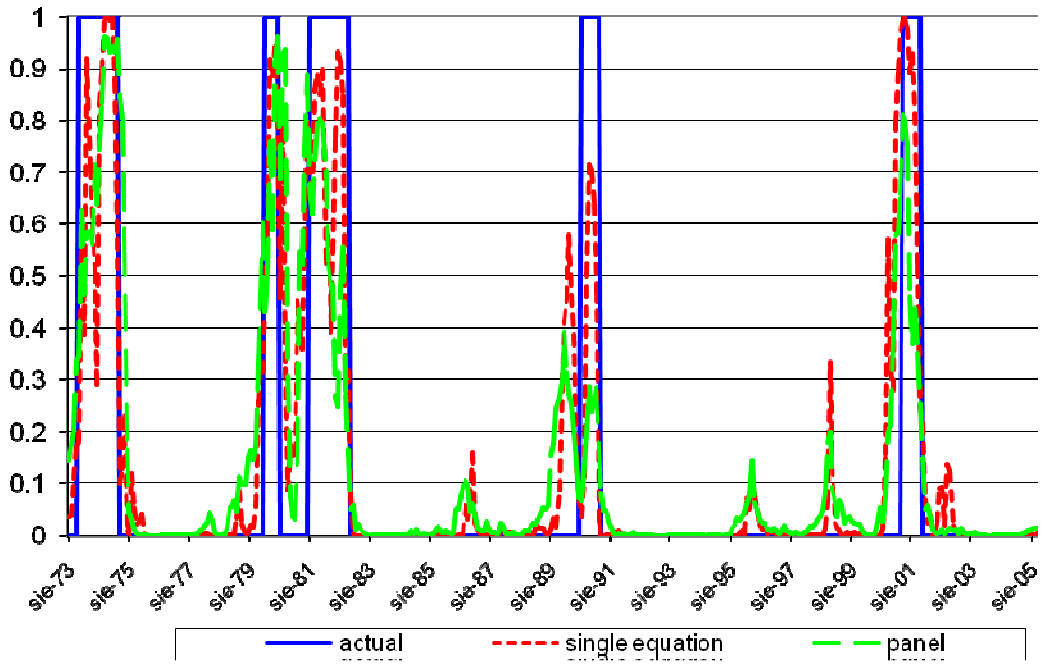


Chart 18
Canada

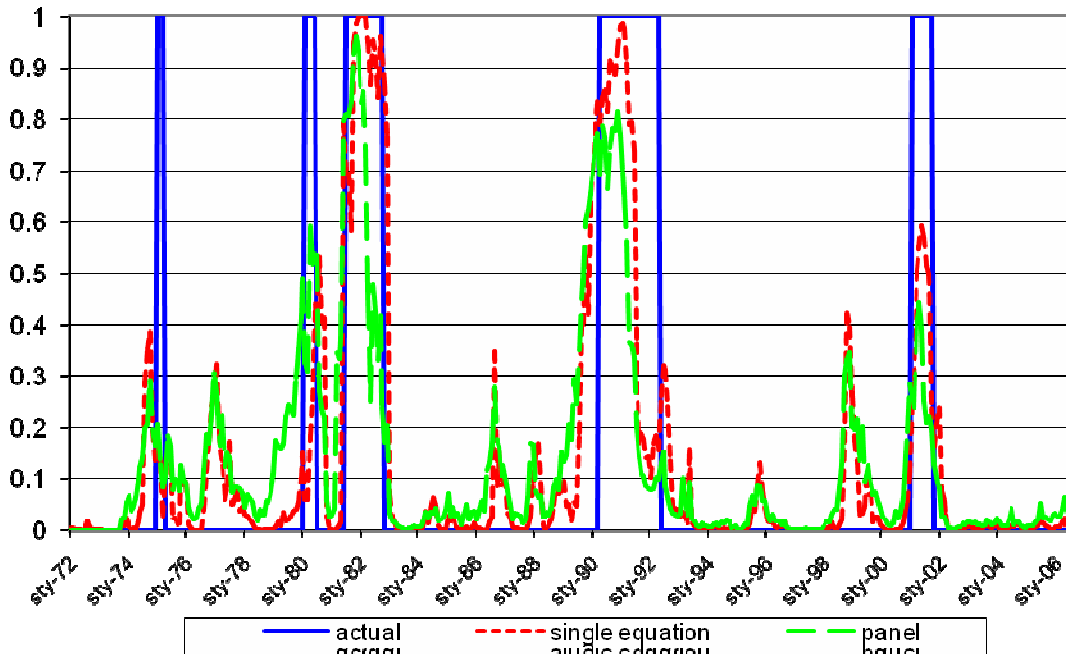


Chart 19
Japan

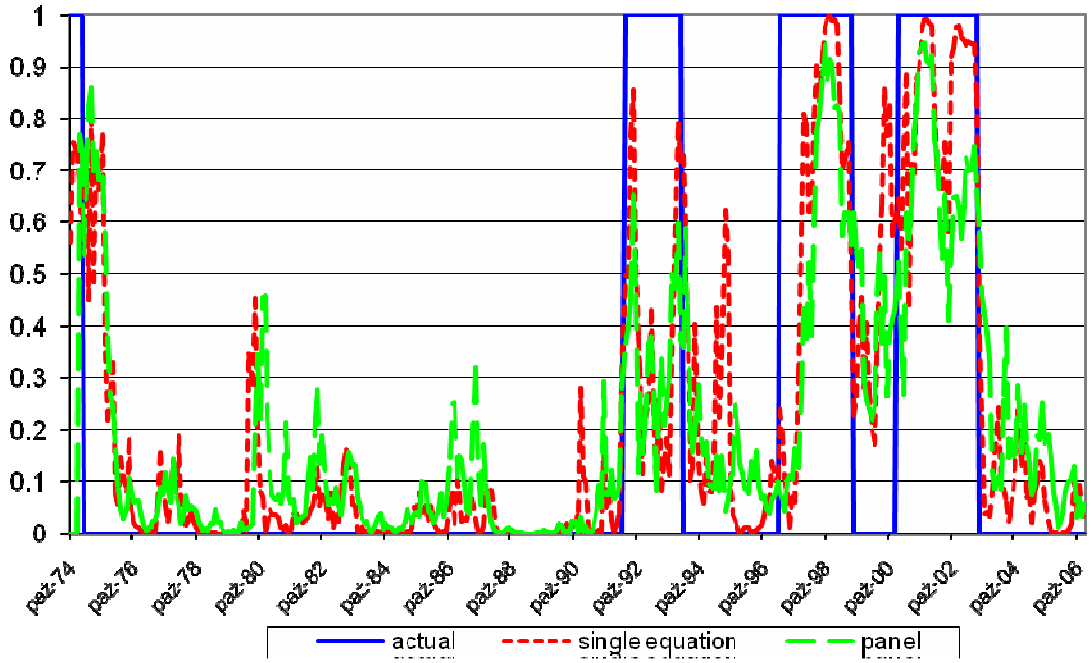


Chart 20
Germany

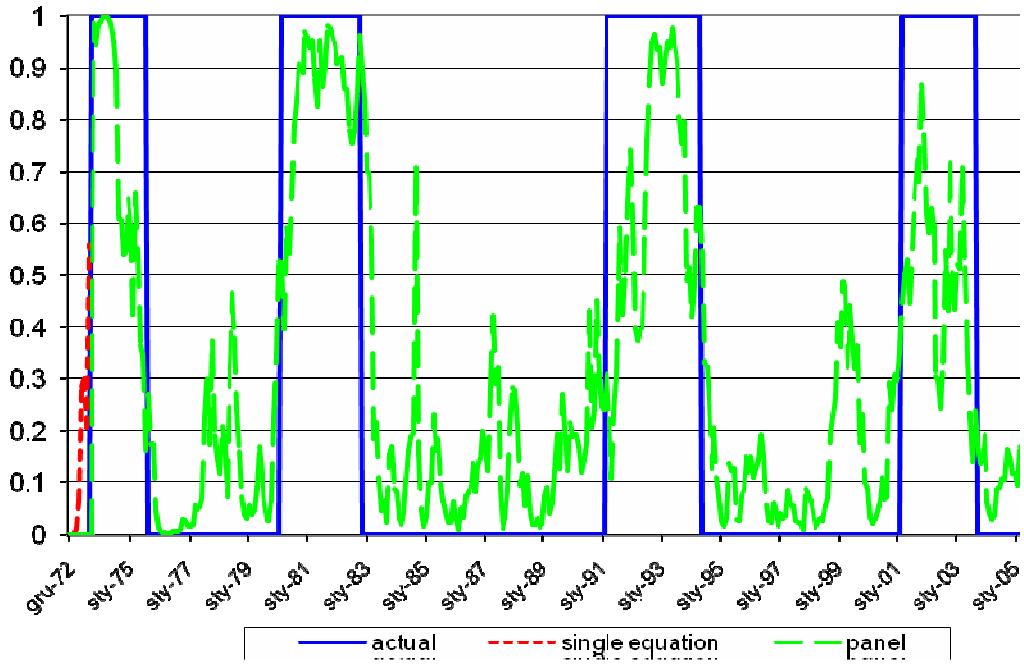


Chart 21
United Kingdom

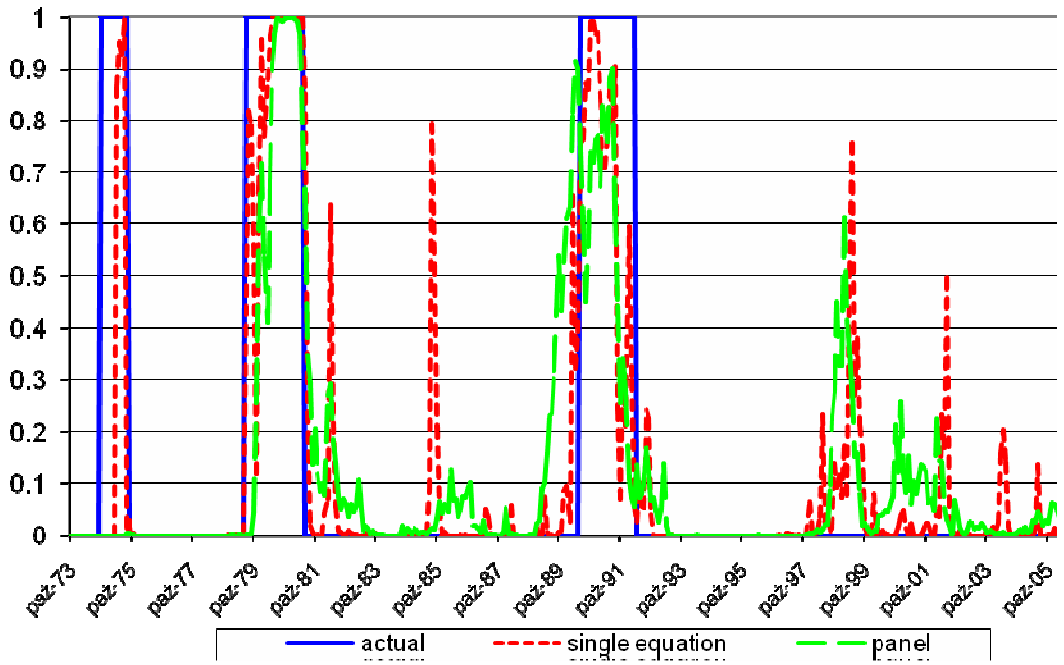
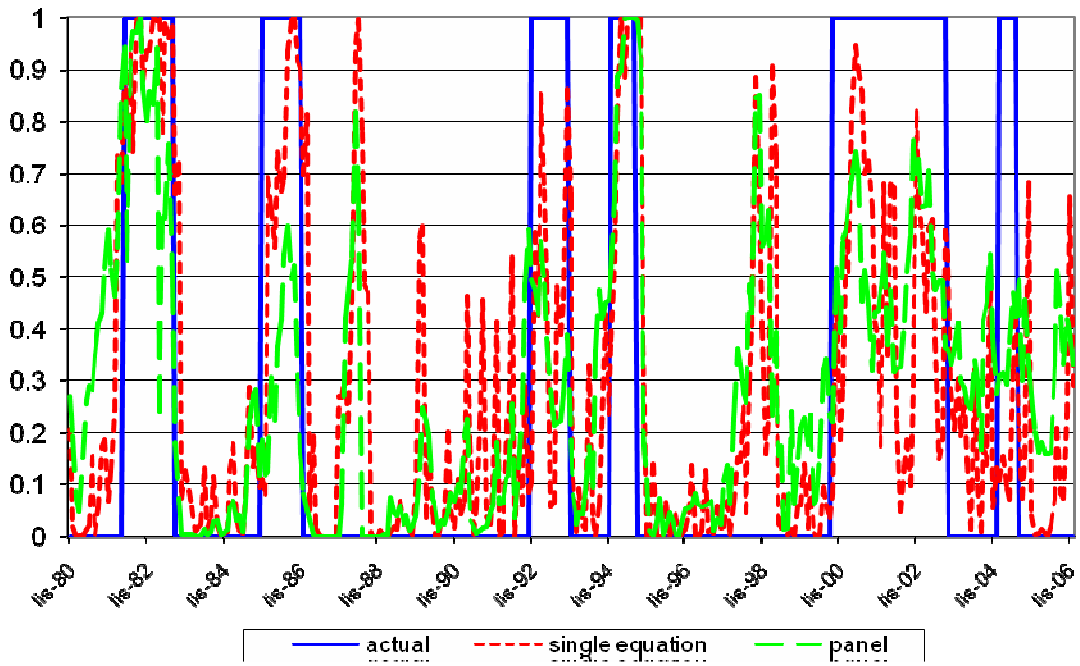


Chart 22
Mexico



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Korea

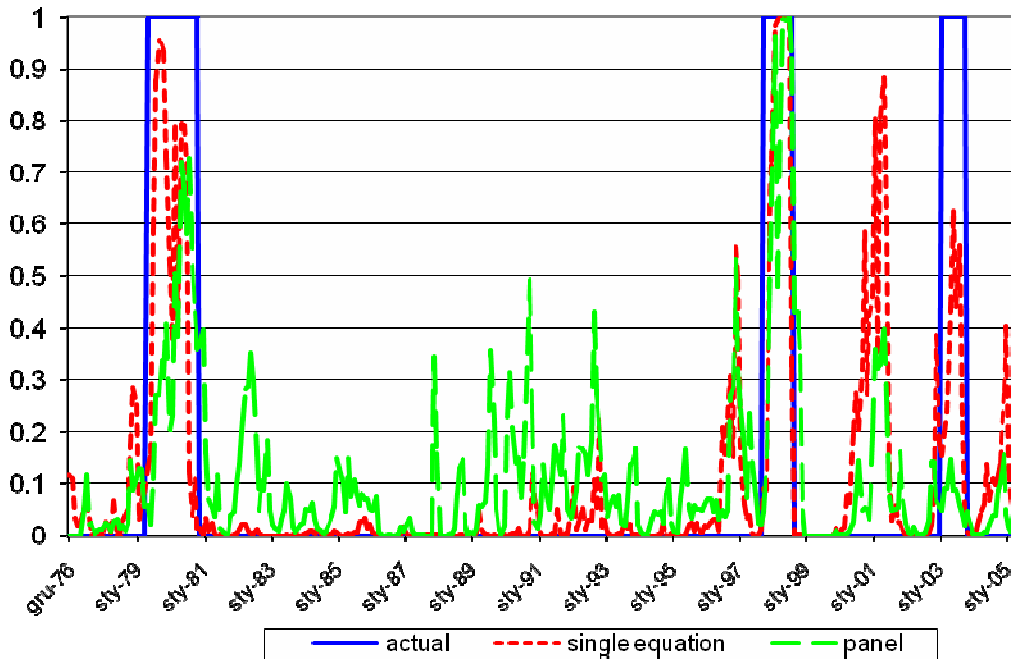
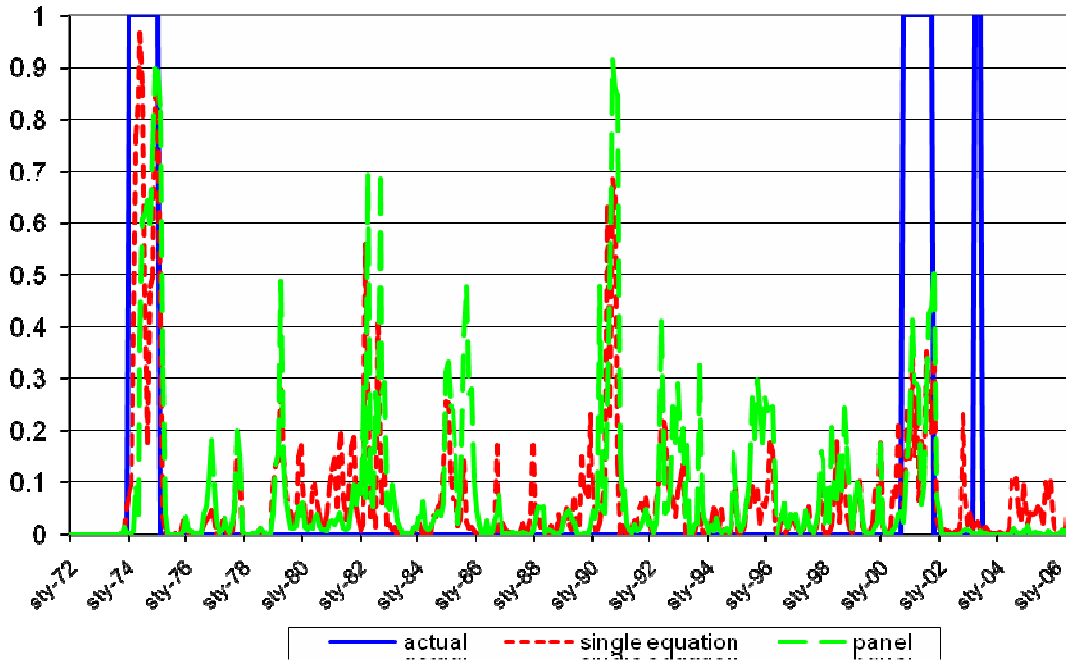


Chart 24
Taiwan



Current Recession

Chart 25
United States

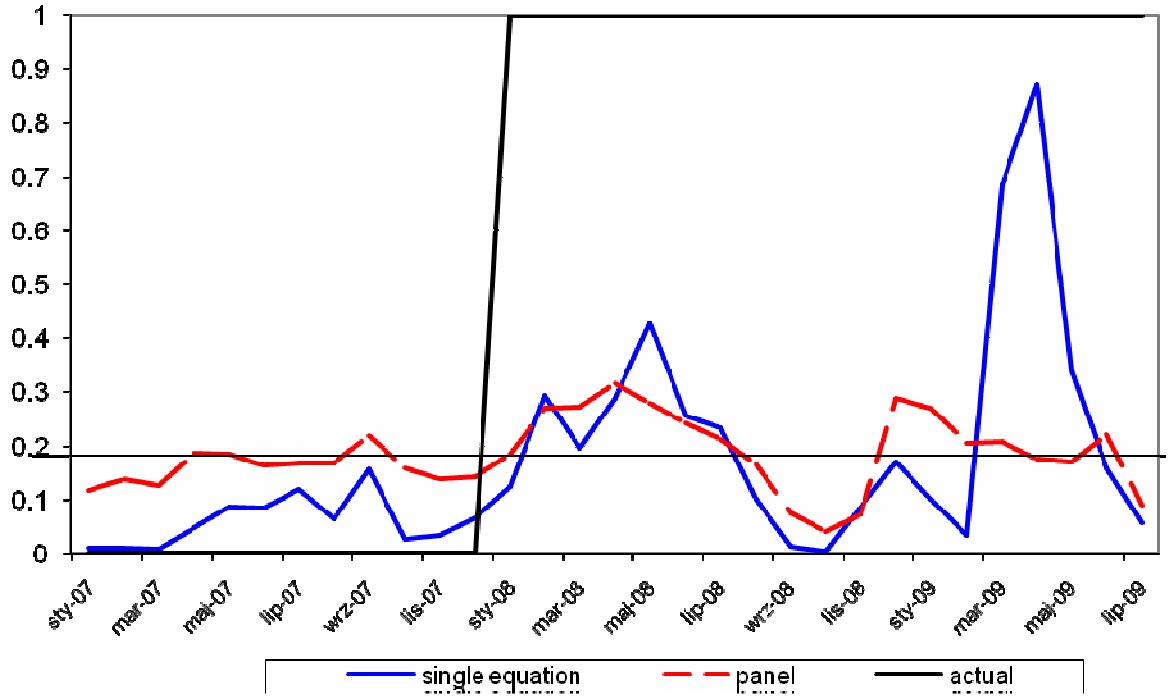


Chart 26
Canada

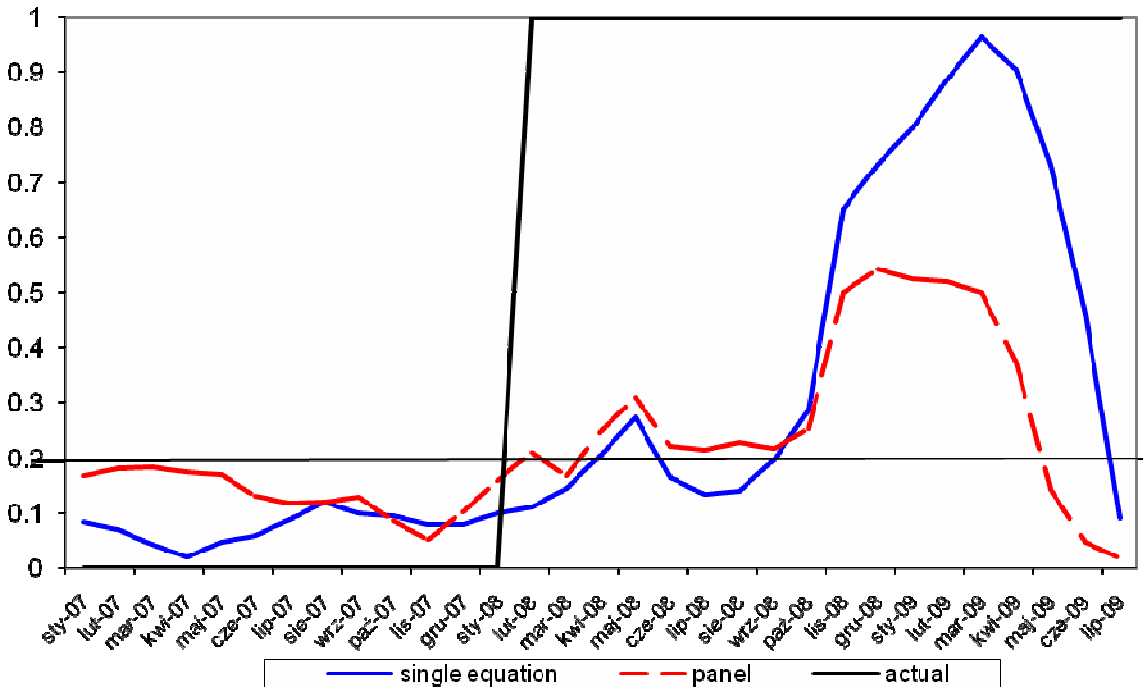


Chart 27
Japan

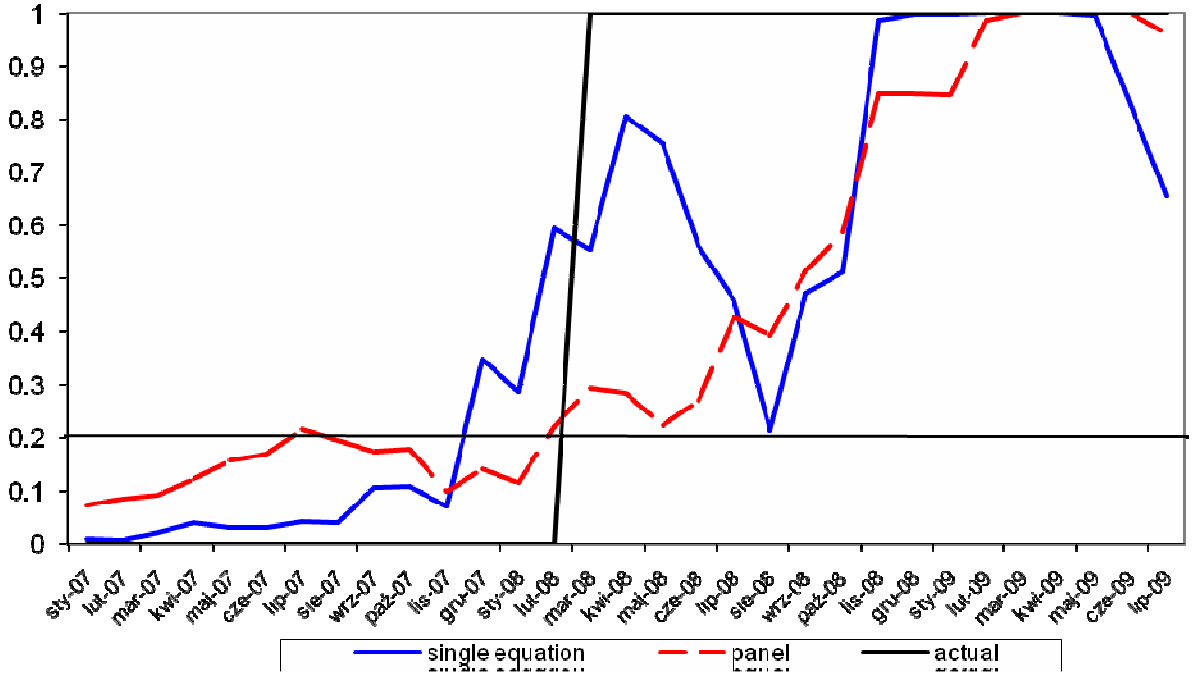


Chart 28
Germany

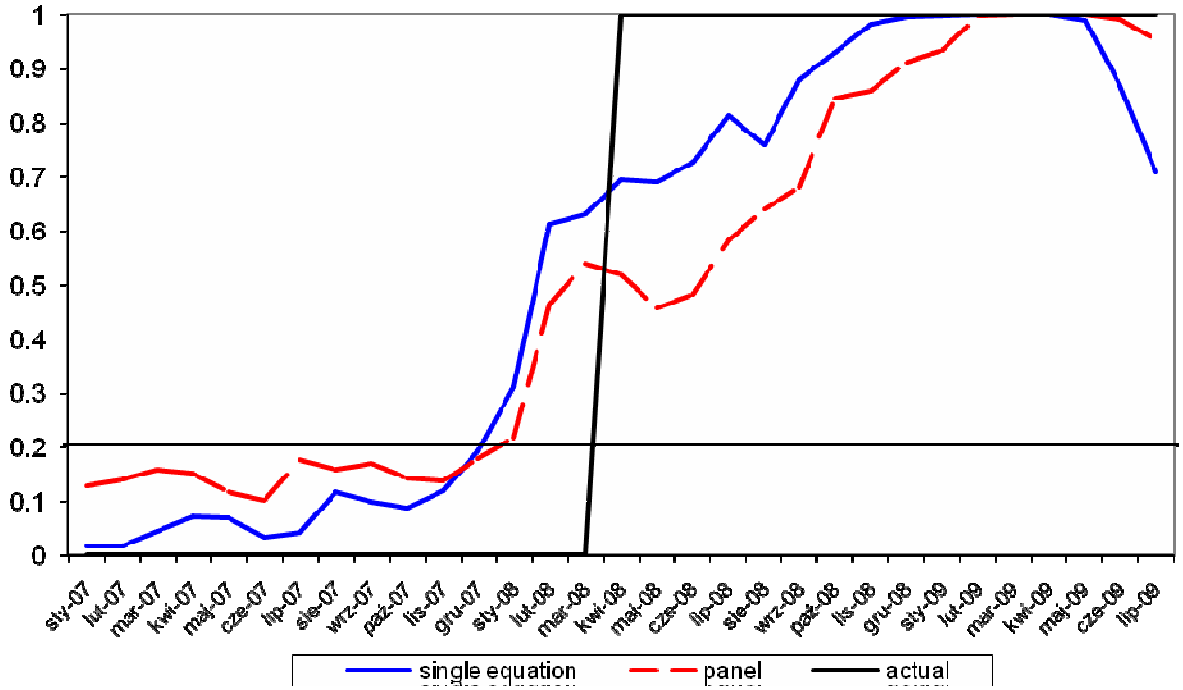


Chart 29
United Kingdom

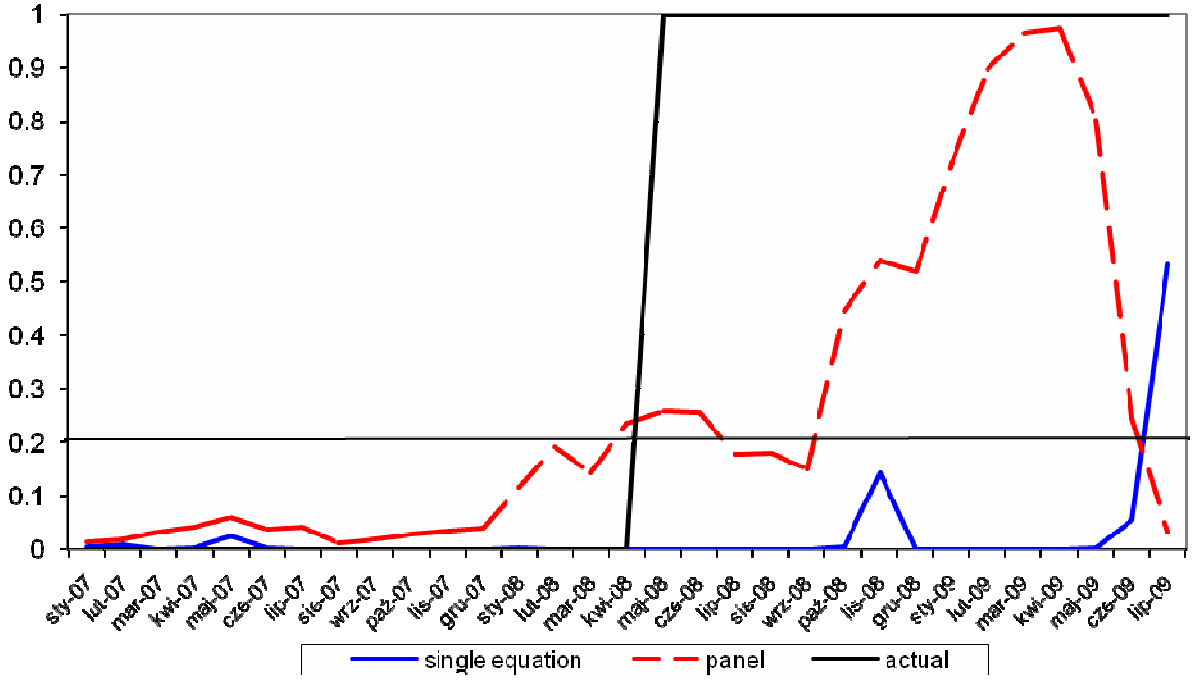


Chart 30
Mexico

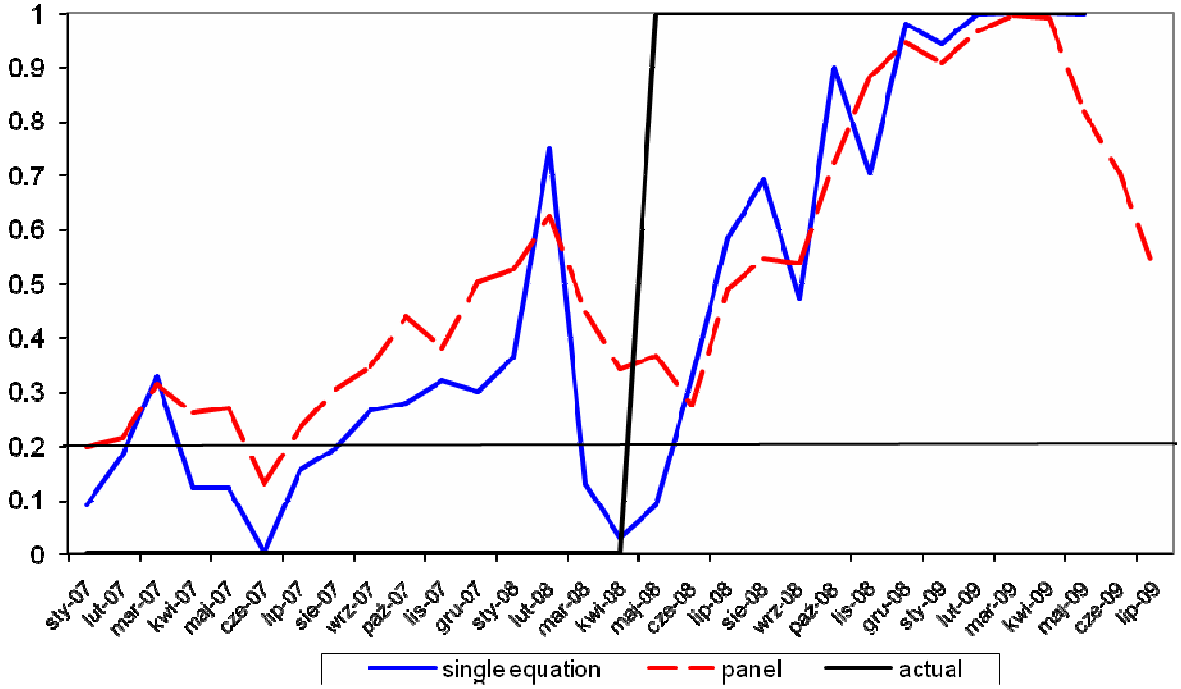


Chart 31
Korea

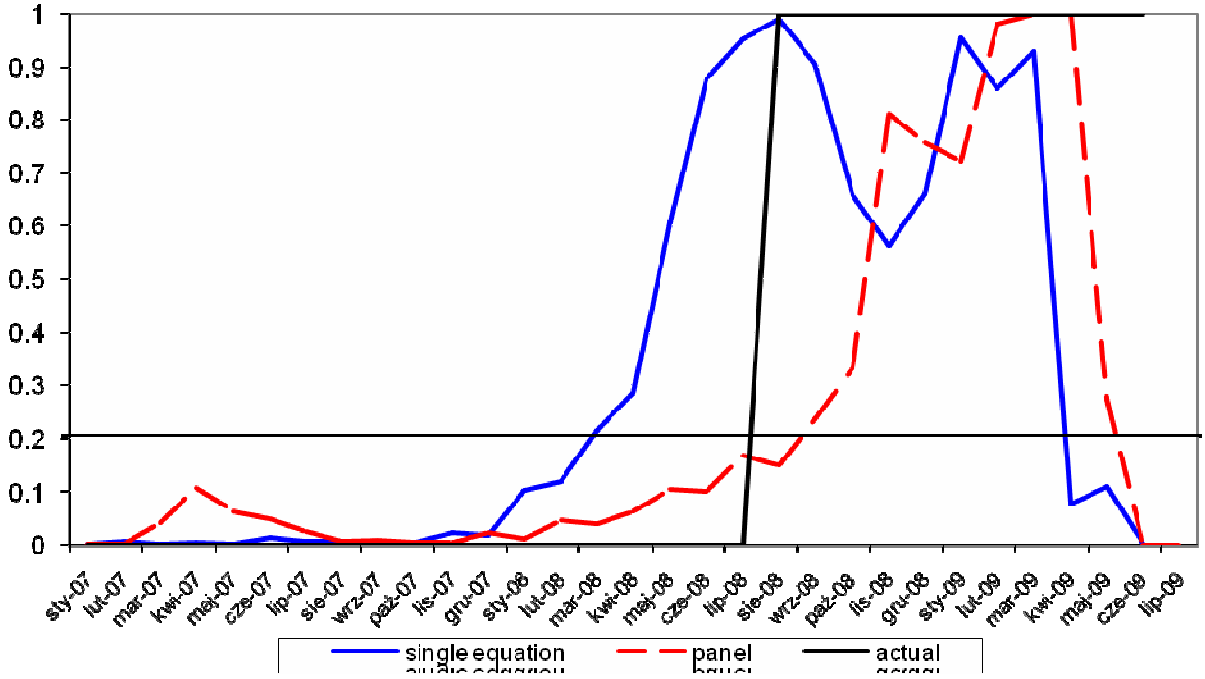
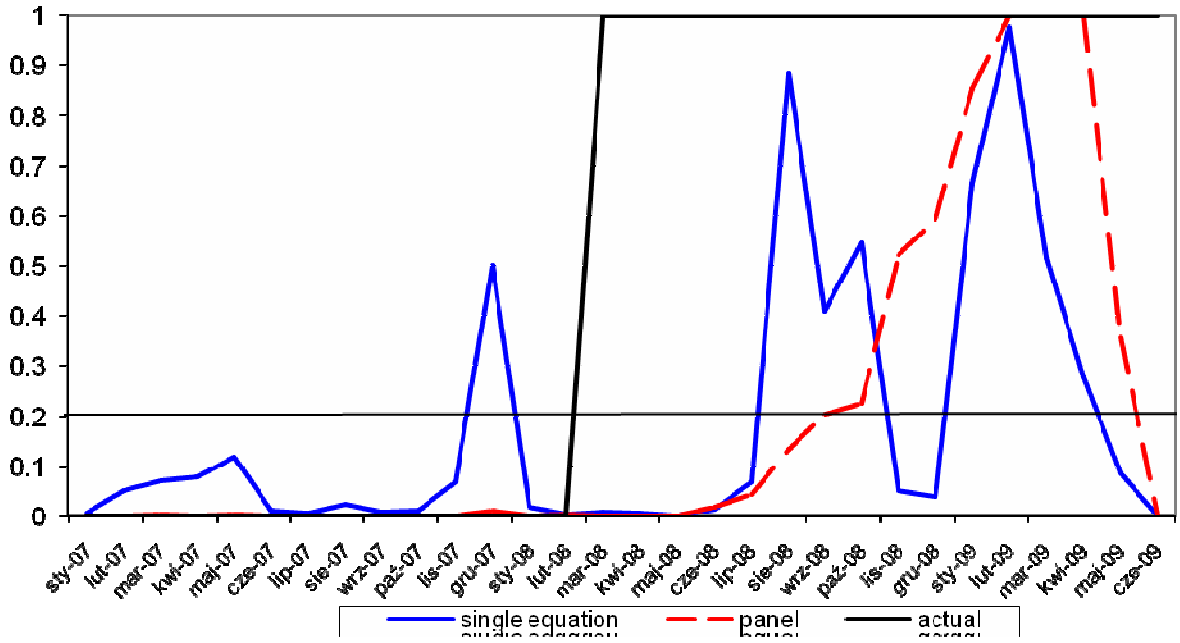


Chart 32
Talwan



Data Appendix

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