Properties of Financial Texts
Internet Appendix

Overview

IA1: Trading Volume

Table 1 demonstrates the results of trading volume stationarity testing using the ADF and KPSS procedures. According to the ADF test, both level measure ($log(Vlm)$) and its first difference ($\Delta log(Vlm)$) are stationary. First difference of the level ($\Delta log(Vlm)$) is stationary according to both ADF and KPSS tests. The level measure is not stationary using the KPSS test. Campbell et al. (1993) find the level of trading volume to be non-stationary as well. As a result, the ADF test does not have sufficient discriminatory power while the KPSS procedure does. Figure 1 provides visual evidence; $log(Vlm)$ is clearly non-stationary, $\Delta log(Vlm)$ is stationary.

IA2: Business Cycle Prediction Errors

Table 1 shows that the prediction errors are lower in expansions when using stationary sentiment measures. Only days with no prior breaks are used for the evaluation. Prediction errors are statistically significantly lower for both market returns and trading volume. Forecast errors are comparable in magnitude to those obtained using the raw, non-stationary word frequencies (presented in the main paper) further establishing the robustness of residual-based evaluation.

IA3: Quantile Regressions

Table 1 and Table 2 complement Figure 3 in the main paper. They include estimates for all quantiles, lower and upper bounds, and p-values. The regression specifications are: $R_t = \beta_M M_{t-1} + \beta_R R_{t-1} + \beta_{RSq} R^2_{t-1} + C + \epsilon$ and $\Delta log(Vlm)_t = \beta_M M_{t-1} +$

$\beta_{Vlm}\Delta log(Vlm)_{t-1} + \beta_R R_{t-1} + \beta_{RSq} R^2_{t-1} + C + \epsilon$. The results are computed using the stationary sentiment measures. Only days with no prior breaks are used for the evaluation. Longest possible time series are used, 1905-2005 for the Dow returns, 1926-2005 for the trading volume. Quantile regression confidence intervals follow Koenker (1994), kernel p-value is based on Powell (1991), bootstrap is pairwise as described in Koenker (2005).

IA4: Prediction Quality

Table 1 includes correlations between prediction residuals from different stationary sentiment measures. It also lists p-values from testing the equality of means of absolute (squared) forecast errors. The correlations are generally very close to 1; all p-values are also near 1. These facts demonstrate that all stationary sentiment measures forecast Dow returns or trading volume on the same days. Some (for example, negative sentiment) predict it a bit more precisely (perhaps due to a higher quality dictionary, negation being more common for the positive words,[1] etc.). Therefore, it makes sense to draw economic conclusions from the estimate with the largest magnitude; none will tangibly increase the breadth of coverage.

[1] Intuitively, this makes sense; double negatives are generally frowned upon.

IA1: Trading Volume

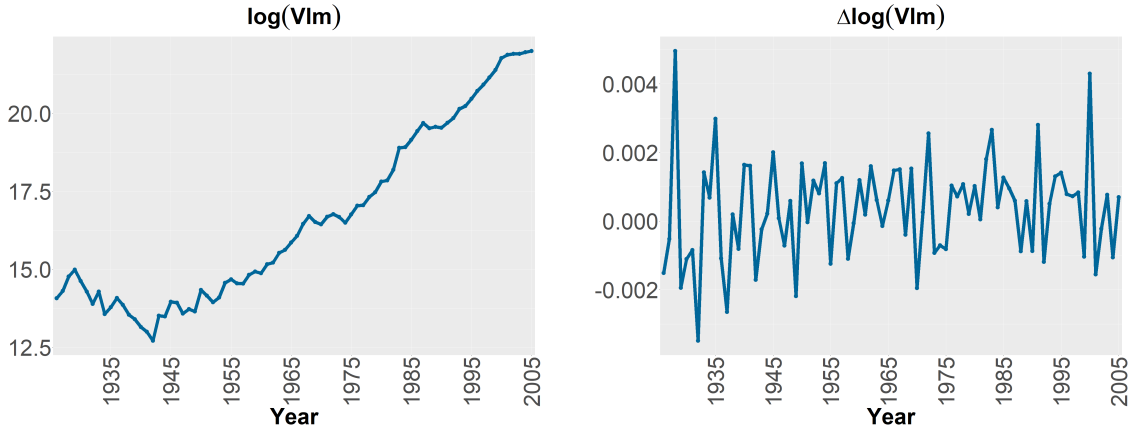
IA1, Table 1: **Trading Volume Stationarity**

Trading volume data covers 1926 - 2005. $log(Vlm)$, $\Delta log(Vlm)$ are logarithm of the trading volume aggregated across common shares and its first difference respectively. The ADF test includes intercept and trend, the number of lags is set to 1. The ADF null hypotheses: presence of a unit root (τ_3), unit root without trend (ϕ_3), unit root without trend and without drift (ϕ_2). The KPSS null hypothesis is trend-stationarity. The number of lags (KPSS) is set to $4(T/100)^{0.25}$.

	Statistic		**Critical Values**		
	$\boldsymbol{log(Vlm)}$	$\boldsymbol{\Delta log(Vlm)}$	**10%**	**5%**	**1%**
ADF, $\boldsymbol{\tau_3}$	-15.63	-154.40	-3.12	-3.41	-3.96
ADF, $\boldsymbol{\phi_2}$	81.42	7,946.11	4.03	4.68	6.09
ADF, $\boldsymbol{\phi_3}$	122.10	11,919.16	5.34	6.25	8.27
KPSS	26.09	0.002	0.12	0.15	0.22

IA1, Figure 1: **Trading Volume**

Values are aggregated (yearly means). Left panel depicts $log(Vlm)$, right panel $\Delta log(Vlm)$. $log(Vlm)$, $\Delta log(Vlm)$ are logarithm of the trading volume aggregated across common shares and its first difference respectively.



IA2: Forecast Errors in Expansions and Recessions

IA2, Table 1: **Prediction Errors and Business Cycle**

All sentiment measures are computed using a two-step procedure and are stationary. MAE and MSE are compared using two-sample Welch's t-test; RMSE (square root of MSE) is reported instead to match units. Return orediction erros are in basis points (bps), trading volume in percentage points (%pp). All p-values less than 0.001 are reported as 0. Only days with no prior breaks are included. Recessions are from NBER (USRECD).

Dow Returns, 1905-2005						
$R_t = \beta_M M_{t-1} + \beta_R R_{t-1} + \beta_{RSq} R^2_{t-1} + C + \epsilon$						
	MAE (bps)			**RMSE (bps)**		
	Exp	**Rec**	**p-value**	**Exp**	**Rec**	**p-value**
$\boldsymbol{\Delta Pos}$	63.847	91.614	0	90.340	140.822	0
$\boldsymbol{\Delta Neg}$	63.814	91.533	0	90.321	140.775	0
$\boldsymbol{\Delta Pess}$	63.805	91.532	0	90.302	140.777	0
Trading Volume, 1926-2005						
$\Delta log(Vlm)_t = \beta_M M_{t-1} + \beta_{Vlm} \Delta log(Vlm)_{t-1} + \beta_R R_{t-1} + \beta_{RSq} R^2_{t-1} + C + \epsilon$						
	MAE (%pp)			**RMSE (%pp)**		
	Exp	**Rec**	**p-value**	**Exp**	**Rec**	**p-value**
$\boldsymbol{\Delta Pos}$	14.048	17.183	0	19.841	23.389	0
$\boldsymbol{\Delta Neg}$	13.998	17.149	0	19.789	23.345	0
$\boldsymbol{\Delta Pess}$	14.017	17.177	0	19.812	23.366	0

IA3: Quantile Regressions

IA3, Table 1: **Quantile Regressions, Daily Dow, Stationary Sentiment**

	β_M	LB	UB	p_{boot}	p_{ker}
Panel A: ΔPos					
$\tau = 0.1$	-2.11	-4.36	0.82	0.15	0.12
$\tau = 0.2$	0.88	-0.52	2.33	0.30	0.35
$\tau = 0.3$	2.58	1.18	3.82	0	0
$\tau = 0.4$	2.42	1.37	3.72	0	0
$\tau = 0.5$	2.59	1.51	3.57	0	0
$\tau = 0.6$	2.78	1.83	4.01	0	0
$\tau = 0.7$	3.91	2.65	5.00	0	0
$\tau = 0.8$	4.95	3.25	6.17	0	0
$\tau = 0.9$	4.10	2.47	6.08	0	0
Panel B: ΔNeg					
	β_M	LB	UB	p_{boot}	p_{ker}
$\tau = 0.1$	-1.45	-3.97	0.40	0.27	0.27
$\tau = 0.2$	-2.11	-3.44	-0.47	0.02	0.02
$\tau = 0.3$	-3.18	-4.23	-1.83	0	0
$\tau = 0.4$	-3.82	-4.81	-2.50	0	0
$\tau = 0.5$	-3.72	-5.04	-2.87	0	0
$\tau = 0.6$	-3.51	-4.63	-2.49	0	0
$\tau = 0.7$	-3.15	-4.31	-2.10	0	0
$\tau = 0.8$	-3.47	-5.02	-2.06	0	0
$\tau = 0.9$	-3.89	-5.82	-1.98	0	0
Panel C: $\Delta Pess$					
	β_M	LB	UB	p_{boot}	p_{ker}
$\tau = 0.1$	-0.05	-2.09	2.69	0.98	0.97
$\tau = 0.2$	-1.96	-3.64	-0.33	0.03	0.04
$\tau = 0.3$	-3.59	-4.69	-2.43	0	0
$\tau = 0.4$	-3.88	-4.88	-2.89	0	0
$\tau = 0.5$	-3.98	-4.96	-2.95	0	0
$\tau = 0.6$	-4.27	-5.33	-3.24	0	0
$\tau = 0.7$	-5.27	-6.47	-3.85	0	0
$\tau = 0.8$	-5.48	-6.71	-4.20	0	0
$\tau = 0.9$	-5.47	-7.34	-3.34	0	0

IA3, Table 2: **Quantile Regressions, Trading Volume, Stationary Sentiment**

	β_M	LB	UB	p_{boot}	p_{ker}
Panel A: ΔPos					
$\tau = 0.1$	0.01	-0.72	0.58	0.98	0.98
$\tau = 0.2$	0.47	0.14	0.80	0.01	0.03
$\tau = 0.3$	0.34	0.08	0.67	0.06	0.06
$\tau = 0.4$	0.38	0.11	0.57	0.01	0.02
$\tau = 0.5$	0.34	0.04	0.62	0.05	0.04
$\tau = 0.6$	0.42	0.11	0.70	0.02	0.01
$\tau = 0.7$	0.45	0.17	0.68	0.01	0.01
$\tau = 0.8$	0.55	0.21	0.86	0	0.01
$\tau = 0.9$	0.92	0.25	1.51	0.01	0
Panel B: ΔNeg					
	β_M	LB	UB	p_{boot}	p_{ker}
$\tau = 0.1$	-1.71	-2.26	-1.07	0	0
$\tau = 0.2$	-1.33	-1.70	-1.10	0	0
$\tau = 0.3$	-1.42	-1.73	-1.11	0	0
$\tau = 0.4$	-1.37	-1.61	-1.17	0	0
$\tau = 0.5$	-1.37	-1.61	-1.19	0	0
$\tau = 0.6$	-1.31	-1.49	-1.11	0	0
$\tau = 0.7$	-1.24	-1.49	-0.95	0	0
$\tau = 0.8$	-1.41	-1.77	-1.03	0	0
$\tau = 0.9$	-1.83	-2.30	-1.15	0	0
Panel C: $\Delta Pess$					
	β_M	LB	UB	p_{boot}	p_{ker}
$\tau = 0.1$	-0.99	-1.56	-0.49	0	0
$\tau = 0.2$	-1.09	-1.46	-0.77	0	0
$\tau = 0.3$	-1.15	-1.47	-0.81	0	0
$\tau = 0.4$	-1.02	-1.24	-0.77	0	0
$\tau = 0.5$	-1.13	-1.42	-0.83	0	0
$\tau = 0.6$	-1.15	-1.37	-0.89	0	0
$\tau = 0.7$	-1.11	-1.42	-0.76	0	0
$\tau = 0.8$	-1.22	-1.49	-0.84	0	0
$\tau = 0.9$	-1.64	-2.24	-1.04	0	0

IA4: Prediction Quality

IA4, Table 1: **Prediction Quality by Measure**

Residuals are from: $R_t = \beta_M M_{t-1} + \beta_R R_{t-1} + \beta_{RSq} R^2_{t-1} + C + \epsilon$ and $\Delta log(Vlm)_t = \beta_M M_{t-1} + \beta_{Vlm} \Delta log(Vlm)_{t-1} + \beta_R R_{t-1} + \beta_{RSq} R^2_{t-1} + C + \epsilon$. Dow spans 1905-2005, trading volume data covers 1926 - 2005, only days with no prior breaks are included. Two-sided Welch's t-test is used to compare MAE (MSE).

Dow, Welch's t-test

	ΔPos	ΔNeg	$\Delta Pess$	
ΔPos	1	0.955	0.947	MAE
ΔNeg	0.989	1	0.993	
$\Delta Pess$	0.984	0.995	1	
	MSE			

Dow, Correlations

	$\epsilon_{\Delta Pos}$	$\epsilon_{\Delta Neg}$	$\epsilon_{\Delta Pess}$	
$\epsilon_{\Delta Pos}$	1	0.999	1.000	Pearson
$\epsilon_{\Delta Neg}$	0.969	1	1.000	
$\epsilon_{\Delta Pess}$	0.982	0.978	1	
	Kendall			

Volume, Welch's t-test

	ΔPos	ΔNeg	$\Delta Pess$	
ΔPos	1	0.776	0.872	MAE
ΔNeg	0.868	1	0.901	
$\Delta Pess$	0.927	0.940	1	
	MSE			

Volume, Correlations

	$\epsilon_{\Delta Pos}$	$\epsilon_{\Delta Neg}$	$\epsilon_{\Delta Pess}$	
$\epsilon_{\Delta Pos}$	1	0.997	0.999	Pearson
$\epsilon_{\Delta Neg}$	0.945	1	0.999	
$\epsilon_{\Delta Pess}$	0.968	0.961	1	
	Kendall			

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