

The dynamic relations between market returns and two types of risk with business cycles

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Introduction

- The traditional macroeconomic business cycle literature: aggregate shocks to macro economy.
- The traditional asset pricing theories: the relation between market return and market risk and treat market risk and idiosyncratic risk separately.
- However, Independent sector-specific disturbances can also have significant aggregate effects.
 - E.g., Horvath (1998, 2000): a multi-sector dynamic G.E model of business cycles; aggregate fluctuations are driven by independent sectoral shocks.
 - Idiosyncratic risk predicts aggregate market returns (Campbell, Lettau, Malkiel, and Xu, 2001; Goyal and Santa-Clara, 2003; Ang, Hodrick, Xing, and Zhang, 2006; Jiang and Lee, 2006, 2009; Fu, 2009).

- Pastor and Veronesi (2009): the nature of the risk associated with new technologies changes over time. Initially, this risk is mostly idiosyncratic. For the technologies that are ultimately adopted, however, the risk gradually changes from idiosyncratic to systematic.

- Recessions tend to be triggered by some idiosyncratic (sectoral) shocks.
 - Recessions in early 1970s and early 1980s (follows oil crises)
 - Recession in 1990 (follows savings and loans crises)
 - Recession in 2001 (follows technology stock bubble burst)
 - Recession in 2008 (follows subprime mortgage crises, Lehman Brother bankruptcy)

Research Questions

- What is the dynamic relation among market return, market risk, idiosyncratic risk, and macroeconomic activities, particularly around business cycles?
- Are these dynamic relations time-varying? especially before and after, and in the stage of business cycle?

Main findings

- XR forecasts (Granger causes) MV and IV with a negative effect.
 - Leading economic indicator; More significant and strong in recessions.
- IV forecasts (Granger causes) MV with a positive effect.
 - Stronger before recession and remain in recessions.
 - IV is converted into MV before recessions and continue to be converted at the early stage of recessions.
- MV forecasts IV with negative effect.
 - Not much time-varying.
 - MV can substitute IV to some extent. Further, its negative net effect on IV is stronger in early expansion periods: lower MV leads to a higher IV in early expansion periods as the economy moves out of recessions.

Empirical framework

- VAR: $Z_t = A(L) Z_{t-1} + e_t$, (1)

where Z_t is an $m \times 1$ vector; $A(L)$ is a polynomial in the lag operator L (i.e., $A(L) = \sum_{s=1}^k A_{ij}(s)L^{s-1}$ for $i, j = 1, 2, \dots, m.$), with L being a lag operator (i.e., $L^n X_t = X_{t-n}$); $A_{ij}(s)$ is an $m \times m$ coefficient matrix; and, e_t is an $m \times 1$ vector of the error term.

- Bivariate VAR

- $Z1_t = [XR_t, MV_t]'$: Merton (1973, 1980), Harvey (1989)
- $Z2_t = [XR_t, IV_t]'$: Levy (1978), Merton (1987), Mayers (1976), Barberis and Huang (2001)
- $Z3_t = [MV_t, IV_t]'$: Horvath (1998, 2000), Pastor and Veronesi (2009)

- Trivariate VAR

- $Z_t = [XR_t, MV_t, IV_t]'$: Merton's ICAPM (1973)

- Fourvariate VAR

- $Z_t = [XR_t, MV_t, IV_t, IPG_t]'$: Schwert (1989)

Data

- value-weighted market volatility (MV) as:

$$MV_t = \sqrt{\left(\sum_{d=1}^{D_t} r_{m,d}^2 + 2\sum_{d=2}^{D_t} r_{m,d}r_{m,d-1}\right)},$$

where $r_{m,d}$ is the value-weighted CRSP index return on day d , and D_t is the number of days in month t . The second term is added to adjust for autocorrelation in daily returns using the approach proposed by French, Schwert, and Stambaugh (1987).

- aggregate idiosyncratic volatility (IV)

$$r_{id} - r_{fd} = \alpha_{it} + \beta_{iMKTt}MKT_d + \beta_{iSMBt}SMB_d + \beta_{iHMLt}HML_d + \varepsilon_{id},$$

- use the equal-weighted average of idiosyncratic volatility across all stocks as a proxy for the aggregate idiosyncratic volatility (IV)

$$IV_t = \frac{1}{N_t} \sum_{i=1}^{N_t} \sqrt{VAR(\varepsilon_{it})}$$

- For the robustness check, we compute IV based on the one-factor CAPM model and Fama-French's (1993, 1996) and Carhart's (1997) four-factor model
- the industrial production growth rate (IPG) as a proxy for macroeconomic activities: IP index is from the Board of Governors of the Federal Reserve System.
- Recessions and expansions in business cycles are defined by the NBER.

$D = 1$ if the economy is in a recession, or zero.

$d1$ ($d2$) = 1 if the economy is in the four months before (after) a recession starts.

$d3$ ($d4$) = 1 if the economy is in the four months before (after) a recession ends.

Empirical results

- Figures
- Regression results
- Granger causality tests
- Variance decomposition analysis

- **Table 1:** *Descriptive statistics* for XR, MV, IV, and IPG for the sample period of July 1963 to December 2009.
 - The mean of IV is much higher than that of MV;
Both MV and IV are quite persistent, particularly for IV.
 - The MV (IV) in recession is 49% (10%) higher than the averages.
 - The variations also increase in recessions, except for IPG.
 - XR is already negative (-0.12%) before recessions and strongly positive (3.63%) before expansions: a leading economic indicator.
 - MV and IV are positively correlated with a correlation of 0.49 for the full sample (e.g., Campbell, Lettau, Malkiel, and Xu (2001) and Goyal and Santa Clara (2003)). This is mainly driven by a recession period ($d=1$) with a high correlation of 0.64.

- **Table 2:** the dynamic relations among XR, MV, IV, and IPG using simple one-period forecast regressions (whole period).
 - XR leads both MV and IV with a significant negative sign :
a lower XR anticipates higher MV and IV.
 - Either MV or IV (or IPG) does not forecasts XR.
 - IPG forecasts MV and IV with a significant negative sign.
 - IV forecasts MV with a positive sign while MV forecasts IV with a negative sign: MV and IV are correlated not only contemporaneously but also dynamically over time.
 - Higher IV leads to a higher MV while lower MV leads to a higher IV

- **Table 3:** recession and expansion (D=1 or 0)
 - *in XR regressions*, we do not find that MV or IV forecasts XR in either recessions or expansions, consistent with Table 2.
 - *in MV regressions*, XR forecasts MV with a negative sign in both recessions (stronger) and expansions.
IV also forecasts MV with a positive sign, and the relation is more significant and stronger in recessions.
 - *in IV regressions*, XR forecasts IV in both recessions and expansions with a negative sign.
MV forecasts IV with a negative sign in both recessions and expansions.

- **Table 4:** before and after a recession starts, and before and after an expansion starts ($d1, d2, d3, d4 = 1$ or 0).
- $d1=1$: When an economy is in the four months prior to an expansion, XR (IV) predicts MV negatively (positively).
- $d2=1$: During the four-month period after a recession starts, IV significantly predicts a positive MV.
- $d4=1$: When an economy is in the four months after an expansion starts, XR does not predict either MV or IV as it does in other stages.

However, MV predicts IV negatively, suggesting that, as the economy recovers, a low MV leads to a high IV.

- $d=1$: Around the peaks before recessions, negative shocks trigger low market risk premiums, which signal future high idiosyncratic risk and market risk.
- $d=2$: A high idiosyncratic risk eventually evolves into a market risk as the economy moves into a recession.
- $d=3$: Before expansions, a high market risk premium leads a low market and idiosyncratic risk. A high market risk does not lead to an idiosyncratic risk.
- $d=4$: In the early stage of expansions, market risk premium fails to lead market risk and idiosyncratic risk. Interestingly, a low market risk evolves into a high idiosyncratic risk in this period.

- **Table 5, 6, 7:** Causality tests

- XR Granger causes both MV and IV and its net effect is negative, and these relations are more significant (stronger) in recession.
- IV Granger causes MV and its effect is positive: the positive net effect is stronger before recessions and in the early recession periods.

IV converts into MV before recessions, and this conversion continues in the early stage of recessions.

- MV Granger causes IV with a negative net effect in both recessions and expansions; its negative net effect on IV is quite strong in the early expansion period: lower MV leads to a higher IV in the early expansion period.

Figure 1: Market excess returns and industrial production growth rates

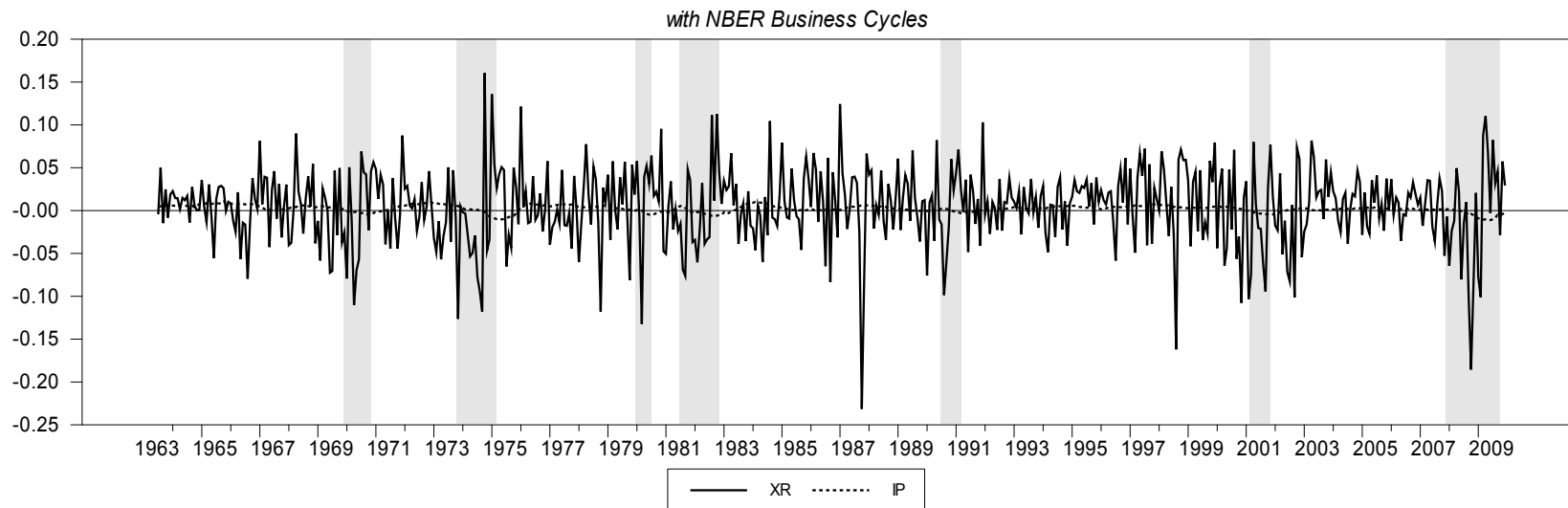


Figure 2: Market volatility and idiosyncratic volatility

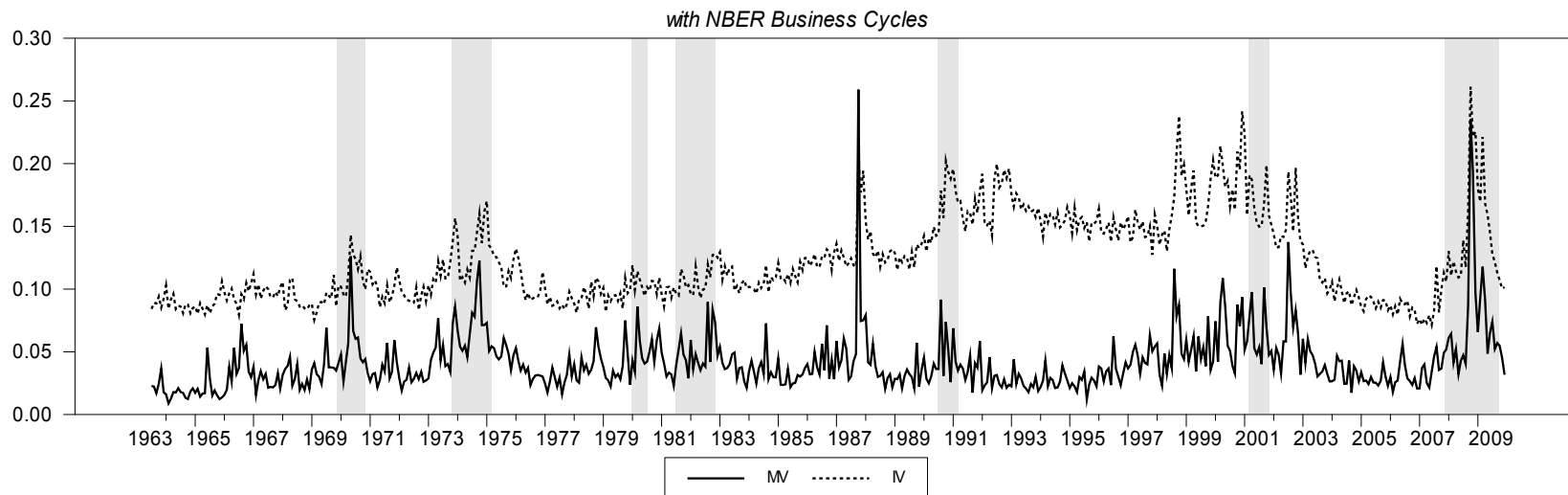


Table 1. Time series properties of market excess return, market volatility, and idiosyncratic volatility: 1963:07 – 2009:12

Panel A: Univariate statistics																
Variable	Mean x100	S.D. x100	Skew	Kurt	Autocorrelation at lags											
					1	2	3	4	5	6	7	8	9	10	11	12
XR	0.42	4.51	-0.58	2.14	0.09	-0.03	0.02	0.02	0.06	-0.05	-0.01	-0.04	-0.02	0.01	0.01	0.0
MV	4.16	2.38	3.56	23.21	0.55	0.42	0.35	0.29	0.31	0.28	0.24	0.23	0.26	0.23	0.19	0.1
IV	12.30	3.43	0.93	0.42	0.90	0.86	0.83	0.77	0.76	0.73	0.70	0.68	0.69	0.67	0.66	0.6
IPG	0.23	0.40	-0.81	0.91	0.97	0.93	0.88	0.82	0.75	0.67	0.59	0.51	0.43	0.35	0.26	0.1
dXR	-0.56	6.52	-0.04	-0.19	0.23	-0.04	0.08	0.10	-0.07	-0.17	-0.10	-0.03	-0.04	-0.07	-0.10	0.0
dMV	6.21	3.13	2.79	11.59	0.49	0.17	0.08	0.06	0.06	-0.05	-0.08	-0.04	-0.01	-0.07	-0.05	-0.0
dIV	13.49	3.60	1.09	0.82	0.78	0.63	0.51	0.37	0.29	0.15	0.05	-0.03	-0.09	-0.13	-0.13	-0.1
dIPG	-0.25	0.38	-0.30	-0.24	0.86	0.70	0.54	0.39	0.26	0.15	0.06	-0.05	-0.14	-0.22	-0.30	-0.3
d1XR	-0.12	4.79	-0.61	-0.03	-0.36	0.00	0.12	0.01								
d1MV	4.29	1.62	1.54	2.63	0.37	0.11	0.12	0.00								
d1IV	12.27	4.02	1.75	2.77	0.74	0.40	0.14	0.02								
d1IPG	0.21	0.23	0.91	-0.04	0.65	0.36	0.15	0.01								
d2XR	-2.34	5.34	-0.19	-0.25	-0.19	-0.22	0.06	0.00								
d2MV	5.69	1.92	0.53	-0.55	-0.01	0.08	-0.01	0.00								
d2IV	13.01	3.24	0.81	-0.47	0.59	0.41	0.18	0.04								
d2IPG	0.10	0.23	0.18	-0.33	0.66	0.32	0.07	-0.02								
d3XR	3.63	5.20	-0.59	1.11	0.07	-0.03	-0.05	-0.01								
d3MV	5.61	1.90	0.75	-0.08	-0.01	0.04	0.18	0.00								
d3IV	13.93	3.30	0.38	-1.19	0.71	0.39	0.20	0.05								
d3IPG	-0.47	0.23	-0.32	0.24	0.65	0.35	0.13	-0.01								
d4XR	2.18	3.49	-0.70	1.20	-0.11	-0.01	-0.08	-0.01								
d4MV	4.28	0.96	0.08	-0.91	0.38	0.36	0.18	0.06								
d4IV	12.56	2.05	0.62	-0.44	0.60	0.41	0.32	0.04								
d4IPG	-0.37	0.29	-1.34	0.67	0.71	0.46	0.16	-0.01								

Panel B: Cross correlations

	MV	IV	IPG		dMV	dIV	dIPG		d1MV	d1IV	d1IPG		d2M V	d2IV	d2IPG
XR	-0.29	0.00	-0.07	dXR	-0.25	-0.04	-0.33	d1XR	-0.28	-0.12	0.15	d2XR	-0.26	-0.06	-0.33
MV		0.49	-0.31	dMV		0.64	-0.17	d1MV		0.63	-0.09	d2MV		0.59	0.05
IV			-0.23	dIV			-0.25	d1IV			-0.21	d2IV			-0.17
	d3MV	d3IV	d3IPG		d4MV	d4IV	d4IPG								
d3XR	0.06	-0.11	-0.14	d4XR	0.15	-0.27	0.10								
d3MV		0.17	-0.23	d4MV		-0.22	-0.34								
d3IV			0.25	d4IV			0.04								

This table summarizes the time-series statistics of market excess return, market volatility, and idiosyncratic volatility. XR denotes the excess market return, calculated as CRSP value weighted index return over one-month T-bill rate. MV denotes the market volatility, calculated as in French, Schwert, and Stambaugh (1987). IV denotes the idiosyncratic volatility, calculated as follows. In every month, excess daily returns of each individual stock are regressed on the daily Fama- French three factors: RmRf, SMB, and HML. The (monthly) idiosyncratic volatility is the equal weighted average of the idiosyncratic volatility of the stock which is the product of the standard deviation of the regression residuals and the square root of the number of observations in the month. IPG denotes the industry production growth rate. d = 1 if the economy is in recession, and d = 0 otherwise. d1 = 1 if the economy is in 4 months before recession, and d1 = 0 otherwise. d2 = 1 if the economy is in 4 months after recession, and d2 = 0 otherwise. d3 = 1 if the economy is in 4 months before expansion, and d3 = 0 otherwise. d4 = 1 if the economy is in 4 months after expansion, and d4 = 0 otherwise.

**Table 2. The dynamic relation among XR, MV, IV, and IP:
1963:07 – 2009:12**

Dependent variable	XR _{t-1}	MV _{t-1}	IV _{t-1}	IP _{t-1}	R ²
XR _t	0.091 (2.051)	-0.022 (-0.281)			0.006
	0.095 (2.012)		0.049 (0.864)		0.007
	0.082 (1.802)	-0.081 (-0.911)	0.077 (1.227)		0.006
	0.071 (1.507)	-0.127 (-1.507)	0.070 (1.102)	-0.852 (-1.562)	0.009
MV _t	-0.111 (-4.247)	0.492 (6.568)			0.344
		0.508 (6.002)	0.064 (1.754)		0.310
	-0.122 (-4.553)	0.420 (4.810)	0.094 (2.149)		0.357
	-0.136 (-4.947)	0.367 (4.851)	0.085 (1.915)	-1.012 (-4.165)	0.381
IV _t	-0.096 (-5.227)		0.902 (43.086)		0.831
		-0.046 (-1.885)	0.918 (51.728)		0.815
	-0.116 (-5.827)	-0.129 (-4.490)	0.946 (54.800)		0.836
	-0.120 (-5.913)	-0.145 (-5.191)	0.944 (51.475)	-0.301 (-2.055)	0.837
IP _t	0.000 (-0.169)	-0.007 (-2.431)	-0.001 (-0.578)	0.960 (73.835)	0.952

Table 3. The asymmetric dynamic relation among XR, MV, IV, and IP: Recession effect: d=1 if recessions, b=1-d

Dependent variable	dXR _{t-1}	bXR _{t-1}	dMV _{t-1}	bMV _{t-1}	dIV _{t-1}	bIV _{t-1}	dIP _{t-1}	bIP _{t-1}	R ²
XR _t			-0.040 (-0.433)	0.018 (0.160)					0.005
					0.028 (0.444)	0.065 (1.097)			0.007
			-0.030 (-0.137)	-0.059 (-0.488)	0.039 (0.323)	0.081 (1.327)			0.004
			-0.084 (-0.354)	-0.096 (-0.768)	-0.057 (-0.366)	0.083 (1.341)	-5.277 (-3.571)	-0.384 (-0.682)	0.031
MV _t	-0.187 (-3.664)	-0.068 (-2.202)							0.355
					0.148 (4.086)	0.056 (2.082)			0.341
	-0.191 (-4.201)	-0.087 (-3.581)			0.176 (4.934)	0.082 (2.891)			0.398
	-0.222 (-4.235)	-0.092 (-3.776)			0.137 (4.206)	0.080 (2.811)	-1.507 (-2.431)	-0.420 (-2.170)	0.407
IV _t	-0.126 (-3.248)	-0.079 (-3.402)							0.831
			-0.039 (-1.335)	-0.063 (-1.896)					0.815
	-0.141 (-5.569)	-0.102 (-4.618)	-0.121 (-3.729)	-0.145 (-3.815)					0.836
	-0.158 (-4.960)	-0.103 (-4.647)	-0.155 (-4.071)	-0.142 (-3.771)			-0.677 (-1.343)	-0.236 (-1.684)	0.837
IP _t	-0.001 (-0.749)	0.000 (-0.170)	-0.005 (-1.314)	-0.001 (-0.405)	-0.007 (-3.451)	-0.001 (-0.761)			0.957

Table 4. The asymmetric dynamic relation among XR, MV, IV, and IP: Other business cycle effects

Dependent variable	dXR _{t-1}	bXR _{t-1}	dMV _{t-1}	bMV _{t-1}	dIV _{t-1}	bIV _{t-1}	dIP _{t-1}	bIP _{t-1}	R ²
Panel A: d = 1 if the economy is in 4 months before a recession starts, and d = 0 otherwise. b = 1 - d.									
XR _t			-0.248 (-1.673)	-0.017 (-0.211)					0.006
					-0.067 (-1.050)	0.058 (1.106)			0.011
			1.121 (1.726)	-0.105 (-1.030)	-0.443 (-1.673)	0.100 (1.784)			0.015
			1.197 (1.958)	-0.149 (-1.596)	-0.455 (-1.723)	0.089 (1.535)	-3.593 (-1.279)	-0.836 (-1.419)	0.018
MV _t	-0.157 (-2.815)	-0.108 (-4.029)							0.343
					0.081 (2.691)	0.063 (2.385)			0.309
	-0.153 (-3.803)	-0.120 (-4.596)			0.104 (3.513)	0.092 (3.213)			0.355
	-0.164 (-3.908)	-0.136 (-5.161)			0.076 (2.747)	0.087 (2.984)	0.466 (0.594)	-1.035 (-4.551)	0.379
IV _t	-0.202 (-2.365)	-0.090 (-4.274)							0.831
			-0.024 (-0.352)	-0.047 (-1.700)					0.815
	-0.211 (-2.089)	-0.110 (-6.422)	-0.134 (-2.187)	-0.126 (-4.012)					0.836
	-0.223 (-2.113)	-0.115 (-6.337)	-0.199 (-2.494)	-0.143 (-4.403)			0.822 (0.840)	-0.307 (-1.875)	0.837
IP _t	-0.002 (-0.880)	0.000 (-0.055)	-0.025 (-2.819)	-0.007 (-2.511)	0.005 (1.191)	-0.001 (-0.838)			0.952

Panel B: d = 1 if the economy is in 4 months after a recession starts, and d = 0 otherwise. b = 1 - d.									
XR _t			-0.149 (-1.174)	-0.010 (-0.114)			0.005		
					-0.040 (-0.683)	0.058 (0.964)	0.009		
			0.756 (1.465)	-0.091 (-0.852)	-0.365 (-1.413)	0.091 (1.506)	0.010		
			0.917 (1.716)	-0.140 (-1.441)	-0.436 (-1.641)	0.082 (1.345)	-5.710 (-1.636)	-0.857 (-1.464)	0.016
MV _t	-0.087 (-1.163)	-0.113 (-4.048)						0.343	
					0.108 (3.059)	0.063 (2.422)		0.312	
	-0.059 (-0.827)	-0.125 (-4.605)			0.131 (3.561)	0.093 (3.259)		0.356	
	-0.037 (-0.515)	-0.140 (-5.172)			0.107 (3.152)	0.087 (3.011)	1.624 (1.632)	-1.044 (-4.593)	0.382
IV _t	-0.068 (-1.216)	-0.099 (-4.423)						0.830	
			-0.069 (-1.802)	-0.043 (-1.533)				0.815	
	-0.118 (-2.877)	-0.118 (-6.394)	-0.190 (-4.666)	-0.123 (-3.718)				0.836	
	-0.106 (-2.472)	-0.123 (-6.384)	-0.224 (-4.860)	-0.141 (-4.156)			0.952 (1.047)	-0.326 (-1.989)	0.837
IP _t	-0.003 (-0.907)	0.000 (-0.414)	-0.012 (-1.434)	-0.006 (-2.332)	-0.004 (-1.520)	-0.001 (-0.624)		0.953	

Panel C: $d = 1$ if the economy is in 4 months before a recession ends, and $d = 0$ otherwise. $b = 1 - d$.								
XR _t			0.495	-0.093				0.027
			(3.705)	(-1.103)				
					0.237	0.024		0.023
					(2.927)	(0.423)		
		0.469	-0.156	0.066	0.081			0.026
		(1.451)	(-1.486)	(0.449)	(1.383)			
		0.306	-0.168	0.044	0.081	-2.528	-0.272	0.024
		(0.785)	(-1.726)	(0.291)	(1.382)	(-0.994)	(-0.436)	
MV _t	-0.071	-0.115						0.344
	(-1.273)	(-4.360)						
					0.082	0.062		0.309
					(2.359)	(2.360)		
	-0.136	-0.128			0.146	0.090		0.358
(-2.416)	(-4.947)			(3.750)	(3.128)			
-0.156	-0.137			0.088	0.085	-1.488	-0.967	0.378
(-2.868)	(-5.315)			(2.071)	(2.921)	(-1.599)	(-3.952)	
IV _t	-0.135	-0.093						0.831
	(-3.226)	(-4.246)						
			-0.051	-0.046				0.815
			(-0.932)	(-1.669)				
	-0.182	-0.116	-0.016	-0.137				0.836
(-4.690)	(-6.355)	(-0.342)	(-4.327)					
-0.183	-0.119	-0.029	-0.147			0.035	-0.253	0.837
(-4.655)	(-6.294)	(-0.437)	(-4.538)			(0.056)	(-1.472)	
IP _t	-0.001	0.000	-0.004	-0.007	-0.005	-0.001		0.952
	(-0.489)	(0.212)	(-0.587)	(-2.445)	(-1.907)	(-0.527)		

Panel D: $d = 1$ if the economy is in 4 months after a recession ends, and $d = 0$ otherwise. $b = 1 - d$.								
XR _t			0.159	-0.027				0.005
			(1.004)	(-0.330)				
					0.119	0.048		0.007
					(1.551)	(0.837)		
		-0.182	-0.081	0.179	0.074		0.004	
		(-0.456)	(-0.775)	(1.192)	(1.216)			
		-0.160	-0.122	0.154	0.067	0.586	-0.815	0.005
		(-0.307)	(-1.288)	(0.954)	(1.104)	(0.203)	(-1.267)	
MV _t	-0.048	-0.114						0.344
	(-0.696)	(-4.387)						
					0.062	0.064		0.309
					(2.151)	(2.422)		
	-0.036	-0.126			0.095	0.096		0.355
(-0.430)	(-5.016)			(3.041)	(3.314)			
-0.037	-0.139			0.033	0.087	-1.108	-1.102	0.380
(-0.456)	(-5.565)			(1.101)	(3.024)	(-2.106)	(-4.369)	
IV _t	-0.019	-0.099						0.831
	(-0.345)	(-4.644)						
			-0.095	-0.046				0.815
			(-2.218)	(-1.675)				
	0.029	-0.120	-0.201	-0.133				0.836
(0.407)	(-6.881)	(-3.355)	(-4.149)					
0.023	-0.124	-0.196	-0.151			0.449	-0.365	0.837
(0.344)	(-6.891)	(-2.369)	(-4.639)			(0.809)	(-2.080)	
IP _t	-0.004	0.000	0.006	-0.007	0.000	-0.001		0.952
	(-1.283)	(-0.163)	(0.653)	(-2.596)	(-0.122)	(-0.589)		

**Table 5. Tests of causal relations among XR, MV, IV, and IP:
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Panel A: Granger causality tests									
VAR	q	Hypothesis	Comments	F-stats (p level)		Hypothesis	Comments	F-stats (p level)	
[XR _t , MV _t]	2	H ₀ :A ₁₂ (L)=0	MV→XR	2.708(0.068)		H ₀ :A ₂₁ (L)=0	XR→MV	23.621(0.000)	
[XR _t , IV _t]	2	H ₀ :A ₁₂ (L)=0	IV→XR	0.372(0.689)		H ₀ :A ₂₁ (L)=0	XR→IV	33.811(0.000)	
[MV _t , IV _t]	4	H ₀ :A ₁₂ (L)=0	IV→MV	1.721(0.144)		H ₀ :A ₂₁ (L)=0	MV→IV	10.127(0.000)	
[XR _t , MV _t , IV _t]	3	H ₀ :A ₁₂ (L)=0	MV→XR	3.317(0.020)		H ₀ :A ₂₁ (L)=0	XR→MV	19.243(0.000)	
	3	H ₀ :A ₁₃ (L)=0	IV→XR	1.759(0.154)		H ₀ :A ₃₁ (L)=0	XR→IV	20.518(0.000)	
	3	H ₀ :A ₂₃ (L)=0	IV→MV	2.943(0.033)		H ₀ :A ₃₂ (L)=0	MV→IV	7.195(0.000)	
[XR _t , MV _t , IV _t , IP _t]	2	H ₀ :A ₁₂ (L)=0	MV→XR	4.852(0.008)		H ₀ :A ₂₁ (L)=0	XR→MV	30.383(0.000)	
	2	H ₀ :A ₁₃ (L)=0	IV→XR	2.177(0.114)		H ₀ :A ₃₁ (L)=0	XR→IV	38.781(0.000)	
	2	H ₀ :A ₁₄ (L)=0	IP→XR	2.157(0.117)		H ₀ :A ₄₁ (L)=0	XR→IP	1.941(0.145)	
	2	H ₀ :A ₂₃ (L)=0	IV→MV	4.951(0.007)		H ₀ :A ₃₂ (L)=0	MV→IV	6.314(0.002)	
	2	H ₀ :A ₂₄ (L)=0	IP→MV	7.858(0.000)		H ₀ :A ₄₂ (L)=0	MV→IP	6.076(0.002)	
	2	H ₀ :A ₃₄ (L)=0	IP→IV	1.949(0.143)		H ₀ :A ₄₃ (L)=0	IV→IP	1.089(0.337)	

Panel B: Cumulative effect									
VAR	q	Hypothesis	Comments	F-stats (p level)	sum	Hypothesis	Comments	F-stats(p level)	sum
[XR _t , MV _t]	2	H ₀ :A ₁₂ (1)=0	MV→XR	0.199(0.656)	0.044	H ₀ :A ₂₁ (1)=0	XR→MV	13.930(0.000)	-0.099
[XR _t , IV _t]	2	H ₀ :A ₁₂ (1)=0	IV→XR	0.573(0.450)	0.043	H ₀ :A ₂₁ (1)=0	XR→IV	43.003(0.000)	-0.117
[MV _t , IV _t]	4	H ₀ :A ₁₂ (1)=0	IV→MV	0.905(0.342)	0.028	H ₀ :A ₂₁ (1)=0	MV→IV	6.560(0.011)	-0.095
[XR _t , MV _t , IV _t]	3	H ₀ :A ₁₂ (1)=0	MV→XR	0.255(0.614)	0.064	H ₀ :A ₂₁ (1)=0	XR→MV	7.229(0.007)	-0.091
	3	H ₀ :A ₁₃ (1)=0	IV→XR	0.251(0.617)	0.034	H ₀ :A ₃₁ (1)=0	XR→IV	38.351(0.000)	-0.149
	3	H ₀ :A ₂₃ (1)=0	IV→MV	2.430(0.120)	0.044	H ₀ :A ₃₂ (1)=0	MV→IV	11.924(0.001)	-0.129
[XR _t , MV _t , IV _t , IP _t]	2	H ₀ :A ₁₂ (1)=0	MV→XR	0.232(0.630)	-0.060	H ₀ :A ₂₁ (1)=0	XR→MV	20.752(0.000)	-0.126
	2	H ₀ :A ₁₃ (1)=0	IV→XR	0.256(0.613)	0.034	H ₀ :A ₃₁ (1)=0	XR→IV	54.878(0.000)	-0.148
	2	H ₀ :A ₁₄ (1)=0	IP→XR	2.972(0.085)	-0.919	H ₀ :A ₄₁ (1)=0	XR→IP	1.651(0.199)	0.002
	2	H ₀ :A ₂₃ (1)=0	IV→MV	3.883(0.049)	0.055	H ₀ :A ₃₂ (1)=0	MV→IV	12.404(0.000)	-0.132
	2	H ₀ :A ₂₄ (1)=0	IP→MV	14.683(0.000)	-0.846	H ₀ :A ₄₂ (1)=0	MV→IP	11.693(0.001)	-0.008
	2	H ₀ :A ₃₄ (1)=0	IP→IV	1.387(0.239)	-0.188	H ₀ :A ₄₃ (1)=0	IV→IP	0.153(0.696)	0.000

Table 6. Tests of asymmetric causal relations among XR, MV, IV and IP: Business cycle effect

Panel A: Granger causality test										
VAR	q	H ₀ : A ₁₂ (L)=0 F-stats (p level)	H ₀ : A ₁₃ (L)=0 F-stats (p level)	VAR	H ₀ : A ₁₂ (L)=0 F-stats (p level)	H ₀ : A ₁₃ (L)=0 F-stats (p level)				
[XR _t , dMV _t , bMV _t]	2	1.890(0.152)	1.853(0.158)	[MV _t , dXR _t , bXR _t]	25.523(0.000)	6.640(0.001)				
[XR _t , dIV _t , bIV _t]	2	0.192(0.825)	0.796(0.451)	[IV _t , dXR _t , bXR _t]	27.104(0.000)	13.664(0.000)				
[MV _t , dIV _t , bIV _t]	4	4.503(0.001)	1.137(0.338)	[IV _t , dMV _t , bMV _t]	10.929(0.000)	8.539(0.000)				
[XR _t , dMV _t , bMV _t , IV _t]	3	2.089(0.101)	2.454(0.062)	[MV _t , dXR _t , bXR _t , IV _t]	17.732(0.000)	6.423(0.000)				
[XR _t , dIV _t , bIV _t , MV _t]	3	0.903(0.439)	2.037(0.108)	[IV _t , dXR _t , bXR _t , MV _t]	18.066(0.000)	8.510(0.000)				
[MV _t , dIV _t , bIV _t , XR _t]	3	8.214(0.000)	2.143(0.094)	[IV _t , dMV _t , bMV _t , XR _t]	6.209(0.000)	5.885(0.001)				
[XR _t , dMV _t , bMV _t , IV _t , IP _t]	3	3.713(0.025)	3.315(0.037)	[MV _t , dXR _t , bXR _t , IV _t , IP _t]	28.170(0.000)	9.816(0.000)				
[XR _t , dIV _t , bIV _t , MV _t , IP _t]	3	0.908(0.404)	2.614(0.074)	[IV _t , dXR _t , bXR _t , MV _t , IP _t]	28.685(0.000)	18.045(0.000)				
[XR _t , dIP _t , bIP _t , MV _t , IV _t]	3	6.710(0.001)	0.795(0.452)	[IP _t , dXR _t , bXR _t , MV _t , IV _t]	4.984(0.007)	0.079(0.924)				
[MV _t , dIV _t , bIV _t , XR _t , IP _t]	3	10.770(0.000)	3.686(0.026)	[IV _t , dMV _t , bMV _t , XR _t , IP _t]	7.567(0.001)	3.824(0.022)				
[MV _t , dIP _t , bIP _t , XR _t , IV _t]	2	5.281(0.005)	3.062(0.048)	[IV _t , dMV _t , bMV _t , XR _t , IV _t]	15.387(0.000)	0.097(0.908)				
[IV _t , dIP _t , bIP _t , XR _t , MV _t]	3	0.609(0.544)	1.817(0.163)	[IP _t , dIV _t , bIV _t , XR _t , MV _t]	8.080(0.000)	1.525(0.218)				
Panel B: Cumulative effect										
VAR	q	H ₀ : A ₁₂ (1)=0 F-stats (p level)	sum	H ₀ : A ₁₃ (1)=0 F-stats (p level)	sum	VAR	H ₀ : A ₁₂ (1)=0 F-stats (p level)	sum	H ₀ : A ₁₃ (1)=0 F-stats (p level)	sum
[XR _t , dMV _t , bMV _t]	2	0.030(0.864)	0.017	0.907(0.341)	0.119	[MV _t , dXR _t , bXR _t]	16.124(0.000)	-0.158	2.373(0.124)	-0.051
[XR _t , dIV _t , bIV _t]	2	0.146(0.702)	0.024	0.808(0.369)	0.053	[IV _t , dXR _t , bXR _t]	22.260(0.000)	-0.131	22.573(0.000)	-0.107
[MV _t , dIV _t , bIV _t]	4	7.782(0.005)	0.101	1.195(0.275)	0.032	[IV _t , dMV _t , bMV _t]	5.456(0.020)	-0.086	6.523(0.011)	-0.121
[XR _t , dMV _t , bMV _t , IV _t]	3	0.112(0.738)	0.043	0.652(0.420)	0.127	[MV _t , dXR _t , bXR _t , IV _t]	10.944(0.001)	-0.160	0.957(0.328)	-0.042
[XR _t , dIV _t , bIV _t , MV _t]	3	0.001(0.981)	0.002	0.301(0.584)	0.037	[IV _t , dXR _t , bXR _t , MV _t]	21.945(0.000)	-0.161	22.229(0.000)	-0.142
[MV _t , dIV _t , bIV _t , XR _t]	3	10.933(0.001)	0.112	2.454(0.118)	0.044	[IV _t , dMV _t , bMV _t , XR _t]	10.112(0.002)	-0.120	7.062(0.008)	-0.122
[XR _t , dMV _t , bMV _t , IV _t , IP _t]	3	1.136(0.287)	-0.141	0.116(0.734)	0.048	[MV _t , dXR _t , bXR _t , IV _t , IP _t]	20.645(0.000)	-0.183	5.916(0.015)	-0.082
[XR _t , dIV _t , bIV _t , MV _t , IP _t]	3	0.336(0.562)	-0.050	0.274(0.601)	0.035	[IV _t , dXR _t , bXR _t , MV _t , IP _t]	28.617(0.000)	-0.156	31.881(0.000)	-0.138
[XR _t , dIP _t , bIP _t , MV _t , IV _t]	3	12.421(0.000)	-4.223	0.063(0.802)	0.159	[IP _t , dXR _t , bXR _t , MV _t , IV _t]	4.500(0.034)	0.004	0.029(0.865)	0.000
[MV _t , dIV _t , bIV _t , XR _t , IP _t]	3	8.096(0.005)	0.100	3.770(0.053)	0.053	[IV _t , dMV _t , bMV _t , XR _t , IP _t]	12.960(0.000)	-0.143	5.504(0.019)	-0.100
[MV _t , dIP _t , bIP _t , XR _t , IV _t]	2	9.487(0.002)	-1.538	5.545(0.019)	-0.624	[IP _t , dMV _t , bMV _t , XR _t , IV _t]	30.555(0.000)	-0.013	0.009(0.926)	0.000
[IV _t , dIP _t , bIP _t , XR _t , MV _t]	3	0.346(0.557)	-0.213	0.818(0.366)	-0.174	[IP _t , dIV _t , bIV _t , XR _t , MV _t]	16.108(0.000)	-0.006	0.198(0.656)	-0.001

Table 7. Tests of asymmetric causal relations among XR, MV, IV and IP: Pre/post recession and pre/post expansion.

Panel A1: Four month before recession: Granger causality, $d = 1$ if the economy is in 4 months before a recession starts, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)	VAR	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)				
[XR _t , dMV _t , bMV _t]	2	0.988(0.373)	2.897(0.056)	[MV _t , dXR _t , bXR _t]	2.395(0.092)	21.480(0.000)				
[XR _t , dIV _t , bIV _t]	2	0.882(0.414)	0.506(0.603)	[IV _t , dXR _t , bXR _t]	4.427(0.012)	29.488(0.000)				
[MV _t , dIV _t , bIV _t]	4	1.779(0.132)	1.669(0.156)	[IV _t , dMV _t , bMV _t]	2.401(0.049)	9.997(0.000)				
[XR _t , dMV _t , bMV _t , IV _t]	3	3.901(0.009)	3.050(0.028)	[MV _t , dXR _t , bXR _t , IV _t]	3.016(0.030)	17.193(0.000)				
[XR _t , dIV _t , bIV _t , MV _t]	3	2.281(0.078)	2.032(0.108)	[IV _t , dXR _t , bXR _t , MV _t]	5.438(0.001)	19.526(0.000)				
[MV _t , dIV _t , bIV _t , XR _t]	3	2.290(0.077)	2.975(0.031)	[IV _t , dMV _t , bMV _t , XR _t]	1.814(0.144)	7.186(0.000)				
[XR _t , dMV _t , bMV _t , IV _t , IP _t]	3	1.744(0.176)	4.987(0.007)	[MV _t , dXR _t , bXR _t , IV _t , IP _t]	2.984(0.051)	27.833(0.000)				
[XR _t , dIV _t , bIV _t , MV _t , IP _t]	3	2.696(0.068)	2.248(0.107)	[IV _t , dXR _t , bXR _t , MV _t , IP _t]	4.674(0.010)	34.839(0.000)				
[XR _t , dIP _t , bIP _t , MV _t , IV _t]		2.588(0.076)	1.764(0.172)	[IP _t , dXR _t , bXR _t , MV _t , IV _t]	2.044(0.131)	1.281(0.279)				
[MV _t , dIV _t , bIV _t , XR _t , IP _t]	3	2.884(0.057)	5.078(0.007)	[IV _t , dMV _t , bMV _t , XR _t , IP _t]	1.894(0.152)	6.335(0.002)				
[MV _t , dIP _t , bIP _t , XR _t , IV _t]	2	0.986(0.374)	8.062(0.000)	[IP _t , dMV _t , bMV _t , XR _t , IV _t]	2.691(0.069)	6.040(0.003)				
[IV _t , dIP _t , bIP _t , XR _t , MV _t]		1.258(0.285)	1.936(0.145)	[IP _t , dIV _t , bIV _t , XR _t , MV _t]	1.428(0.241)	0.989(0.373)				
Panel A2: Four month before recession: Cumulative effect, $d = 1$ if the economy is in 4 months before a recession starts, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	Q	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum	VAR	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum
[XR _t , dMV _t , bMV _t]	2	1.976(0.160)	-0.313	0.276(0.600)	0.052	[MV _t , dXR _t , bXR _t]	1.713(0.191)	-0.175	12.763(0.000)	-0.097
[XR _t , dIV _t , bIV _t]	2	1.356(0.245)	-0.103	0.876(0.350)	0.054	[IV _t , dXR _t , bXR _t]	5.109(0.024)	-0.216	38.441(0.000)	-0.113
[MV _t , dIV _t , bIV _t]	4	4.138(0.042)	0.096	0.726(0.395)	0.025	[IV _t , dMV _t , bMV _t]	0.066(0.797)	-0.021	7.016(0.008)	-0.099
[XR _t , dMV _t , bMV _t , IV _t]	3	5.352(0.021)	-0.587	0.342(0.559)	0.074	[MV _t , dXR _t , bXR _t , IV _t]	0.015(0.901)	0.023	7.557(0.006)	-0.094
[XR _t , dIV _t , bIV _t , MV _t]	3	5.085(0.025)	-0.225	0.602(0.438)	0.052	[IV _t , dXR _t , bXR _t , MV _t]	0.369(0.544)	0.078	41.502(0.000)	-0.155
[MV _t , dIV _t , bIV _t , XR _t]	3	3.909(0.049)	0.083	2.078(0.150)	0.041	[IV _t , dMV _t , bMV _t , XR _t]	2.649(0.104)	-0.123	11.890(0.001)	-0.129
[XR _t , dMV _t , bMV _t , IV _t , IP _t]	3	3.255(0.072)	-0.427	0.215(0.643)	-0.058	[MV _t , dXR _t , bXR _t , IV _t , IP _t]	1.563(0.212)	-0.164	19.361(0.000)	-0.124
[XR _t , dIV _t , bIV _t , MV _t , IP _t]	3	1.536(0.216)	-0.117	0.447(0.504)	0.045	[IV _t , dXR _t , bXR _t , MV _t , IP _t]	5.936(0.015)	-0.231	50.137(0.000)	-0.145
[XR _t , dIP _t , bIP _t , MV _t , IV _t]	3	4.660(0.031)	-6.409	2.347(0.126)	-0.820	[IP _t , dXR _t , bXR _t , MV _t , IV _t]	1.229(0.268)	0.007	1.184(0.277)	0.001
[MV _t , dIV _t , bIV _t , XR _t , IP _t]	3	3.782(0.052)	0.076	3.523(0.061)	0.052	[IV _t , dMV _t , bMV _t , XR _t , IP _t]	3.752(0.053)	-0.138	12.445(0.000)	-0.132
[MV _t , dIP _t , bIP _t , XR _t , IV _t]	2	0.223(0.637)	0.582	15.295(0.000)	-0.868	[IP _t , dMV _t , bMV _t , XR _t , IV _t]	5.375(0.021)	-0.010	11.599(0.001)	-0.008
[IV _t , dIP _t , bIP _t , XR _t , MV _t]		0.778(0.378)	0.786	1.615(0.204)	-0.204	[IP _t , dIV _t , bIV _t , XR _t , MV _t]	0.342(0.559)	-0.001	0.118(0.731)	0.000

Panel B1: Four month after recession: Granger causality, $d = 1$ if the economy is in 4 months after a recession starts, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)	VAR	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)				
$[XR_t, dMV_t, bMV_t]$	2	0.542(0.582)	3.075(0.047)	$[MV_t, dXR_t, bXR_t]$	2.033(0.132)	22.020(0.000)				
$[XR_t, dIV_t, bIV_t]$	2	0.482(0.618)	0.474(0.623)	$[IV_t, dXR_t, bXR_t]$	2.512(0.082)	31.043(0.000)				
$[MV_t, dIV_t, bIV_t]$	4	3.532(0.007)	1.176(0.320)	$[IV_t, dMV_t, bMV_t]$	3.867(0.004)	10.175(0.000)				
$[XR_t, dMV_t, bMV_t, IV_t]$	3	0.766(0.513)	3.301(0.020)	$[MV_t, dXR_t, bXR_t, IV_t]$	1.529(0.206)	18.098(0.000)				
$[XR_t, dIV_t, bIV_t, MV_t]$	3	1.516(0.209)	1.819(0.143)	$[IV_t, dXR_t, bXR_t, MV_t]$	1.536(0.204)	19.520(0.000)				
$[MV_t, dIV_t, bIV_t, XR_t]$	3	4.240(0.006)	2.547(0.055)	$[IV_t, dMV_t, bMV_t, XR_t]$	4.286(0.005)	6.900(0.000)				
$[XR_t, dMV_t, bMV_t, IV_t, IP_t]$	3	1.438(0.238)	4.825(0.008)	$[MV_t, dXR_t, bXR_t, IV_t, IP_t]$	2.048(0.130)	28.957(0.000)				
$[XR_t, dIV_t, bIV_t, MV_t, IP_t]$	3	2.195(0.112)	2.033(0.132)	$[IV_t, dXR_t, bXR_t, MV_t, IP_t]$	2.832(0.060)	36.471(0.000)				
$[XR_t, dIP_t, bIP_t, MV_t, IV_t]$		1.568(0.209)	2.405(0.091)	$[IP_t, dXR_t, bXR_t, MV_t, IV_t]$	4.650(0.010)	0.891(0.411)				
$[MV_t, dIV_t, bIV_t, XR_t, IP_t]$	3	5.439(0.005)	4.439(0.012)	$[IV_t, dMV_t, bMV_t, XR_t, IP_t]$	7.503(0.001)	5.786(0.003)				
$[MV_t, dIP_t, bIP_t, XR_t, IV_t]$	2	1.759(0.173)	8.322(0.000)	$[IP_t, dMV_t, bMV_t, XR_t, IV_t]$	12.942(0.000)	5.278(0.005)				
$[IV_t, dIP_t, bIP_t, XR_t, MV_t]$		1.206(0.300)	2.469(0.086)	$[IP_t, dIV_t, bIV_t, XR_t, MV_t]$	4.448(0.012)	0.993(0.371)				
Panel B2: Four month after recession: Cumulative effect, $d = 1$ if the economy is in 4 months after a recession starts, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum	VAR	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum
$[XR_t, dMV_t, bMV_t]$	2	0.934(0.334)	-0.173	0.433(0.511)	0.066	$[MV_t, dXR_t, bXR_t]$	0.533(0.466)	-0.065	13.582(0.000)	-0.102
$[XR_t, dIV_t, bIV_t]$	2	0.780(0.378)	-0.078	0.839(0.360)	0.053	$[IV_t, dXR_t, bXR_t]$	2.649(0.104)	-0.104	39.865(0.000)	-0.118
$[MV_t, dIV_t, bIV_t]$	4	2.995(0.084)	0.082	0.859(0.355)	0.027	$[IV_t, dMV_t, bMV_t]$	1.513(0.219)	-0.079	6.797(0.009)	-0.099
$[XR_t, dMV_t, bMV_t, IV_t]$	3	0.703(0.402)	-0.175	0.430(0.512)	0.084	$[MV_t, dXR_t, bXR_t, IV_t]$	0.004(0.951)	-0.007	7.771(0.005)	-0.098
$[XR_t, dIV_t, bIV_t, MV_t]$	3	1.324(0.250)	-0.118	0.318(0.573)	0.039	$[IV_t, dXR_t, bXR_t, MV_t]$	1.139(0.286)	-0.085	38.100(0.000)	-0.154
$[MV_t, dIV_t, bIV_t, XR_t]$	3	3.031(0.082)	0.074	2.299(0.130)	0.043	$[IV_t, dMV_t, bMV_t, XR_t]$	12.138(0.001)	-0.214	10.958(0.001)	-0.124
$[XR_t, dMV_t, bMV_t, IV_t, IP_t]$	3	1.726(0.189)	-0.263	0.137(0.712)	-0.046	$[MV_t, dXR_t, bXR_t, IV_t, IP_t]$	0.542(0.462)	-0.065	20.916(0.000)	-0.132
$[XR_t, dIV_t, bIV_t, MV_t, IP_t]$	3	0.930(0.335)	-0.094	0.300(0.584)	0.037	$[IV_t, dXR_t, bXR_t, MV_t, IP_t]$	3.631(0.057)	-0.122	52.284(0.000)	-0.151
$[XR_t, dIP_t, bIP_t, MV_t, IV_t]$	3	0.571(0.450)	-2.841	2.874(0.091)	-0.904	$[IP_t, dXR_t, bXR_t, MV_t, IV_t]$	7.290(0.007)	0.011	0.328(0.567)	0.001
$[MV_t, dIV_t, bIV_t, XR_t, IP_t]$	3	1.608(0.205)	0.051	3.692(0.055)	0.053	$[IV_t, dMV_t, bMV_t, XR_t, IP_t]$	14.954(0.000)	-0.231	11.381(0.001)	-0.126
$[MV_t, dIP_t, bIP_t, XR_t, IV_t]$	2	0.030(0.863)	-0.269	14.841(0.000)	-0.849	$[IP_t, dMV_t, bMV_t, XR_t, IV_t]$	25.802(0.000)	-0.019	10.178(0.002)	-0.007
$[IV_t, dIP_t, bIP_t, XR_t, MV_t]$		0.675(0.412)	-0.925	1.226(0.269)	-0.177	$[IP_t, dIV_t, bIV_t, XR_t, MV_t]$	8.155(0.004)	-0.005	0.079(0.779)	0.000

Panel C1: Four month before expansion: Granger causality, $d = 1$ if the economy is in 4 months before a recession ends, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)	VAR	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)				
$[XR_t, dMV_t, bMV_t]$	2	6.415(0.002)	3.120(0.045)	$[MV_t, dXR_t, bXR_t]$	1.712(0.181)	22.183(0.000)				
$[XR_t, dIV_t, bIV_t]$	2	4.827(0.008)	0.090(0.914)	$[IV_t, dXR_t, bXR_t]$	5.615(0.004)	29.183(0.000)				
$[MV_t, dIV_t, bIV_t]$	4	1.278(0.278)	1.703(0.148)	$[IV_t, dMV_t, bMV_t]$	5.804(0.000)	9.735(0.000)				
$[XR_t, dMV_t, bMV_t, IV_t]$	3	3.963(0.008)	3.391(0.018)	$[MV_t, dXR_t, bXR_t, IV_t]$	1.213(0.304)	18.392(0.000)				
$[XR_t, dIV_t, bIV_t, MV_t]$	3	2.770(0.041)	1.710(0.164)	$[IV_t, dXR_t, bXR_t, MV_t]$	2.877(0.036)	18.236(0.000)				
$[MV_t, dIV_t, bIV_t, XR_t]$	3	3.072(0.027)	2.834(0.038)	$[IV_t, dMV_t, bMV_t, XR_t]$	2.419(0.065)	7.828(0.000)				
$[XR_t, dMV_t, bMV_t, IV_t, IP_t]$	3	4.261(0.015)	5.599(0.004)	$[MV_t, dXR_t, bXR_t, IV_t, IP_t]$	2.612(0.074)	27.739(0.000)				
$[XR_t, dIV_t, bIV_t, MV_t, IP_t]$	3	5.972(0.003)	2.096(0.124)	$[IV_t, dXR_t, bXR_t, MV_t, IP_t]$	5.463(0.004)	33.804(0.000)				
$[XR_t, dIP_t, bIP_t, MV_t, IV_t]$		7.567(0.001)	1.365(0.256)	$[IP_t, dXR_t, bXR_t, MV_t, IV_t]$	1.253(0.286)	1.978(0.139)				
$[MV_t, dIV_t, bIV_t, XR_t, IP_t]$	3	4.786(0.009)	4.832(0.008)	$[IV_t, dMV_t, bMV_t, XR_t, IP_t]$	1.699(0.184)	6.550(0.002)				
$[MV_t, dIP_t, bIP_t, XR_t, IV_t]$	2	1.544(0.215)	6.670(0.001)	$[IP_t, dMV_t, bMV_t, XR_t, IV_t]$	6.907(0.001)	5.396(0.005)				
$[IV_t, dIP_t, bIP_t, XR_t, MV_t]$		1.463(0.232)	1.338(0.263)	$[IP_t, dIV_t, bIV_t, XR_t, MV_t]$	0.934(0.394)	1.184(0.307)				
Panel C2: Four month before expansion: Cumulative effect, $d = 1$ if the economy is in 4 months before a recession ends, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum	VAR	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	Sum
$[XR_t, dMV_t, bMV_t]$	2	12.323(0.000)	0.636	0.376(0.540)	-0.062	$[MV_t, dXR_t, bXR_t]$	0.236(0.627)	-0.038	14.248(0.000)	-0.108
$[XR_t, dIV_t, bIV_t]$	2	9.488(0.002)	0.260	0.042(0.837)	0.012	$[IV_t, dXR_t, bXR_t]$	5.877(0.016)	-0.135	38.023(0.000)	-0.115
$[MV_t, dIV_t, bIV_t]$	4	0.125(0.724)	0.016	0.976(0.324)	0.029	$[IV_t, dMV_t, bMV_t]$	4.104(0.043)	-0.138	6.036(0.014)	-0.093
$[XR_t, dMV_t, bMV_t, IV_t]$	3	9.055(0.003)	0.617	0.257(0.613)	-0.067	$[MV_t, dXR_t, bXR_t, IV_t]$	0.065(0.799)	-0.023	7.831(0.005)	-0.104
$[XR_t, dIV_t, bIV_t, MV_t]$	3	6.164(0.013)	0.259	0.177(0.674)	0.029	$[IV_t, dXR_t, bXR_t, MV_t]$	2.982(0.085)	-0.108	35.953(0.000)	-0.157
$[MV_t, dIV_t, bIV_t, XR_t]$	3	2.006(0.157)	0.062	2.339(0.127)	0.043	$[IV_t, dMV_t, bMV_t, XR_t]$	1.508(0.220)	-0.075	13.246(0.000)	-0.142
$[XR_t, dMV_t, bMV_t, IV_t, IP_t]$	3	7.348(0.007)	0.582	0.844(0.359)	-0.114	$[MV_t, dXR_t, bXR_t, IV_t, IP_t]$	1.640(0.201)	-0.102	19.350(0.000)	-0.129
$[XR_t, dIV_t, bIV_t, MV_t, IP_t]$	3	8.293(0.004)	0.288	0.172(0.679)	0.027	$[IV_t, dXR_t, bXR_t, MV_t, IP_t]$	5.995(0.015)	-0.141	49.333(0.000)	-0.149
$[XR_t, dIP_t, bIP_t, MV_t, IV_t]$	3	14.904(0.000)	-7.852	0.182(0.670)	-0.240	$[IP_t, dXR_t, bXR_t, MV_t, IV_t]$	0.381(0.537)	-0.002	2.569(0.110)	0.002
$[MV_t, dIV_t, bIV_t, XR_t, IP_t]$	3	1.166(0.281)	0.045	3.844(0.050)	0.054	$[IV_t, dMV_t, bMV_t, XR_t, IP_t]$	2.291(0.131)	-0.098	12.592(0.000)	-0.134
$[MV_t, dIP_t, bIP_t, XR_t, IV_t]$	2	1.207(0.272)	-0.936	12.761(0.000)	-0.842	$[IP_t, dMV_t, bMV_t, XR_t, IV_t]$	9.778(0.002)	-0.013	10.646(0.001)	-0.008
$[IV_t, dIP_t, bIP_t, XR_t, MV_t]$		1.185(0.277)	-0.671	0.688(0.407)	-0.141	$[IP_t, dIV_t, bIV_t, XR_t, MV_t]$	1.848(0.175)	-0.003	0.106(0.744)	0.000

Panel D1: Four month after expansion: Granger causality, $d = 1$ if the economy is in 4 months after a recession ends, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)	VAR	$H_0: A_{12}(L)=0$ F-stats (p level)	$H_0: A_{13}(L)=0$ F-stats (p level)				
$[XR_t, dMV_t, bMV_t]$	2	0.562(0.570)	2.763(0.064)	$[MV_t, dXR_t, bXR_t]$	0.211(0.810)	23.851(0.000)				
$[XR_t, dIV_t, bIV_t]$	2	1.369(0.255)	0.312(0.732)	$[IV_t, dXR_t, bXR_t]$	1.234(0.292)	34.746(0.000)				
$[MV_t, dIV_t, bIV_t]$	4	1.186(0.316)	1.664(0.157)	$[IV_t, dMV_t, bMV_t]$	1.744(0.139)	10.002(0.000)				
$[XR_t, dMV_t, bMV_t, IV_t]$	3	0.117(0.950)	3.306(0.020)	$[MV_t, dXR_t, bXR_t, IV_t]$	0.446(0.720)	19.186(0.000)				
$[XR_t, dIV_t, bIV_t, MV_t]$	3	2.528(0.057)	1.618(0.184)	$[IV_t, dXR_t, bXR_t, MV_t]$	1.184(0.315)	21.310(0.000)				
$[MV_t, dIV_t, bIV_t, XR_t]$	3	1.639(0.179)	2.940(0.033)	$[IV_t, dMV_t, bMV_t, XR_t]$	1.848(0.137)	7.180(0.000)				
$[XR_t, dMV_t, bMV_t, IV_t, IP_t]$	3	0.285(0.752)	4.961(0.007)	$[MV_t, dXR_t, bXR_t, IV_t, IP_t]$	0.887(0.413)	30.411(0.000)				
$[XR_t, dIV_t, bIV_t, MV_t, IP_t]$	3	3.575(0.029)	2.050(0.130)	$[IV_t, dXR_t, bXR_t, MV_t, IP_t]$	1.329(0.266)	40.396(0.000)				
$[XR_t, dIP_t, bIP_t, MV_t, IV_t]$		0.249(0.779)	2.645(0.072)	$[IP_t, dXR_t, bXR_t, MV_t, IV_t]$	0.070(0.933)	1.953(0.143)				
$[MV_t, dIV_t, bIV_t, XR_t, IP_t]$	3	2.270(0.104)	4.953(0.007)	$[IV_t, dMV_t, bMV_t, XR_t, IP_t]$	2.555(0.079)	6.394(0.002)				
$[MV_t, dIP_t, bIP_t, XR_t, IV_t]$	2	0.110(0.896)	7.849(0.000)	$[IP_t, dMV_t, bMV_t, XR_t, IV_t]$	0.381(0.683)	6.018(0.003)				
$[IV_t, dIP_t, bIP_t, XR_t, MV_t]$		1.885(0.153)	2.110(0.122)	$[IP_t, dIV_t, bIV_t, XR_t, MV_t]$	1.539(0.216)	1.048(0.351)				
Panel D2: Four month after expansion: Cumulative effect, $d = 1$ if the economy is in 4 months after a recession ends, and $d = 0$ otherwise. $b = 1 - d$.										
VAR	q	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum	VAR	$H_0: A_{12}(1)=0$ F-stats (p level)	sum	$H_0: A_{13}(1)=0$ F-stats (p level)	sum
$[XR_t, dMV_t, bMV_t]$	2	0.222(0.638)	0.115	0.135(0.713)	0.036	$[MV_t, dXR_t, bXR_t]$	0.387(0.534)	-0.081	13.694(0.000)	-0.101
$[XR_t, dIV_t, bIV_t]$	2	0.529(0.467)	0.070	0.485(0.486)	0.040	$[IV_t, dXR_t, bXR_t]$	1.404(0.237)	-0.110	42.093(0.000)	-0.117
$[MV_t, dIV_t, bIV_t]$	4	0.710(0.400)	0.043	0.934(0.334)	0.029	$[IV_t, dMV_t, bMV_t]$	1.996(0.158)	-0.125	6.309(0.012)	-0.094
$[XR_t, dMV_t, bMV_t, IV_t]$	3	0.147(0.702)	0.103	0.154(0.695)	0.051	$[MV_t, dXR_t, bXR_t, IV_t]$	0.047(0.828)	-0.033	7.253(0.007)	-0.094
$[XR_t, dIV_t, bIV_t, MV_t]$	3	0.337(0.562)	0.064	0.250(0.617)	0.034	$[IV_t, dXR_t, bXR_t, MV_t]$	1.986(0.159)	-0.149	37.439(0.000)	-0.151
$[MV_t, dIV_t, bIV_t, XR_t]$	3	0.978(0.323)	0.046	2.420(0.120)	0.044	$[IV_t, dMV_t, bMV_t, XR_t]$	3.661(0.056)	-0.152	11.551(0.001)	-0.129
$[XR_t, dMV_t, bMV_t, IV_t, IP_t]$	3	0.351(0.554)	-0.168	0.253(0.615)	-0.063	$[MV_t, dXR_t, bXR_t, IV_t, IP_t]$	1.754(0.186)	-0.175	19.625(0.000)	-0.124
$[XR_t, dIV_t, bIV_t, MV_t, IP_t]$	3	0.001(0.980)	0.003	0.247(0.619)	0.033	$[IV_t, dXR_t, bXR_t, MV_t, IP_t]$	1.197(0.274)	-0.104	55.094(0.000)	-0.150
$[XR_t, dIP_t, bIP_t, MV_t, IV_t]$	3	0.147(0.702)	0.832	3.550(0.060)	-1.079	$[IP_t, dXR_t, bXR_t, MV_t, IV_t]$	0.009(0.925)	0.002	1.766(0.184)	0.000
$[MV_t, dIV_t, bIV_t, XR_t, IP_t]$	3	0.222(0.637)	0.021	3.907(0.049)	0.055	$[IV_t, dMV_t, bMV_t, XR_t, IP_t]$	4.380(0.037)	-0.178	12.544(0.000)	-0.132
$[MV_t, dIP_t, bIP_t, XR_t, IV_t]$	2	0.113(0.737)	-0.304	14.380(0.000)	-0.902	$[IP_t, dMV_t, bMV_t, XR_t, IV_t]$	0.476(0.490)	-0.004	11.561(0.001)	-0.008
$[IV_t, dIP_t, bIP_t, XR_t, MV_t]$		0.679(0.410)	0.537	2.261(0.133)	-0.258	$[IP_t, dIV_t, bIV_t, XR_t, MV_t]$	0.177(0.674)	0.001	0.164(0.686)	-0.001

Table 8
Variance decomposition: Bivariate model

Model	[MV, XR]'						[IV, XR]'						[IV, MV]'					
Variables explained	MV			XR			IV			XR			IV			MV		
Horizons (months)	Errors	MV	XR	Errors	MV	XR	Errors	IV	XR	Errors	IV	XR	Errors	IV	MV	Errors	IV	MV
1	0.02	100.00	0.00	0.04	11.50	88.50	0.01	100.00	0.00	0.04	0.24	99.76	0.01	100.00	0.00	0.02	35.21	64.80
2	0.02	93.93	6.07	0.04	12.31	87.69	0.02	92.40	7.60	0.05	0.28	99.72	0.02	99.01	0.99	0.02	36.89	63.11
3	0.02	94.31	5.69	0.05	12.64	87.36	0.02	90.32	9.68	0.05	0.28	99.72	0.02	97.88	2.13	0.02	35.75	64.26
4	0.02	94.13	5.87	0.05	12.68	87.32	0.02	89.05	10.95	0.05	0.29	99.71	0.02	98.21	1.79	0.02	36.59	63.41
5	0.02	94.15	5.85	0.05	12.71	87.29	0.02	88.36	11.64	0.05	0.30	99.70	0.02	98.26	1.74	0.02	36.91	63.09
6	0.02	94.14	5.87	0.05	12.72	87.28	0.02	87.88	12.12	0.05	0.31	99.70	0.02	98.28	1.72	0.02	36.95	63.05
7	0.02	94.14	5.87	0.05	12.73	87.28	0.03	87.54	12.46	0.05	0.31	99.69	0.02	97.95	2.06	0.02	37.24	62.76
8	0.02	94.13	5.87	0.05	12.73	87.27	0.03	87.28	12.72	0.05	0.32	99.69	0.02	97.58	2.42	0.02	37.39	62.61
9	0.02	94.13	5.87	0.05	12.73	87.27	0.03	87.08	12.92	0.05	0.32	99.68	0.03	97.15	2.85	0.02	37.50	62.50
10	0.02	94.13	5.87	0.05	12.73	87.27	0.03	86.93	13.07	0.05	0.32	99.68	0.03	96.60	3.40	0.02	37.63	62.37
11	0.02	94.13	5.87	0.05	12.73	87.27	0.03	86.80	13.20	0.05	0.33	99.67	0.03	96.08	3.92	0.02	37.72	62.29
12	0.02	94.13	5.87	0.05	12.73	87.27	0.03	86.70	13.30	0.05	0.33	99.67	0.03	95.56	4.44	0.02	37.79	62.21
18	0.02	94.13	5.87	0.05	12.73	87.27	0.03	86.36	13.64	0.05	0.34	99.66	0.03	92.80	7.20	0.02	38.03	61.97
24	0.02	94.13	5.87	0.05	12.73	87.27	0.03	86.23	13.78	0.05	0.35	99.65	0.03	91.00	9.00	0.02	38.12	61.88

Table 9
Variance decomposition: Trivariate model

Model		[IV, MV, XR]'										
Variables explained		IV			MV			XR				
Horizons (months)	Errors	Innovations in										
		IV	MV	XR	Errors	IV	MV	XR	Errors	IV	MV	XR
1	0.01	100.00	0.00	0.00	0.02	30.17	69.83	0.00	0.04	0.39	15.61	84.00
2	0.02	92.39	0.85	6.76	0.02	29.43	63.05	7.52	0.04	0.39	16.82	82.79
3	0.02	88.31	2.18	9.51	0.02	28.35	64.18	7.47	0.05	0.43	17.55	82.02
4	0.02	86.23	1.85	11.93	0.02	29.31	63.58	7.11	0.05	0.56	17.52	81.92
5	0.02	85.33	1.67	13.00	0.02	29.54	63.13	7.33	0.05	0.57	17.52	81.91
6	0.02	84.67	1.59	13.74	0.02	29.62	63.10	7.28	0.05	0.59	17.57	81.85
7	0.02	83.66	1.71	14.63	0.02	29.84	62.85	7.30	0.05	0.61	17.57	81.83
8	0.02	82.99	1.86	15.15	0.02	29.96	62.71	7.33	0.05	0.61	17.57	81.82
9	0.02	82.33	2.10	15.57	0.02	30.07	62.59	7.34	0.05	0.62	17.57	81.81
10	0.02	81.69	2.36	15.95	0.02	30.15	62.48	7.37	0.05	0.63	17.57	81.81
11	0.03	81.12	2.63	16.24	0.02	30.22	62.40	7.38	0.05	0.63	17.57	81.80
12	0.03	80.59	2.92	16.50	0.02	30.28	62.33	7.40	0.05	0.64	17.57	81.80
18	0.03	78.23	4.35	17.43	0.02	30.47	62.08	7.45	0.05	0.65	17.56	81.79
24	0.03	76.84	5.27	17.89	0.02	30.55	61.96	7.49	0.05	0.66	17.56	81.78

Table 10
Variance decomposition: Four variable model

Model		[IV, MV, IP, XR]'								
Panel A:										
Variables explained		IV				MV				
Horizons (months)	Errors	IV	MV	IP	XR	Errors	IV	MV	IP	XR
1	0.01	100.00	0.00	0.00	0.00	0.02	27.56	72.45	0.00	0.00
2	0.02	91.26	0.17	0.32	8.25	0.02	27.15	64.75	0.31	7.79
3	0.02	88.18	0.23	0.56	11.02	0.02	26.25	65.12	0.86	7.77
4	0.02	86.62	0.20	0.71	12.48	0.02	26.48	64.06	1.32	8.15
5	0.02	85.81	0.20	0.76	13.24	0.02	26.44	63.63	1.73	8.20
6	0.02	85.25	0.23	0.75	13.77	0.02	26.50	63.15	2.08	8.27
7	0.02	84.87	0.27	0.73	14.14	0.02	26.52	62.79	2.39	8.31
8	0.03	84.58	0.33	0.69	14.40	0.02	26.55	62.47	2.65	8.34
9	0.03	84.36	0.39	0.65	14.60	0.02	26.57	62.20	2.87	8.36
10	0.03	84.18	0.45	0.61	14.75	0.02	26.60	61.96	3.07	8.37
11	0.03	84.03	0.52	0.59	14.86	0.02	26.62	61.75	3.24	8.39
12	0.03	83.90	0.58	0.57	14.95	0.02	26.65	61.56	3.39	8.40
18	0.03	83.26	0.96	0.65	15.13	0.02	26.83	60.77	3.93	8.47
24	0.03	82.67	1.30	0.97	15.07	0.02	27.00	60.35	4.14	8.52

Panel B:

Variables explained	IP					XR				
	Horizons (months)	Errors	IV	MV	IP	XR	Errors	IV	MV	IP
1	0.00	0.09	0.01	99.91	0.00	0.04	0.29	16.08	0.00	83.63
2	0.00	0.08	0.35	99.57	0.00	0.04	0.33	17.75	0.12	81.81
3	0.00	0.15	1.60	98.04	0.22	0.04	0.33	18.00	0.12	81.55
4	0.00	0.40	3.19	95.82	0.59	0.04	0.34	17.99	0.16	81.51
5	0.00	0.73	4.57	93.74	0.96	0.04	0.34	17.99	0.21	81.46
6	0.00	1.08	5.69	91.96	1.27	0.04	0.35	17.98	0.25	81.43
7	0.00	1.42	6.55	90.48	1.54	0.04	0.35	17.98	0.29	81.39
8	0.00	1.75	7.21	89.27	1.78	0.04	0.35	17.97	0.32	81.35
9	0.00	2.05	7.72	88.25	1.98	0.05	0.36	17.97	0.36	81.32
10	0.00	2.34	8.11	87.40	2.15	0.05	0.36	17.97	0.38	81.29
11	0.00	2.61	8.41	86.67	2.31	0.05	0.36	17.97	0.41	81.26
12	0.00	2.87	8.64	86.04	2.45	0.05	0.36	17.96	0.43	81.24
18	0.00	4.23	9.24	83.46	3.07	0.05	0.38	17.95	0.53	81.14
24	0.00	5.31	9.31	81.90	3.48	0.05	0.40	17.95	0.57	81.09

Conclusion

- Prior studies tend to treat market risk and idiosyncratic risk separately.
- We find that the dynamic relation among XR, MV, IV, and IPG is time-varying.
- *First*, excess market return anticipates negative market and idiosyncratic risk:
market return is an economic indicator with respect to both types of risks.
Further, the relation is more significant in recessions.

- *Second*, idiosyncratic risk helps predict market risk with a positive sign mainly in the early part of recessions:

There is a dynamic evolution from idiosyncratic risk to market risk, and this helps us better understand the transition of the economy from expansion to recession.

- This finding provides further evidence for the theoretical models of Horvath (1998, 2000) and Pastor and Veronesi (2009).

- *Third*, market risk helps predict negative idiosyncratic risk: market risk may substitute idiosyncratic risk to some extent. Further, its negative net effect is stronger in the early expansion period: lower market risk leads to a higher idiosyncratic risk in the early expansion period as the economy moves out of recessions, which helps us better understand the transition of the economy from a recession to an expansion.

Overall, we find that the dynamic relations among market returns, two types of risk (MV and IV), and economic activity changes over time, in particular, over business cycles.

- Our findings provide further evidence in support of Horvath (1998, 2000), Pastor and Veronesi (2009), and Chun, Kim, and Morck (2011) with new insights into the dynamic relations between these variables and business cycles.
- We can better understand the recent economic recessions in the context of the dynamic relations between the two types of risks and market returns: as recessions tend to be triggered (or initiated) by some idiosyncratic (sectoral) shocks leading to MV with a positive effect, and the recovery of the economy can be understood by MV leading to IV with a negative effect.

Thank you!