Indexing and Stock Market Serial Dependence Around the World

Internet Appendix

Guido Baltussen, Sjoerd van Bekkum, and Zhi Da

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Summary

In this document, we present material supplementary to the paper titled "Indexing and Stock Market Serial Dependence Around the World." It contains additional checks demonstrating that the change in serial dependence documented in Table 2 ("Two Multi-Period Autocorrelation measures"), Table 3 ("Breaks in Serial Dependence"), and Table 4 ("Index Serial Dependence and Indexing") of the main text is not driven by the choice of serial dependence measure or regression specification. Specifically:

- We repeat the analysis in the main text of Table 2, Table 3, and Table 4 to show that the change in serial dependence does not depend on the choice of q in both $MAC(q)$ and $EMAC(q)$.

  These results are summarized in Figures A.1, A.2, A.3, and A.4.

- We repeat the analysis of Tables 3 and 4 in the main text to show that documenting the change in serial dependence does not depend on the choice between $MAC(q)$ and $EMAC(q)$.

  These results are tabulated in Tables A.1. and A.2.

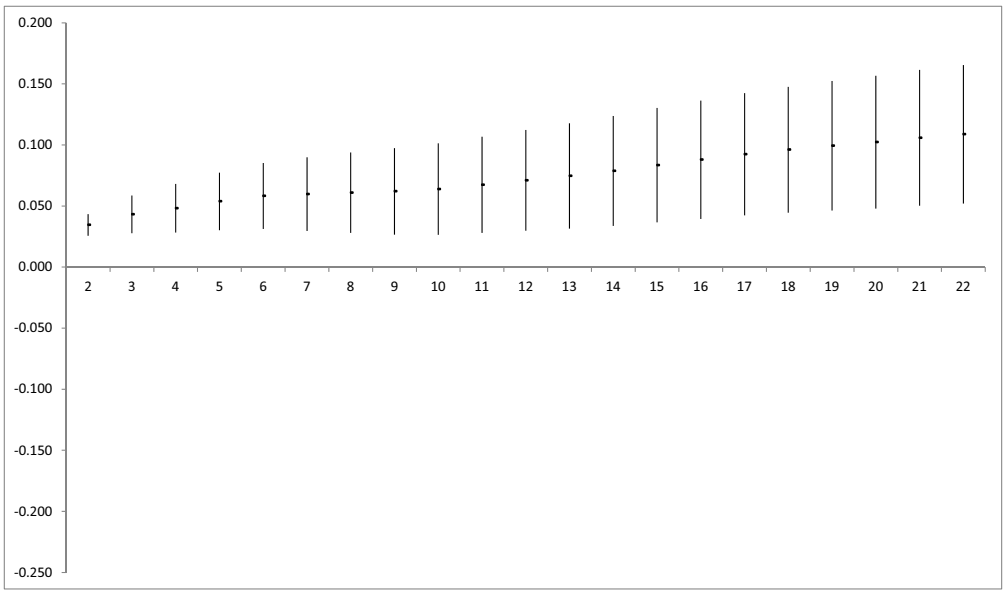
- We repeat the relevant parts of Table 1, Table 2, Table 3, and Table 4 in the main text to show that all results estimated across our cross-section of indices are robust to including a single index per country.

  These results are tabulated in Table A.3.

Figure A.1: Additional lag structures related to Table 2

This Figure plots MAC(q) and EMAC(q) for our panel of stock market indices across the world, before and after March 3rd, 1999, for different lag orders. We repeat the analysis in the forelast row of Table 2 ("Two Multi-Period Autocorrelation measures") and calculate daily MAC(5) (Panels A and B) or EMAC(5) (Panels C and D) separately for $q = 2$ to $q = 22$ (i.e., daily to monthly horizon). The horizontal axis represents each lag order q, and the vertical axis represents MAC(q) (Panels A and B) or EMAC(q) (Panels C and D) . The ranges centered around each MAC(q) or EMAC(q) coefficient represent its corresponding 90% confidence interval.

Panel A: MAC(q) before 1999



Panel B: MAC(q) after 1999

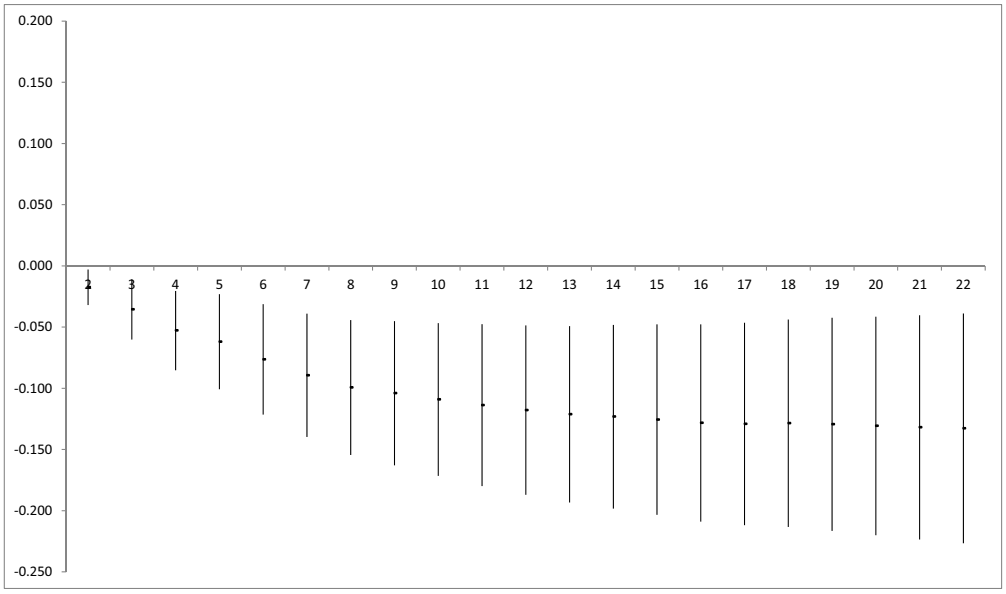
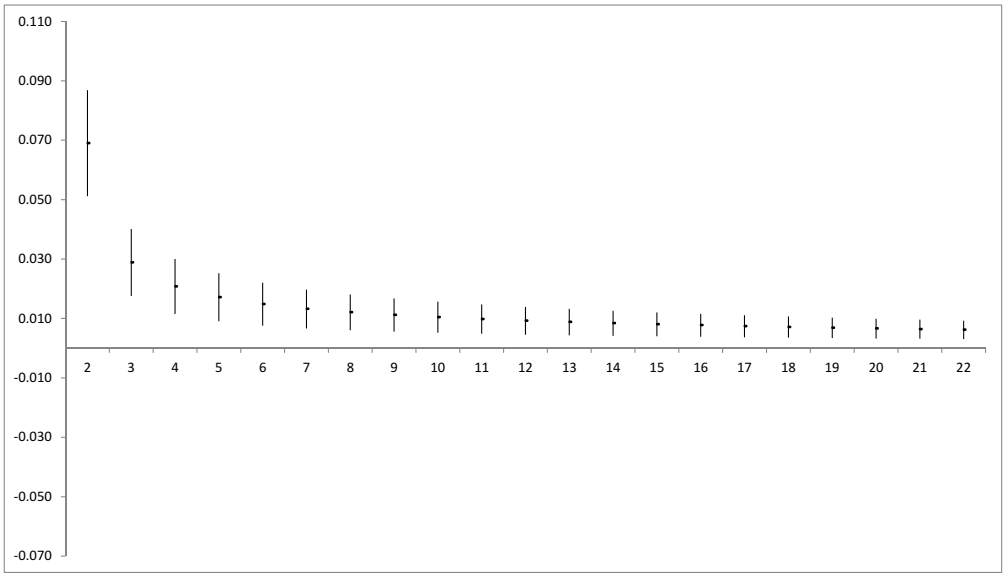


Figure A.1: Additional lag structures related to Table 2 (Cont'd)

Panel C: EMAC(q) before 1999



Panel D: EMAC(q) after 1999

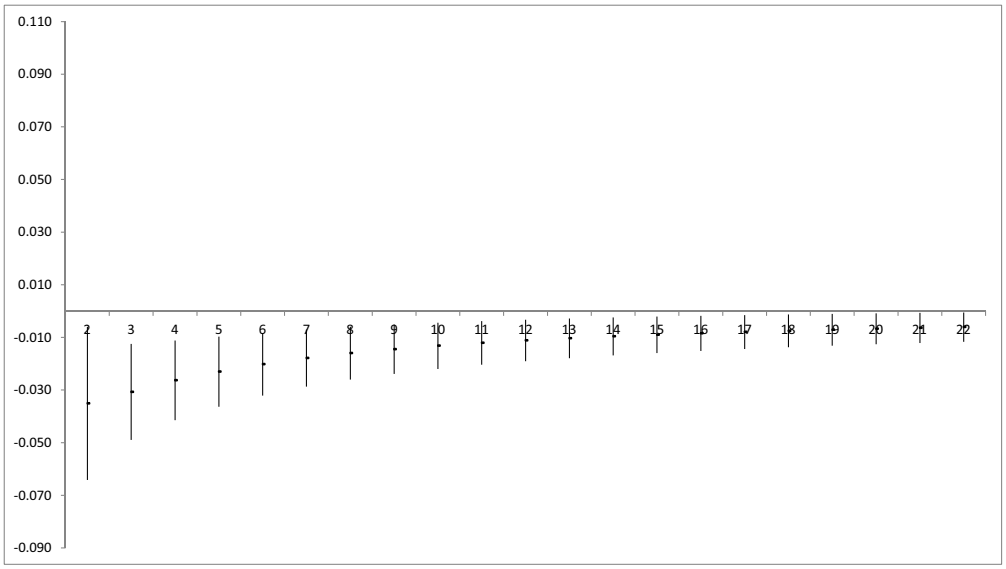
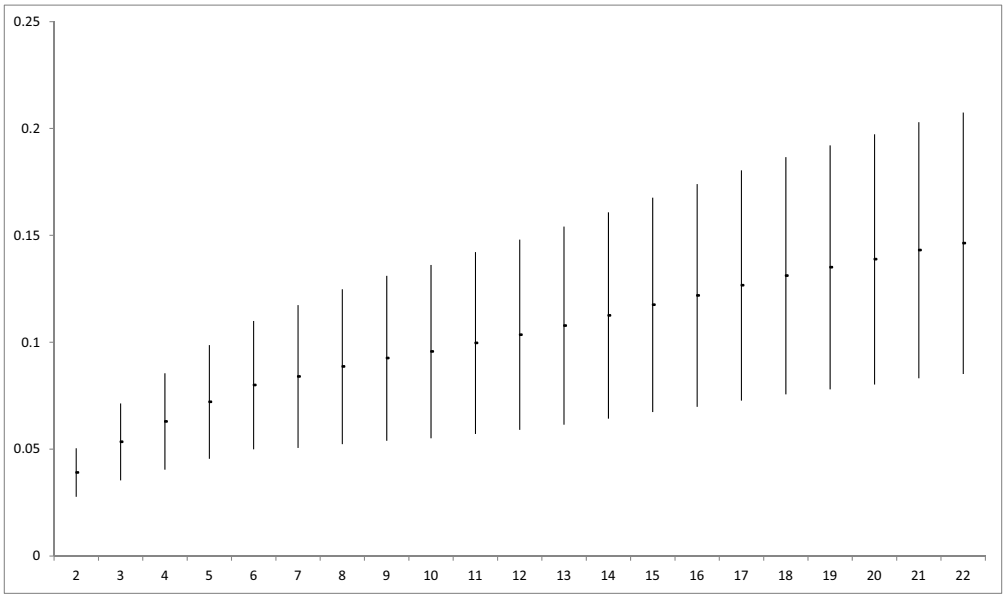


Figure A.2: Lag structures related to Table 3

This Figure plots MAC(q) and EMAC(q) coefficients for our panel of stock market indices across the world, before and after the futures introductions for different lag orders. We repeat the analysis in the forelast row of Table 3 ("Breaks in Serial Dependence") and calculate coefficients on MAC(q) (Panels A and B) or on EMAC(q) (Panels C and D) separately for $q = 2$ to $q = 22$ (i.e., daily to monthly horizon). The horizontal axis represents each lag order q, and the vertical axis represents MAC(q) (Panels A and B) or EMAC(q) (Panels C and D). The ranges centered around each MAC(q) or EMAC(q) coefficient represent its corresponding 90% confidence interval.

Panel A: Coefficient b_1 in $MAC(q)_{Index} = b_1 + b_2 \cdot D_{intro} + \varepsilon$



Panel B: Coefficient b_2 in $MAC(q)_{Index} = b_1 + b_2 \cdot D_{intro} + \varepsilon$

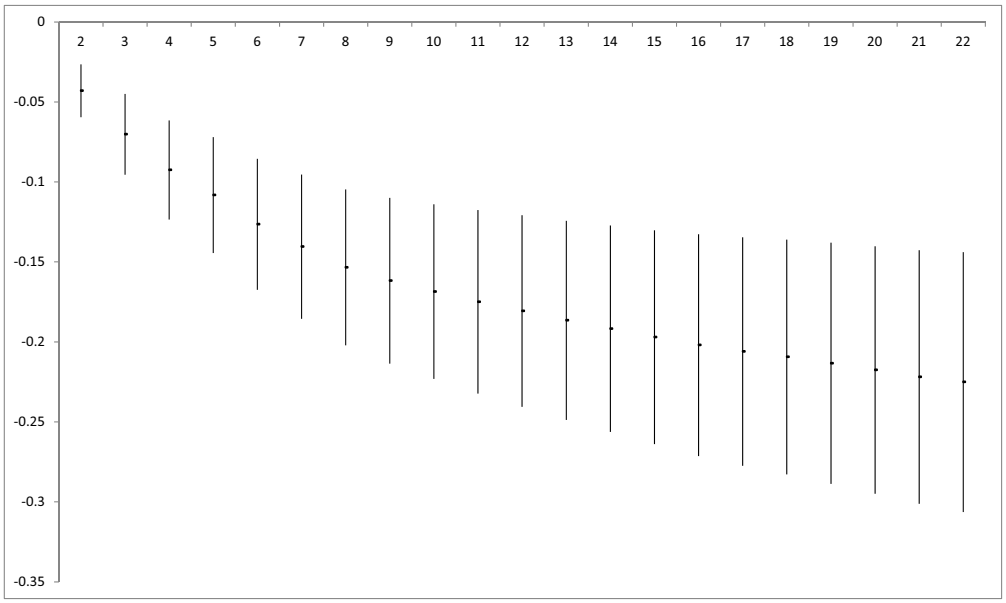
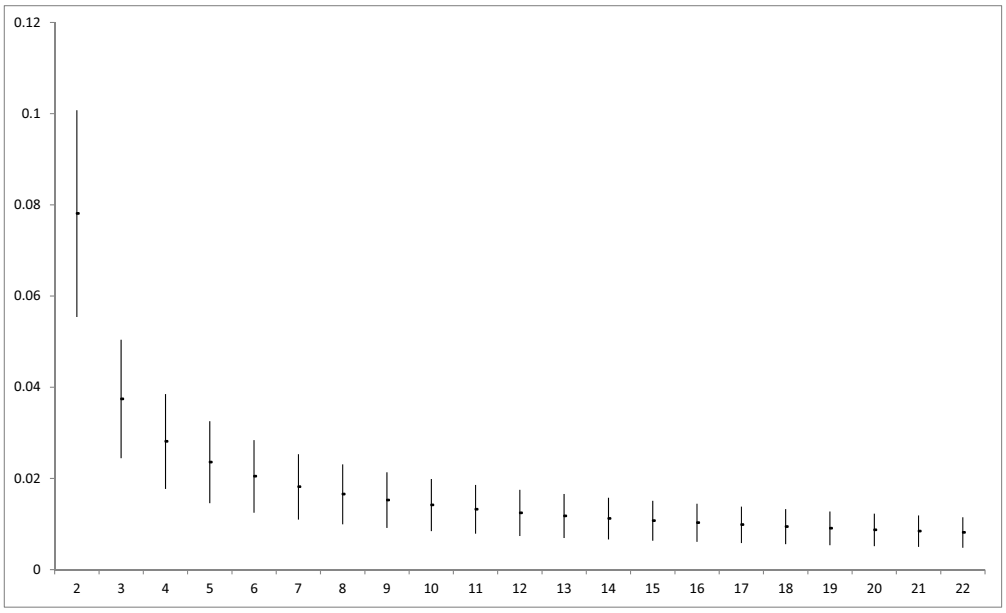


Figure A.2: Lag structures related to Table 3 (Cont'd)

Panel C: Coefficient b_1 in $EMAC(q)_{Index} = b_1 + b_2 \cdot D_{intro} + \varepsilon$



Panel D: Coefficient b_2 in $EMAC(q) = b_1 + b_2 \cdot D_{intro} + \varepsilon$

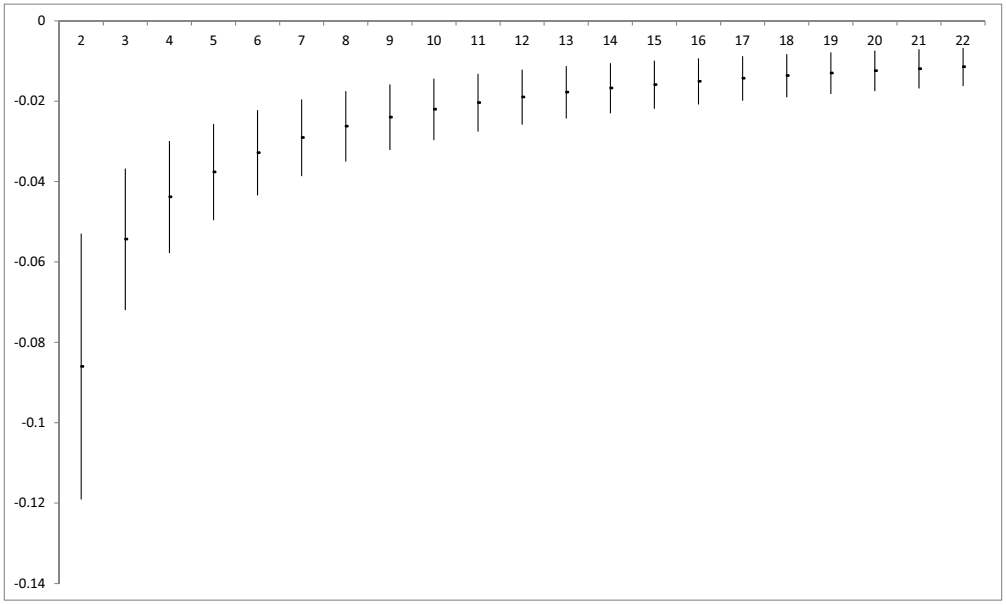
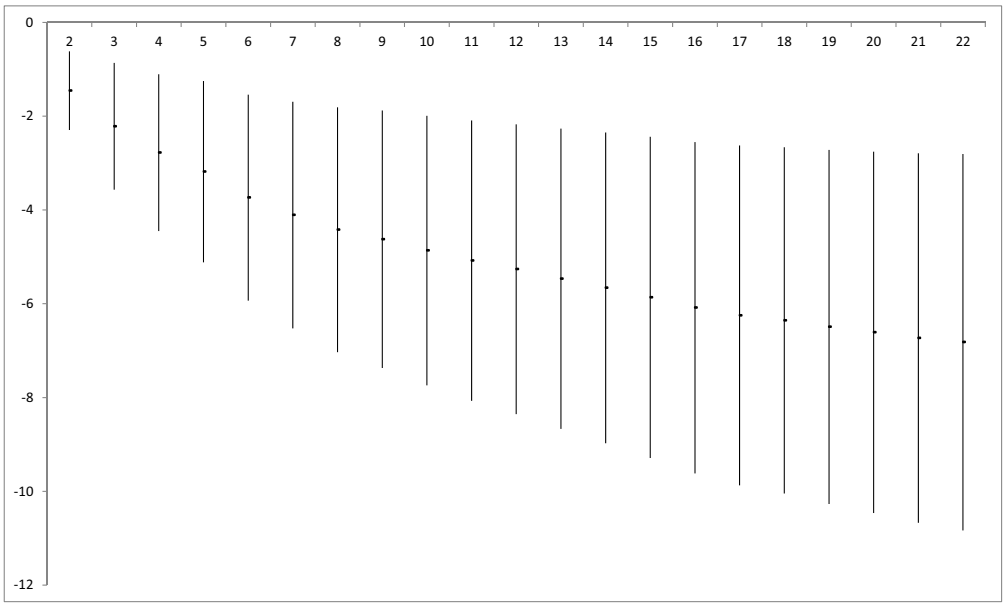


Figure A.3: Lag structures related to Table 4 for MAC

This Figure plots Indexing coefficients for our panel of stock market indices across the world, before and after the futures introductions, for different lag orders. We repeat the analysis of Table 4 ("Index Serial Dependence and Indexing") and calculate coefficients on Indexing for $MAC(q)$ (Panels A and B) and for $\Delta MAC(5)$ (Panels C and D) separately for $q = 2$ to $q = 22$ (i.e., daily to monthly horizon). The horizontal axis represents each lag order q, and the vertical axis the Indexing coefficient for $MAC(q)$ (Panels A and B) or the Indexing coefficient for $\Delta MAC(q)$ (Panels C and D) . The ranges centered around each MAC(q) or EMAC(q) coefficient represent its corresponding 90% confidence interval.

Panel A: Coefficient b_2 in $MAC(q)_{index,it} = b_1 + b_2 \cdot Indexing_{it-1} + \varepsilon_{it}$



Panel B: Coefficient b_2 in $MAC(q)_{index,it} = b_1 + b_2 \cdot Indexing_{it-1} + \theta' \mathbf{X}_{it-1} + \varepsilon_{it}$

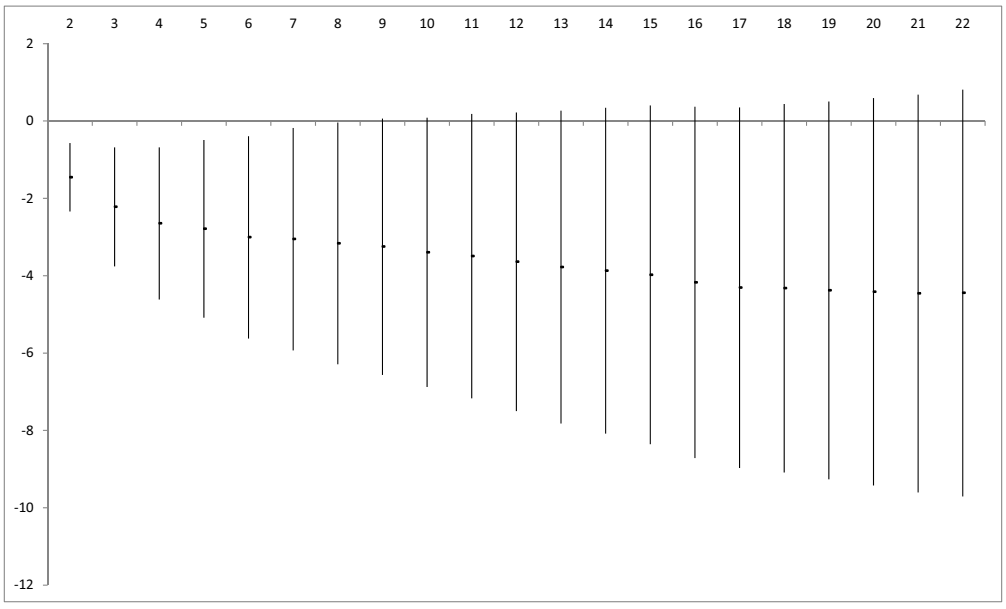
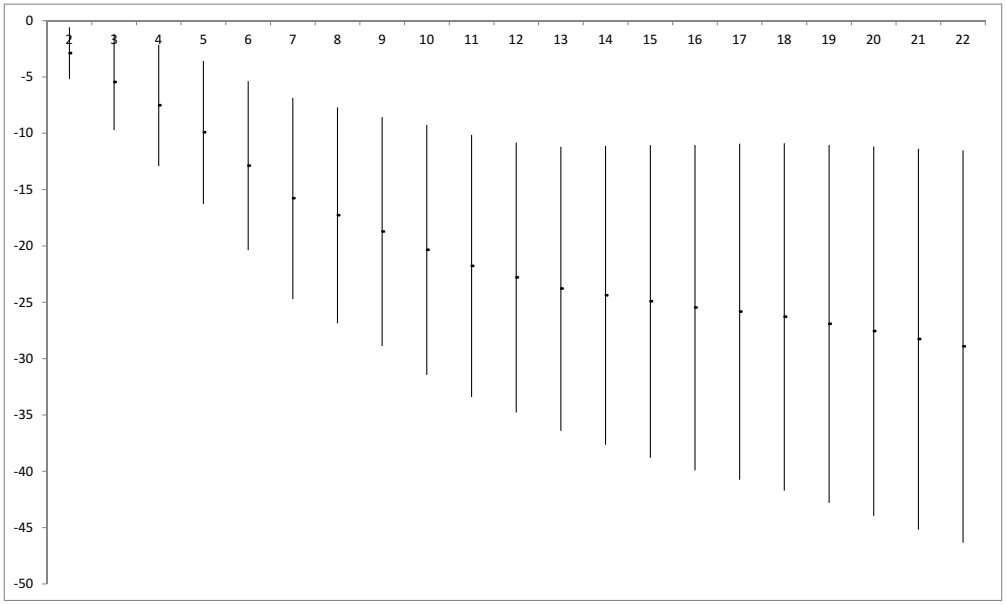


Figure A.3: Lag structures related to Table 4 for MAC (Cont'd)

Panel C: Coefficient b_2 in $\Delta MAC(q)_{index,it} = b_1 + b_2 \cdot \Delta Indexing_{it-1} + \varepsilon_{it}$



Panel D: Coefficient b_2 in $\Delta MAC(q)_{index,it} = b_1 + b_2 \cdot \Delta Indexing_{it-1} + \theta' \mathbf{\Delta X}_{it-1} + \varepsilon_{it}$

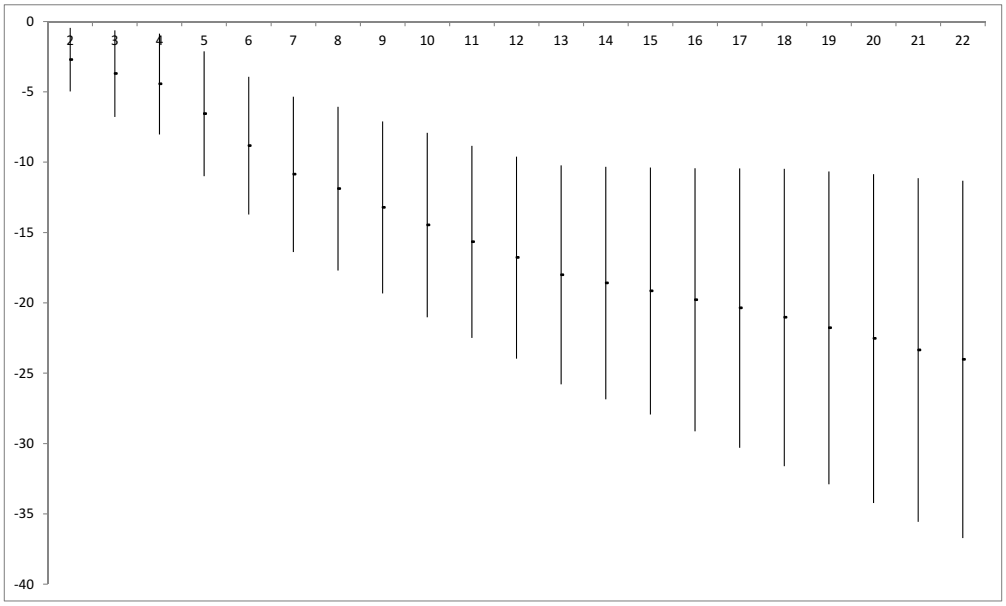
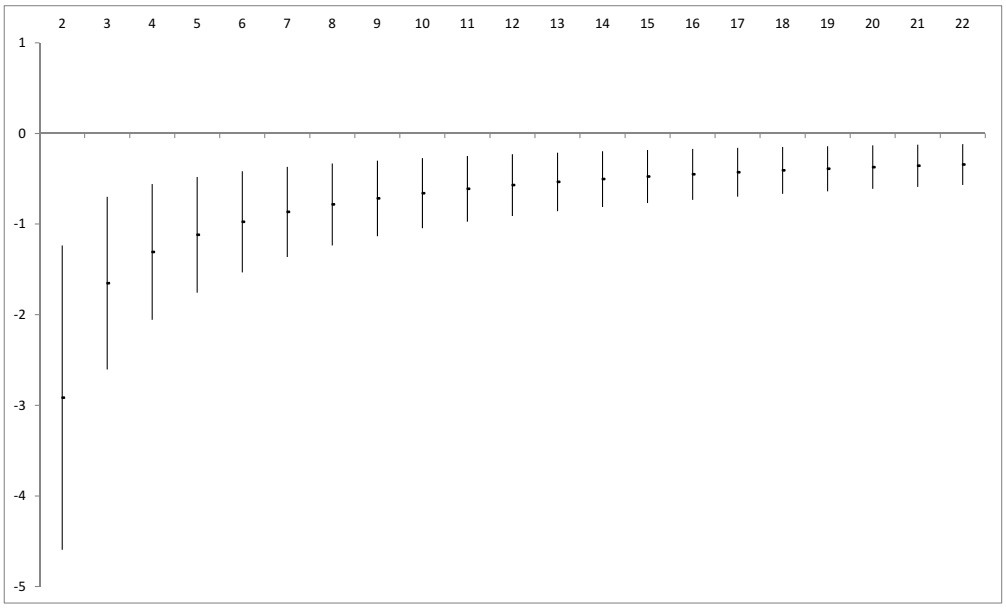


Figure A.4: Lag structures related to Table 4 for EMAC

This Figure plots Indexing coefficients for our panel of stock market indices across the world, before and after the futures introductions, for different horizons. We repeat the analysis of Table 4 ("Index Serial Dependence and Indexing") and calculate coefficients on Indexing for $EMAC(q)$ (Panels A and B) and for $\Delta EMAC(5)$ (Panels C and D) separately for $q = 2$ to $q = 22$ (i.e., daily to monthly horizon). The horizontal axis represents each lag order q, and the vertical axis the Indexing coefficient for $EMAC(q)$ (Panels A and B) or the Indexing coefficient for $\Delta EMAC(q)$ (Panels C and D). The ranges centered around each MAC(q) or EMAC(q) coefficient represent its corresponding 90% confidence interval.

Panel A: Coefficient b_2 in $EMAC(q)_{index,it} = b_1 + b_2 \cdot Indexing_{it-1} + \varepsilon_{it}$



Panel B: Coefficient b_2 in $EMAC(q)_{index,it} = b_1 + b_2 \cdot Indexing_{it-1} + \theta' \mathbf{X}_{it-1} + \varepsilon_{it}$

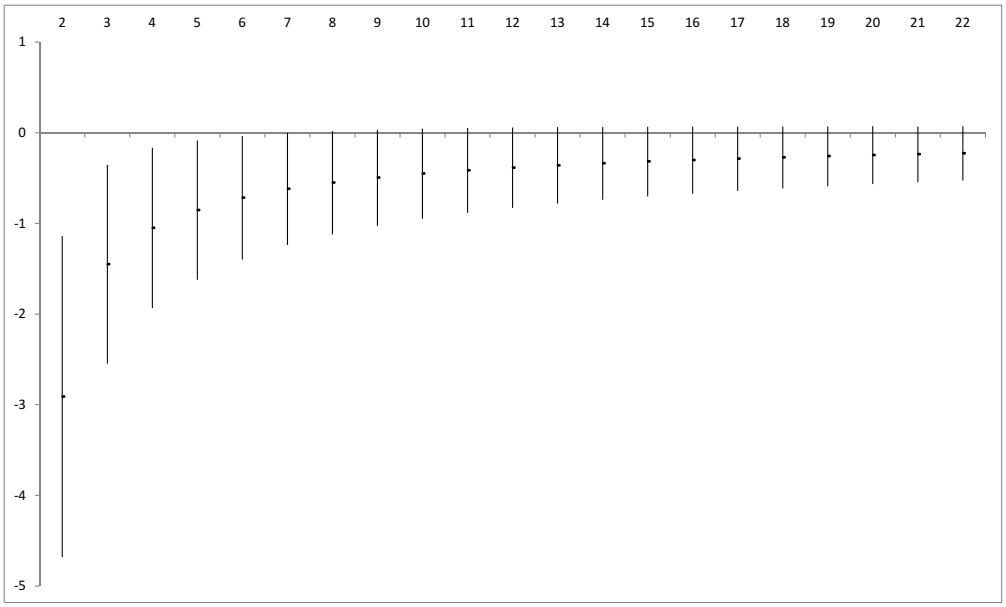
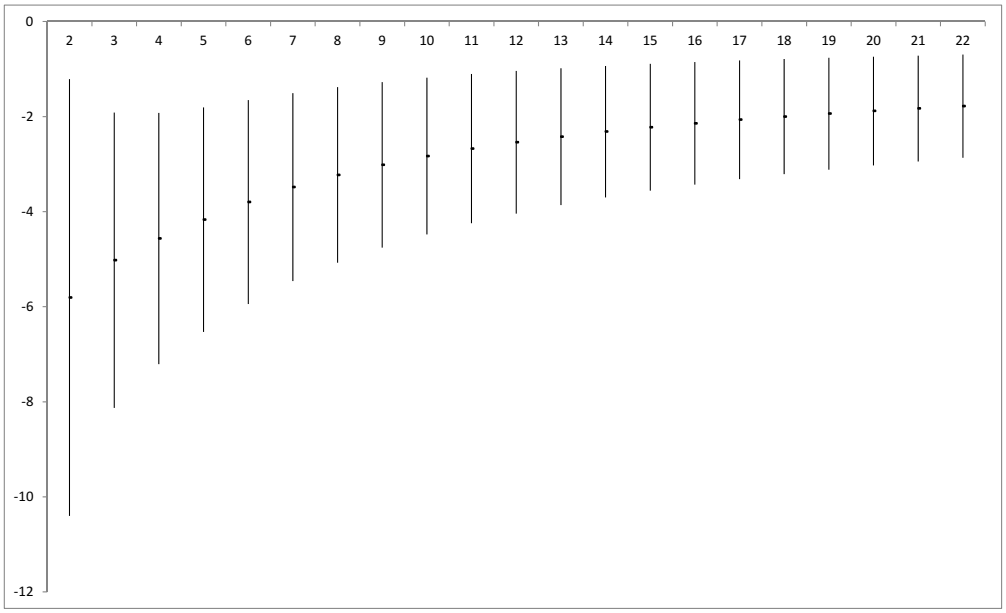


Figure A.4: Lag structures related to Table 4 for EMAC (Cont'd)

Panel C: Coefficient b_2 in $\Delta EMAC(q) = b_1 + b_2 \cdot \Delta Indexing_{it-1} + \varepsilon_{it}$



Panel D: Coefficient b_2 in $\Delta EMAC(5q) = b_1 + b_2 \cdot \Delta Indexing_{it-1} + \theta' \mathbf{\Delta X}_{it-1} + \varepsilon_{it}$

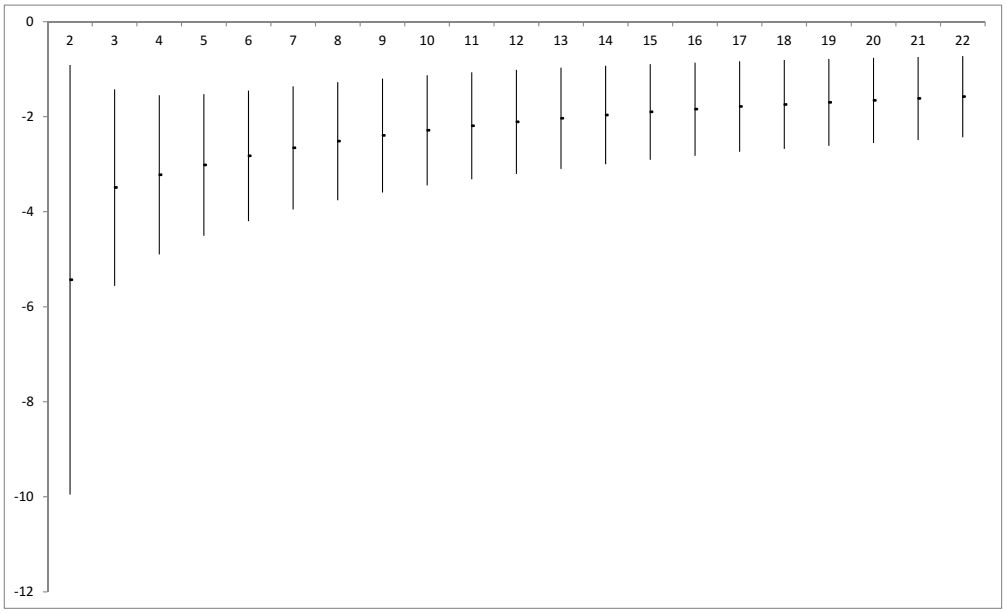


Table A.1: Replication of Table 3 using EMAC

This Table repeats the analysis of Table 3 of the main text ("Breaks in Serial Dependence"), with the dependent variable MAC(5) replaced by EMAC(5). EMAC is an Exponentially weighted Multi-period AutoCorrelation function $EMAC_t = r_t \cdot f(\lambda, r_{t-\tau})/\sigma^2, \tau = 1, ..., \infty$, with $f(.)$ recursively defined as $f(\lambda_q, r_t) = \lambda_q r_t + (1 - \lambda_q) f(\lambda_q, r_{t-1})$. The parameter λ_q is chosen such that the half-life of $EMAC(q)$ is equal to the half-life of $MAC(q)$. All other comments from Table 3 in the main text apply.

	$EMAC(5)_{Index}$				$EMAC(5)_{Futures}$		$EMAC(5)_{ETF}$	
	b_1		b_2		Average		Average	
S&P 500	0.025***	(7.02)	-0.052***	(-5.67)	-0.029***	(-2.87)	-0.029***	(-3.82)
FTSE 100	-0.003	(-1.30)	-0.008	(-1.25)	-0.015***	(-2.75)	-0.034***	(-3.69)
DJESI 50	0.002	(0.38)	-0.029***	(-3.06)	-0.025***	(-4.22)	-0.024***	(-3.77)
TOPIX	0.029***	(6.68)	-0.033***	(-3.14)	-0.017***	(-2.77)	-0.013	(-1.55)
ASX 200	0.000	(-0.06)	-0.015	(-1.41)	-0.014**	(-1.96)	-0.019**	(-2.53)
TSE 60	0.028***	(4.46)	-0.057***	(-4.56)	-0.023***	(-2.94)	-0.018**	(-2.29)
CAC	0.041	(1.04)	-0.058	(-1.47)	-0.018***	(-3.88)	-0.024***	(-3.43)
DAX	0.008	(1.67)	-0.023**	(-2.56)	-0.009	(-1.56)	-0.010	(-1.33)
IBEX	0.050***	(2.13)	-0.058**	(-2.41)	-0.013***	(-2.56)	-0.017**	(-2.15)
MIB-30 / MIB	0.010	(0.50)	-0.017	(-0.85)	-0.007	(-1.15)	-0.007	(-0.95)
AEX	0.005	(0.32)	-0.013	(-0.84)	-0.010*	(-1.85)	-0.010	(-1.24)
OMX Stockholm	0.029	(1.46)	-0.037*	(-1.79)	-0.020***	(-4.09)	-0.028***	(-3.74)
SMI	0.007	(0.32)	-0.014	(-0.57)	-0.009	(-1.36)	-0.019**	(-2.26)
Nikkei 225	0.019***	(4.43)	-0.041***	(-4.13)	-0.016***	(-2.59)	-0.015*	(-1.78)
HSI	0.053***	(3.66)	-0.053***	(-3.39)	-0.005	(-0.50)	-0.013*	(-1.85)
Nasdaq 100	0.012	(1.56)	-0.044***	(-3.97)	-0.023***	(-3.42)	-0.025***	(-3.52)
NYSE	0.039***	(7.35)	-0.056***	(-5.91)	-0.031***	(-2.74)	-0.024**	(-2.05)
Russell 2000	0.056***	(4.71)	-0.074***	(-4.92)	-0.018**	(-2.54)	-0.022***	(-2.95)
S&P 400	0.049**	(2.32)	-0.063***	(-2.83)	-0.019***	(-2.48)	-0.016**	(-1.97)
KOSPI 200	0.002	(0.34)	-0.006	(-0.58)	-0.010	(-1.46)	-0.012	(-1.29)
Panel of Indices	0.024***	(4.40)	-0.038***	(-5.27)	-0.017***	(-3.30)	-0.020***	(-3.10)
Panel of Indices (1-day lag)	0.007	(1.66)	-0.023***	(-3.63)	-0.014***	(-2.83)	-0.015**	(-2.44)

Table A.2: Replication of Table 4 using EMAC

This Table repeats the analysis of Table 4 ("Serial Dependence and Indexing"), with the dependent variable $MAC(5)$ replaced for $EMAC(5)$. EMAC is an Exponentially weighted Multi-period AutoCorrelation function $EMAC_t = r_t \cdot f(\lambda, r_{t-\tau})/\sigma^2, \tau = 1, ..., \infty$, with $f(.)$ recursively defined as $f(\lambda_q, r_t) = \lambda_q r_t + (1 - \lambda_q) f(\lambda_q, r_{t-1})$. The parameter λ_q is chosen such that the half-life of $EMAC(q)$ is equal to the half-life of $MAC(q)$. All other comments from Table 4 in the main text apply.

Dependent Variable:	$EMAC(5)_{Index}$					$\Delta EMAC(5)_{Index}$		Fama-MacBeth (>1990)	
Intercept	0.013	0.004	0.060	0.059	0.053	0.001	0.001	0.001	-0.004
	(2.28)	(1.32)	(1.49)	(1.48)	(1.41)	(0.15)	(0.14)	(0.12)	(-0.87)
Indexing (futures+ETFs)	-1.094***	-1.119***	-0.852*						-0.528***
	(-3.04)	(-2.94)	(-1.86)						(-4.18)
Indexing (futures)				-1.106*					
				(-1.87)					
Indexing (ETFs)					-1.611				
					(-1.66)				
ΔIndexing (futures+ETFs)						-4.159***	-4.167***	-3.018***	
						(-2.98)	(-2.96)	(-3.40)	
Controls	No	No	Yes	Yes	Yes	No	No	No	No
ΔControls	No	No	No	No	No	No	No	Yes	No
Index fixed effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
R^2(%)	0.055	0.066	0.251	0.251	0.236	0.012	0.012	0.198	

Table A.3: Replication of Results Based on a Panel of Indices, Only One Index per Country

This tables replicates all results from the main text in which are cross-section of indices is pooled together into a panel format, after restricting the sample of indices to a single index per country. Specifically, we remove the DJESI 50, TOPIX, NYSE, Russell 2000, Nasdaq 100, and S&P 400 indices so that each country has exactly one index, and re-run the analyses on the cross-section of remaining indices for Tables 1-3 (Panel A) and Table 4 (Panel B). All relevant comments from Tables 1-4 in the main text apply.

Panel A: Panel-of-Indices results from Tables 1-3 with exactly 1 index per country

Key result	Statistic	Panel of Indices	Panel of Indices (1-day lag)
Table 1	Daily AR(1) before	0.073***	-0.015
		(5.42)	(-1.21)
	Daily AR(1) after	-0.02	-0.029*
		(-1.44)	(-1.79)
	Difference	-0.093***	-0.013
		(-4.49)	(-0.64)
	Weekly AR(1) before	0.032	0.074***
		(1.30)	(3.43)
	Weekly AR(1) after	-0.081**	-0.025
		(-2.23)	(-0.89)
	Difference	-0.114***	-0.099***
		(-2.70)	(-2.85)
Table 2	Index MAC(5) before	0.044***	-0.004
		(3.37)	(-0.31)
	Index MAC(5) after	-0.054**	-0.054**
		(-2.41)	(-2.44)
	Difference	-0.098***	-0.05**
		(-3.75)	(-2.00)
	Index EMAC(5) before	0.014***	0.000
		(3.11)	(0.100)
	Index EMAC(5) after	-0.020***	-0.018**
		(-2.66)	(-2.49)
	Difference	-0.034***	-0.019**
		(-3.94)	(-2.24)
Table 3	Index MAC(5) b1	0.062***	0.012
		(4.06)	(0.93)
	Index MAC(5) b2	-0.094***	-0.058***
		(-4.33)	(-3.12)
	Average futures MAC(5)	-0.040***	-0.042***
		(-2.69)	(-2.83)
	Average ETF MAC(5)	-0.052***	-0.045**
		(-2.77)	(-2.44)

Table A.3: Replication of Results Based on a Panel of Indices, Only One Index per Country (Cont'd)

Panel B: Panel-of-Indices results from Table 4 with exactly 1 index per country

Dependent Variable:	$MAC(5)_{Index}$					$\Delta MAC(5)_{Index}$			Fama-MacBeth (>1990)
Intercept	0.038**	0.020	0.197	0.193	0.171	0.001	0.002	0.001	-0.001
	(2.16)	(1.42)	(1.65)	(1.64)	(1.56)	(0.08)	(1.03)	(0.64)	(-0.07)
Indexing (futures+ETFs)	-3.077***	-3.192***	-2.842*						-1.798***
	(-2.55)	(-2.55)	(-1.75)						(-4.00)
Indexing (futures)				-3.600*					
				(-1.79)					
Indexing (ETFs)					-4.474				
					(-1.47)				
ΔIndexing (futures+ETFs)						-9.221***	-9.227***	-6.328***	
						(-2.67)	(-2.67)	(-2.67)	
Controls	No	No	Yes	Yes	Yes	No	No	No	No
ΔControls	No	No	No	No	No	No	No	Yes	No
Index fixed effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
R^2(%)	0.045	0.055	0.212	0.213	0.193	0.008	0.008	0.183	
Zero serial dependence point	0.012								