# Stock Prices Still Move Too Much For Dividends But Less So: A Reappraisal of Shiller 1981 - Supplementary Material

Table S1: Comparing Statistics: Original vs Replication

	Replication Sample: 1871-1978				Replication Sample: 1963-2018			Replication Sample: 1871-2018	
	Volatility ratio	F-stat	*Volatility ratio*	Change	*F − stat*	Volatility ratio	*Change*	F-stat	
ineq.(1)	5.5446	30.74	5.9560	7.42%	35.47	1.3131	−76.32%	1.72	
ineq.(11) using σ	5.5869	31.21	3.9647	-29.04%	15.72	2.0756	−62.85%	4.31	
ineq.(11) using $\min(\sigma)$	5.0271	25.27	3.4298	-31.77%	11.76	1.8948	−62.31%	3.59	
ineq.(13) using σ	5.4569	29.78	3.9094	-28.36%	15.28	2.0360	−62.69%	4.15	
ineq.(13) using $\min(\sigma)$	4.9105	24.11	3.3820	-31.13%	11.44	1.8586	−62.15%	3.45	

Description: This table reports the statistics for the key inequalities in Shiller, 1981, i.e. (1), (11), (13), and the corresponding volatility ratios and F-statistics. We present the same statistics for the replication of the original sample, 1871-1978, the shorter updated sample, 1963-2018 and the longer updated sample, 1871-2018. The volatility ratios are computed by dividing the estimated sample volatility of market stock prices (either σ or $\min(\sigma)$, where the latter represents the lower bound on σ computed as a one-sided χ^2 95 percent confidence interval) to the theoretical volatility bound estimated using discounted dividends. F-statistics are computed by dividing corresponding variances, i.e. by squaring the volatility ratios.

Interpretation: The results show that the excess volatility phenomena is present in the data, regardless of the chosen data sample. However, the magnitude of the effect is lower in the updated samples that end in 2018, compared to the original sample in Shiller, 1981 that ended in 1979. Specifically, except for the inequality (1) for the shorter updated sample 1963-2018, all volatility ratios and F-statistics computed using inequalities (1), (11) and (13) show a lower excess volatility by between one third and three thirds, depending on which data sample is analized.
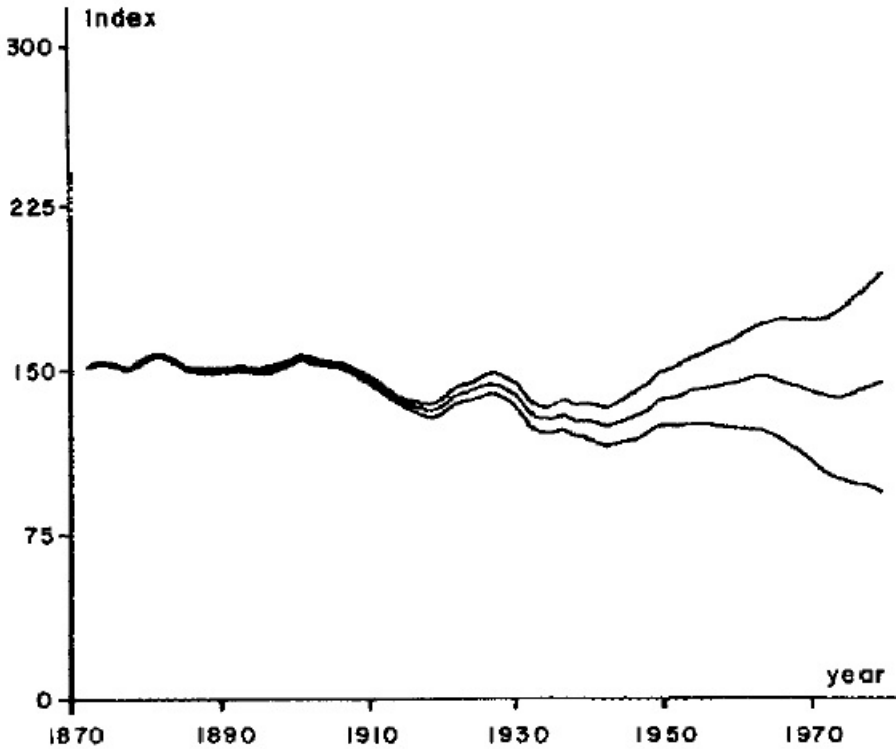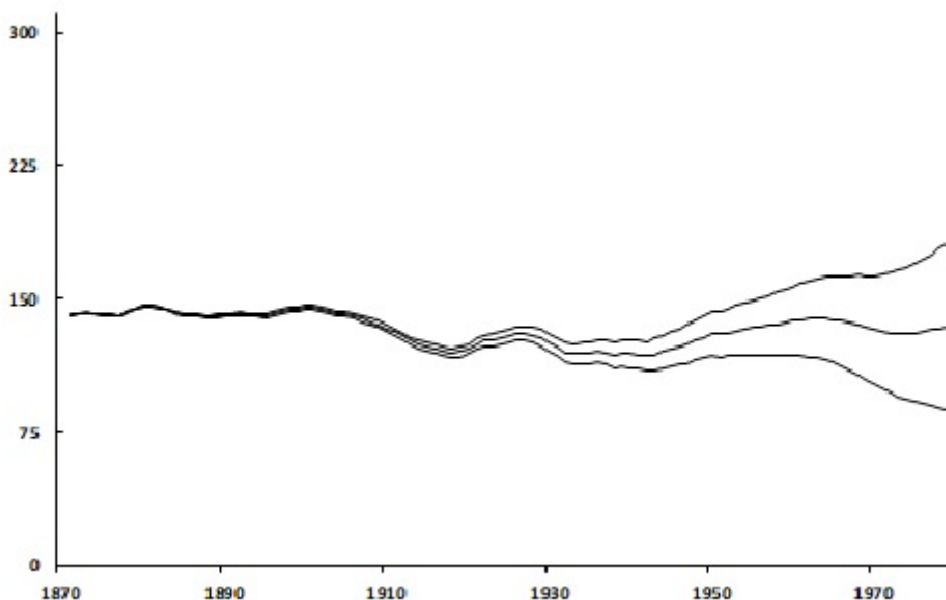
Figure S1: Alternative measures of the ex-post rational price (p*).

Description: This figure is Figure 3 in Shiller, 1981. It plots two alternative measures for the ex-post rational stock prices alongside the initial one, which is used as a benchmark.

Interpretation: The assumption made about the terminal price can have a significant influence on the ex-post rational price estimate towards the end of the sample, but its impact diminishes as we move towards the beginnig of the sample. Also, we observe that the ex-post rational price remains smooth and does not substantially affect volatility estimates, regardless of the terminal condition used.
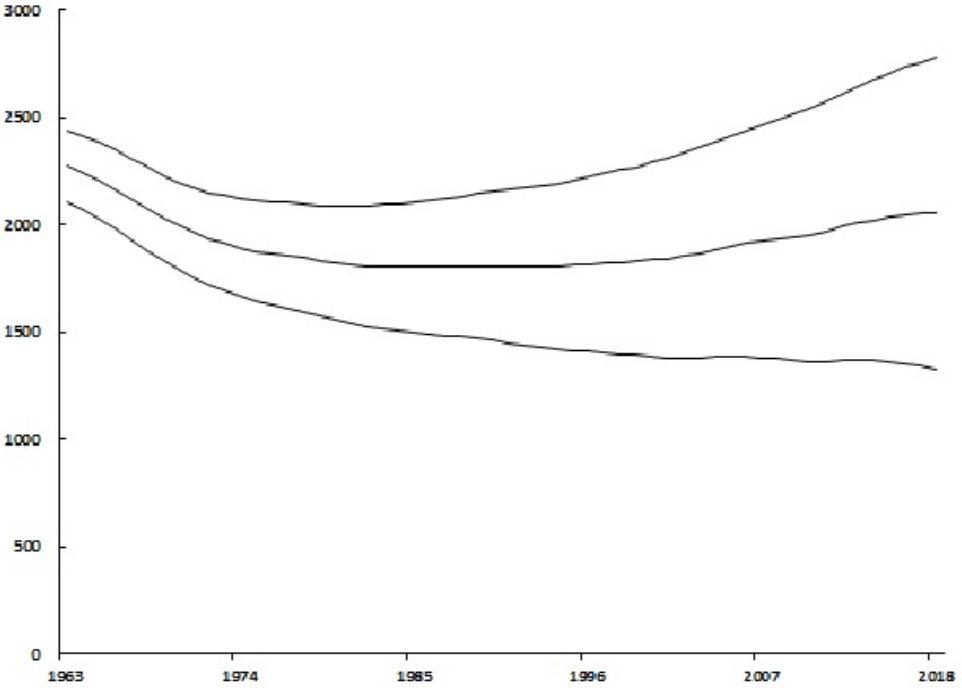
Source: Own Computations.

Figure S2: Alternative measures of the ex-post rational price (p*).

Description: This figure replicates Figure 3 in Shiller, 1981. It plots two alternative measures for the ex-post rational stock prices alonside the initial (middle) one, which is used as a benchmark. The initial terminal condition assumes that the present value of real discounted dividends after 1979 equals the average detrended real price over the entire sample. Shiller, 1981 does not discloses the adjustments made to the terminal condition when computing the alternative measures. In our replication, we adjust the terminal price by adding/subtracting one standard deviation estimated from the series of real detrended stock prices over the entire sample.

Interpretation: The results closely replicate Figure 3 in Shiller, 1981 and the interpretation is the same.
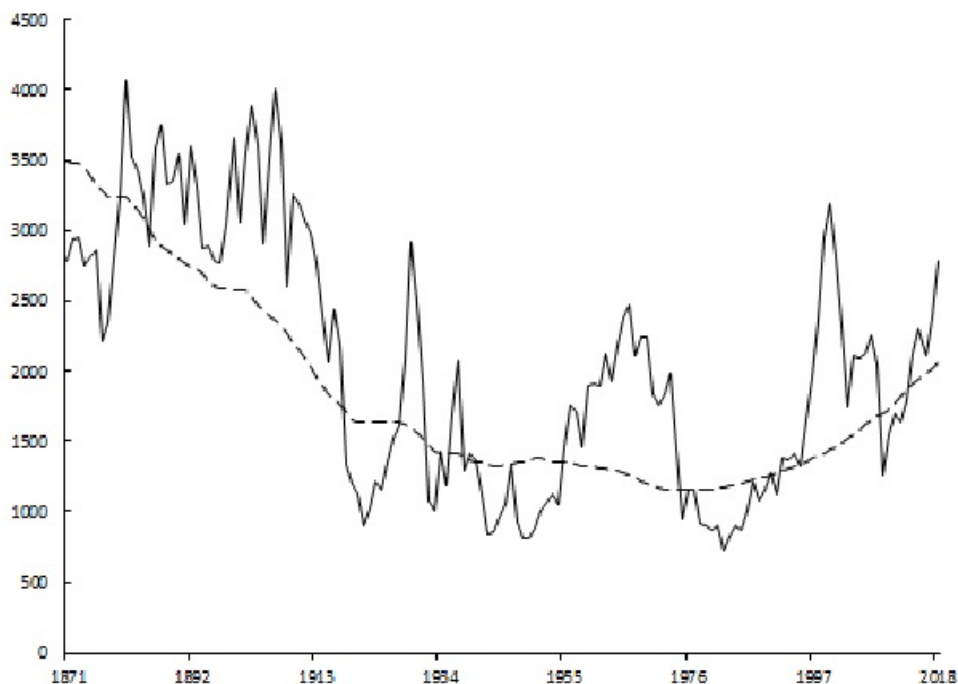
Figure S3: Alternative measures of the ex-post rational price (p*).

Description: This figure extends Figure 3 in Shiller, 1981 for the sample between 1963 and 2018. It plots two alternative measures for the ex-post rational stock prices alongside the initial one, which assumes that the present value of real discounted dividends after 2018 equals the average detrended real price over the entire sample. The alternatives are computed by adjusting the terminal price by adding/subtracting one standard deviation estimated from the series of real detrended stock prices over the entire sample.

Interpretation: As in the original paper, the figure shows that the assumption made about the terminal price can have a significant influence on the level of ex-post rational price estimate towards the end of the sample. Its impact diminishes as we move towards the beginning of the sample, but if the sample is too short (as it is in this case) then the influence does not entirely disappear. However, because the volatility of the ex-post rational price is more important than its level for the objectives of the research, the adjustments do not significantly alter the conclusions.

Source: Own Computations

Figure S4: Real S&P500 Stock Price Index (p) and ex-post rational price (p*).

Description: This figure extends Figure 1 in Shiller, 1981 for the sample between 1871 and 2018. It plots the real S&P 500 index (solid line) and the ex-post rational price (dotted line), computed as the present value of real dividends. Both series are from 1963 to 2018 and are detrended by dividing a long-run exponential growth factor.

Interpretation: The updated sample causes some changes on the shape of the detrended price and dividend series and, consequently, on the ex-post rational price series. However, this does not alter the conclusion that the excess volatility phenomena is still present in the data even after updating the sample to 2018.

Figure S5: Alternative measures of the ex-post rational price (p*).

Description: This figure extends Figure 3 in Shiller, 1981 for the sample between 1871 and 2018. It plots two alternative measures for the ex-post rational stock prices alongside the initial one, which assumes that the present value of real discounted dividends after 2018 equals the average detrended real price over the entire sample. The alternatives are computed by adjusting the terminal price by adding/subtracting one standard deviation estimated from the series of real detrended stock prices over the entire sample.

Interpretation: The figure shows that the assumption made about the terminal price can have a significant influence on the ex-post rational price estimate towards the end of the sample. However, its impact diminishes as we move towards the beginning of the sample. Over the interval 1871-2018, the three series become fairly indistinguishable prior to the 1930's. Also, given the additional data points, the differences observed at the end on the original sample in 1979 are significantly reduced versus the ones reported by Shiller, 1981 when performing this exercise. This implies that alternative specifications for the terminal condition do not have a significant impact on the long-term conclusions related to the excess volatility of stock prices, especially when additionally considering the smoothness of the possible ex-post rational price series.

References

Shiller, R. (1981). "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" *American Economic Review*. 71(3): 421–36.