Expected Returns and Dividend Growth Rates Implied by Derivative Markets

Benjamin Golez

ONLINE APPENDIX

This Online Appendix presents additional results mentioned in the paper. I analyze how sensitive the results are to dividend seasonalities, methodological changes in calculation of the implied dividend growth rates, and extension of the sample period. I also present the time series for the implied interest rates.

OA.1 Seasonality of dividends and maturity of derivatives

The implied dividend growth rates analyzed in the paper are defined as the difference between the log-implied dividend yield and the log dividend-price ratio $idg_t = idy_t - dp_t$. Given the balance between seasonalities in dividend payments, the liquidity of derivatives, and the dividend risk premium, results in the paper are based on an annualized implied dividend yield with six months to maturity and the standard dividend-price ratio estimated by summing dividends over the past 12 months. To address a concern that this maturity mismatch and seasonalities in dividend payments could be driving the documented improvement in predicting returns, I consider three additional tests.

First, I re-run dividend growth rate and return predictability regressions by including monthly dummies. The results reported in Tables OA.1 and OA.2 show that inclusion of monthly dummies has almost no effect on the predictive coefficients of either the standard dividend-price ratio, the implied dividend growth rates, or the corrected dividend-price ratio. Moreover, inclusion of monthly dummies reduces the *adj.* R^2 in all the predictive regressions, which suggests that seasonalities help predict neither dividend growth rates nor returns.

[Insert Table OA.1 and Table OA.2 about here]

In the second test, I re-estimate implied dividend growth rates using implied dividend yields with different maturities. Given the liquidity restrictions, I use implied dividend yields with maturities of between three and seven months.[1] The results are reported in Table OA.3.[2]

Regardless of the maturity of the derivatives, implied dividend growth rates remain a significant predictor of annual dividend growth rates, and the corrected dividend-price ratio predicts

[1]Because implied dividend yields with short maturities are very volatile, the implied dividend yield at maturity of three months has a negative value on three occasions (December 1999, May 2000, and July 2000). I replace these observations with the implied dividend yield at maturity of 4 months.

[2]In Section OA.2, where implied dividend yield is estimated solely from options, I use implied dividend yields with maturities up to 12 months. In untabulated results, I show that return predictability improves with the maturity of the options-implied dividend yield. I also find, however, that implied dividend yields with longer maturities are increasingly contaminated by the dividend risk premium, in line with Binsbergen et al. (2012), and thus cannot be used as proxies for expected yields.

returns better than the realized dividend-price ratio. Still, maturity of the implied dividend yield matters. Implied dividend growth rates with longer maturities are half as volatile as implied dividend growth rates with shorter maturities. Implied dividend growth rates with longer maturities also predict future dividend growth rates much better. Similarly, the corrected dividend-price ratios based on longer-maturity implied dividend growth rates predict returns better. Since dividend seasonalities decline with the maturity of derivatives, and predictability improves with maturity, these results confirm that the documented improvement in the predictability of returns in the main analysis is unlikely to be driven by seasonalities.

[Insert Table OA.3 about here]

In the third test, I repeat the second exercise, but instead of the standard dividend-price ratio with dividends summed over the past 12 months I use the dividend-price ratio based on annualized dividends summed over the past six months, $dp_t^{6m} = \log\left[\frac{2\times D_t^6}{P_t}\right]$, where D_t^6 is the six-month trailing sum of dividends. Results reported in Table OA.4 reveal that the documented predictability is robust to an alternative way of constructing the dividend-price ratio. Comparison of results reported in Tables OA.3 and OA.4 shows that the implied dividend growth rates in both cases exhibit very similar time-series characteristics. While dividend growth rate predictive regressions are slightly affected, return predictive regressions yield almost the same results.[3]

[Insert Table OA.4 about here]

OA.2 Alternative ways to estimate implied dividend yield

In the paper I estimate implied dividend yields simultaneously from options and futures. I motivate this approach by the notion that no-arbitrage relations hold better when there

[3] Note that here, given that dividends are summed over last six months, to better match the data, I consider predicting half-annual dividend growth rates as opposed to annual dividend growth rates.

are options and futures with matching maturities, so any mispricing in options can be easily arbitraged away by trading futures. This approach also enables estimation of implied dividend yields without specifying a proxy for the implied interest rate.

Now I estimate implied dividend yields either from options (based on put-call parity) or from futures (based on the cost-of-carry formula). As a proxy for the interest rate I use either LIBOR (closest to maturity), or the interest rate implied by the derivative markets (see equation 12 in the paper and Figure OA.1).[4] I use six months to maturity options and futures.

The results are reported in Table OA.5. When LIBOR is used in conjunction with either options data or futures data, dividend growth rate predictability results are rather weak, and the corrected dividend-price ratio predicts returns no better than the standard dividend-price ratio. When I use implied interest rates rather than LIBOR, dividend growth rate predictability improves, and the corrected dividend-price ratios become significant predictors of future returns. The *adj.* R^2 in the predictive regression with monthly returns is 1.81% when the corrected dividend-price ratio is based on options, and it is 2.23% when the correction is based on futures. Still, this is much lower than the *adj.* R^2 of 4.93% when the corrected dividend-price ratio is based on implied dividend growth rates estimated simultaneously from options and futures. Thus, it is indeed advantageous to combine no-arbitrage relations and extract information about implied dividends from two closely related markets for S&P 500 derivatives.

[Insert Table OA.5 about here]

OA.3 Synchronicity issues

The main analysis in the paper is based on end-of-day futures and option prices. This could be problematic because spreads tend to widen toward the end of the trading day. Also, options

[4] When estimating implied dividend yield from options, one can circumvent the need to use a proxy for the interest rate by combining options with different strike prices. In untabulated results I find the results comparable to estimating implied dividend yield from options in combination with the interest rate implied by options and futures.

and futures have a different time stamp from the underlying index. While the stock exchange closes at 15:00 (central time), options and futures trade until 15:15 (central time).

To address these synchronicity issues, I obtain from Tick Data the S&P 500 cash index intra-daily data and S&P 500 options and futures intra-daily trades and quotes data. While intra-daily cash index data are available for the whole time period, intra-daily options data run from July 2004 onward and intra-daily futures data run from January 2010 onward.

Using these intra-daily data, I first estimate implied dividend growth rates from January 2010 through June 2011. I use the mid-point between the bid and the ask price for options and futures. I consider only pit data between 10:00 and 14:00. For consistency with the end-of-day data, I focus on quarterly expirations and use ten days of data at the end of each month.

I first make within-minute matches between the call and the put prices and retain, within each minute, the match with the closest time stamp. Similarly I then match option pairs with within-minute observations for the cash index. Finally, I match these data with the futures quotes. Because futures quotes are relatively scarce (in comparison to options quotes), I allow for wider intervals for futures by making within-10-minute matches.

Results are reported in Table OA.6. I use the full period starting in January 1994, but replace implied dividend growth rates based on end-of-day data with implied dividend growth rates based on the intra-daily data for the period from January 2010 through June 2011. As reported in Column 2, the intra-daily data seem to provide added information about future returns over and above the end-of-day data. The predictive regression for monthly returns with the corrected dividend-price ratio has an *adj.* R^2 of 6.20%. Surprisingly, however, implied dividend growth rates based on the intra-daily data are slightly more volatile than the implied dividend growth rates based on the end-of-day data (19.21% versus 18.10%).

Given that futures quotes are less frequent than options quotes, I next consider calculating implied dividend growth rates without futures data by combining options intra-daily data with the implied interest rate. Here I use all the options intra-daily data going back to July 2004. I then replace the implied dividend growth rates based on the end-of-day data with the implied dividend growth rates based on the intra-daily data; results are reported in Column 3. Volatility of implied dividend growth rates is now at approximately the same level as when implied dividend growth rates are based solely on the end-of day data (17.97% versus 18.10%). The predictability results remain strong, but deteriorate slightly, presumably because part of the sample is based on options data only (see Section OA.2).

All in all, although options and futures markets close 15 minutes after the equity market, this non-synchronicity does not seem to play an important role. This is in line with Kamara and Miller (1995), who find that violations of put-call parity in end-of-day S&P 500 options data do not appear to be more frequent than in intra-daily data.[5]

[Insert Table OA.6 about here]

OA.4 Options moneyness and backward-looking data

In the main analysis, I estimate implied dividend yields using ten days of backward-looking data at the end of each month and options across all moneyness levels. Use of such a wide set of data is necessary to mitigate the effects of market frictions, but it may lead to inclusion of unreliable data.

Now, I consider two filters across moneyness levels. A broader filter eliminates options with moneyness levels below 0.6 and above 1.3, and a tighter filter eliminates options with moneyness levels below 0.8 and above 1.1. Additionally, I consider using either 5 or 15 days of data at the end of each month.

Table OA.7 reports the results. As expected, filtering out deep out-of-the money options makes the corrected dividend-price ratio better able to predict monthly returns. In particular,

[5]In the study of dividend strips implied by S&P 500 options, Binsbergen et al. (2012) report that daily data yield similar results as intra-daily data, except that the estimates are more volatile. They use only one day of data at the end of each month, while I use ten days, which substantially smooths estimates of implied dividend growth rates. Indeed, untabulated results show that using ten days of data as opposed to one day reduces the standard deviation of implied dividend growth rates from 40.50% to 18.10%.

using options moneyness levels between 0.8 and 1.1, the corrected dividend-price ratio explains 6.07% of the variation in the future monthly returns. This filter, however, reduces the number of observations for estimation of the implied dividend yields, which makes implied dividend growth rates more volatile and also less able to predict dividend growth rates at the longer horizon (annual).

Similarly, using 15 days as opposed to ten days of data at the end of each month further reduces the volatility of the implied dividend growth rates and preserves the strong predictability results. Using five days of backward-looking data by contrast makes the implied dividend growth rates more volatile. It also reduces the ability of the corrected dividend-price ratio to predict returns, although the estimated parameter on the dp_t^{Corr} remains significant.

[Insert Table OA.7 about here]

OA.5 Extended sample (January 1990-June 2011)

Estimation of implied dividend yields requires liquid options and futures with matching expiration times. While S&P 500 futures and options data are available from January 1990, they are not very liquid in the early years of the sample period. Further, while futures have been settled at the opening value of the index since 1987, the most liquid options initially expired at the closing value of the index. For these reasons, I have confined the main analysis to the period from January 1994 through June 2011.

When I extend the time period back to January 1990, dividend yields in the initial years of the sample are very volatile, as expected. Implied dividend growth rates occasionally take values above 100% and below −100% (in log terms).[6] Because these fluctuations are too big to be reconciled with changes in expectations about dividend growth rates, I restrict implied dividend growth rates to be between −0.5 and 0.5.

[6] The implied dividend growth rate cannot be calculated in July 1993, so I replace this value by the observation from the previous month.

Table OA.8 reports the results. In Column 1, I first establish that restricting implied dividend growth rates to be between −0.5 and 0.5 leaves results largely unaffected in the baseline case.[7] Column 2 then reports results for the extended sample. Despite problems in estimation in the early sample, implied dividend growth rates reliably predict annual dividend growth rates with a t-statistic of 4.38 and an *adj.* R^2 of 10.67%. Also, the corrected dividend-price ratio reliably predicts monthly returns with an *adj.* R^2 of 3.38% and a t-statistic of 3.05. Untabulated results show that imposing somewhat higher or lower bounds on implied dividend growth rates does not change the results.

[Insert Table OA.8 about here]

OA.6 Implied interest rate

Additionally I estimate the implied interest rate, according to equation (12). I use the same estimation procedure as in calculation of the implied dividend yield. Although the implied interest rate is not of direct interest for this study, it is worth noting that the implied interest rate exhibits the expected behavior. Figure OA.1 shows that the implied interest rate strongly co-varies with the T-bill rate and LIBOR, and is on average closer to LIBOR (see also Naranjo, 2009). Still, implied interest rate is more volatile than the T-bill rate and LIBOR at the beginning of the period analyzed, and it diverges from both proxies for the interest rate during the recent financial crisis, when it is notably lower than LIBOR.

[Insert Figure OA.1 about here]

[7] In the main period, implied dividend growth rates twice take a value below −0.5.

Table OA.1

Dividend growth rate regressions with monthly dummies

This table reports regression results for predicting S&P 500 dividend growth rates. Predictor variables include the standard dividend-price ratio dp_t, the implied dividend growth rates idg_t, and the annual realized dividend growth rates Δd_t^A. All variables are expressed in logs. Dividend growth rate horizon h is in months. Hodrick (1992) t-statistics are reported in parentheses. All regressions include monthly dummies. The period is from January 1994 through June 2011, and the frequency is monthly.

Dividend growth horizon h	1	3	6	12
dp_t	-0.0067	-0.0193	-0.0390	-0.0682
	(-1.87)	(-1.74)	(-1.69)	(-1.54)
$adj.\ R^2$	-0.0365	-0.0121	-0.0047	-0.0124
idg_t	0.0163	0.0524	0.1099	0.2076
	(3.83)	(4.38)	(5.03)	(4.84)
$adj.\ R^2$	0.0019	0.1054	0.1477	0.1564
dp_t	-0.0113	-0.0339	-0.0696	-0.1247
	(-2.72)	(-2.62)	(-2.59)	(-2.44)
idg_t	0.0214	0.0681	0.1425	0.2655
	(4.16)	(4.54)	(4.97)	(4.87)
$adj.\ R^2$	0.0531	0.2373	0.3083	0.3097
idg_t				0.1782
				(4.54)
Δd_t^A				0.2886
				(2.47)
$adj.\ R^2$				0.2312

Table OA.2

Return regressions with monthly dummies

This table reports regression results for predicting S&P 500 returns. Predictor variables include the standard dividend-price ratio dp_t, the implied dividend growth rates idg_t, the annual realized dividend growth rates Δd_t^A, and the corrected dividend-price ratio defined as $dp_t^{Corr}(h) = dp_t + \widehat{AF(h)} \times idg_t$, where $\widehat{AF(h)}$ for $h = 1, 3, 6$, and 12 are 7.37, 3.02, 1.84, and 1.27, respectively. All variables are expressed in logs. Return horizon h is in months. Hodrick (1992) t-statistics are reported in parentheses. All regressions include monthly dummies. The period is from January 1994 through June 2011, and the frequency is monthly.

Return horizon h	1	3	6	12
dp_t	0.0162	0.0571	0.1407	0.3166
	(1.11)	(1.36)	(1.77)	(2.21)
adj. R^2	-0.0013	0.0131	0.0353	0.1282
dp_t	0.0041	0.0371	0.1148	0.2746
	(0.24)	(0.80)	(1.34)	(1.86)
idg_t	0.0566	0.0933	0.1203	0.1976
	(2.51)	(1.75)	(1.30)	(1.26)
adj. R^2	0.0399	0.0452	0.0564	0.1546
$dp_t^{Corr}(h)$	0.0074	0.0325	0.0860	0.2220
	(3.14)	(2.56)	(2.44)	(2.56)
adj. R^2	0.0444	0.0499	0.0569	0.1512
dp_t	0.0029	0.0346	0.1108	0.2680
	(0.17)	(0.72)	(1.25)	(1.76)
idg_t	0.0598	0.1001	0.1311	0.2176
	(2.50)	(1.77)	(1.33)	(1.37)
Δd_t^A	-0.0282	-0.0604	-0.0967	-0.1672
	(-0.67)	(-0.48)	(-0.38)	(-0.38)
adj. R^2	0.0374	0.0436	0.0550	0.1545

Table OA.3

Seasonality of dividends and maturity of derivatives I

This table reports summary statistics for implied dividend growth rates (Panel A); regression results for predicting annual S&P 500 dividend growth rates (Panel B); regression results for predicting S&P 500 monthly returns (Panel C); and present value model estimates (Panel D). Predictive regressions are based on monthly frequency. Hodrick (1992) t-statistics are reported in parentheses. Panel D reports the mean for the parameters estimated across 12 successive non-overlapping annual samples. The corresponding 25^{th} and 75^{th} percentile are reported in brackets. Variance decomposition of the dividend-price ratio is based on equation (24). Delta one δ_1 is annual persistence of expected returns μ_t, and gamma one γ_1 is annual persistence of expected dividend growth rates g_t. Implied dividend growth rates are defined as: $idg_t(T) = idy_t^T - dp_t$, where idy_t^T is annualized log-implied dividend yield with maturity T, and dp_t is the standard dividend-price ratio defined as the 12-month trailing sum of dividends divided by the current price. T is either 3 months (Column 1), 4 months (Column 2), 5 months (Column 3), 6 months (Column 4), or 7 months (Column 5). The corrected dividend-price ratio is defined as $dp_t^{Corr}(T) = dp_t + AF(T) \times idg_t(T)$, where $AF(T)$ is the adjustment factor. The period is from January 1994 through June 2011.

		(1)	(2)	(3)	(4)	(5)
Panel A: Summary statistics for idg_t						
Mean		0.0680	0.0537	0.0709	0.0731	0.0677
Stdev		0.4876	0.4145	0.2146	0.1810	0.1774
Panel B: Predicting annual dividend growth rates						
idg_t		0.0347	0.0465	0.1445	0.1957	0.2008
		(3.20)	(3.24)	(4.53)	(4.82)	(4.93)
$adj.\ R^2$		0.0403	0.0540	0.1464	0.1916	0.1936
Panel C: Predicting monthly returns						
dp_t	0.0168					
	(1.15)					
dp_t^{Corr}		0.0066	0.0030	0.0060	0.0073	0.0081
		(2.23)	(1.81)	(2.89)	(3.22)	(3.19)
$adj.\ R^2$	0.0044	0.0246	0.0167	0.0407	0.0493	0.0500
Panel D: Present value model estimates						
δ_1		0.8536	0.8336	0.8015	0.7838	0.7731
		[0.80][0.91]	[0.79][0.89]	[0.76][0.87]	[0.76][0.84]	[0.75][0.84]
γ_1		0.0008	0.0913	0.1986	0.2155	0.1888
		[-0.15][0.16]	[-0.13][0.35]	[0.06][0.41]	[0.08][0.39]	[0.11][0.38]
Discount rate		1.5925	1.5430	1.4125	1.3422	1.2553
		[1.11][1.90]	[1.17][1.80]	[1.11][1.68]	[1.11][1.52]	[1.06][1.43]
Cash-flow		-0.5925	-0.5430	-0.4125	-0.3422	-0.2553
		[-0.90][-0.11]	[-0.80][-0.17]	[-0.68][-0.11]	[-0.52][-0.11]	[-0.43][-0.06]
Correlation between expected returns and expected dividend growth						
$\rho_{\mu_t g_t}$		0.8315	0.8057	0.7741	0.7361	0.7087
		[0.74][0.94]	[0.70][0.92]	[0.67][0.90]	[0.67][0.89]	[0.62][0.86]

Table OA.4

Seasonality of dividends and maturity of derivatives II

This table reports summary statistics for implied dividend growth rates (Panel A); regression results for predicting semiannual S&P 500 dividend growth rates (Panel B); regression results for predicting S&P 500 monthly returns (Panel C); and present value model estimates (Panel D). Predictive regressions are based on monthly frequency. Hodrick (1992) t-statistics are reported in parentheses. Panel D reports the mean for the parameters estimated across 12 successive non-overlapping annual samples. The corresponding 25^{th} and 75^{th} percentile are reported in brackets. Variance decomposition of the dividend-price ratio is based on equation (24). Delta one δ_1 is annual persistence of expected returns μ_t, and gamma one γ_1 is annual persistence of expected dividend growth rates g_t. Implied dividend growth rates are defined as: $idg_t(T) = idy_t^T - dp_t^{6m}$, where idy_t^T is annualized log-implied dividend yield with maturity T, and dp_t^{6m} is annualized dividend-price ratio defined as 2 times the 6-month trailing sum of dividends divided by the current price. T is either 3 months (Column 1), 4 months (Column 2), 5 months (Column 3), 6 months (Column 4), or 7 months (Column 5). The corrected dividend-price ratio is defined as $dp_t^{Corr}(T) = dp_t + AF(T) \times idg_t(T)$, where $AF(T)$ is the adjustment factor. The period is from January 1994 through June 2011.

		(1)	(2)	(3)	(4)	(5)
Panel A: Summary statistics for idg_t						
Mean		0.0593	0.0450	0.0623	0.0644	0.0590
Stdev		0.4864	0.4137	0.2122	0.1783	0.1755
Panel B: Predicting semi-annual dividend growth rates						
idg_t		0.0269	0.0378	0.1166	0.1592	0.1666
		(2.45)	(2.75)	(3.46)	(3.74)	(4.01)
$adj.\ R^2$		0.0380	0.0565	0.1485	0.1967	0.2089
Panel C: Predicting monthly returns						
dp_t^{6m}	0.0171					
	(1.18)					
dp_t^{Corr}		0.0032	0.0033	0.0063	0.0077	0.0085
		(2.17)	(1.82)	(2.92)	(3.25)	(3.21)
$adj.\ R^2$	0.0046	0.0238	0.0169	0.0413	0.0502	0.0506
Panel D: Present value model estimates						
δ_1		0.8510	0.8314	0.8000	0.7821	0.7704
		[0.79][0.91]	[0.79][0.88]	[0.77][0.86]	[0.76][0.83]	[0.75][0.83]
γ_1		-0.0217	0.0700	0.1811	0.2008	0.1702
		[-0.17][0.13]	[-0.17][0.37]	[-0.01][0.43]	[0.03][0.39]	[0.05][0.37]
Discount rate		1.6358	1.5859	1.4509	1.3726	1.2779
		[1.14][2.01]	[1.17][1.82]	[1.14][1.75]	[1.10][1.58]	[1.10][1.46]
Cash-flow		-0.6358	-0.5859	-0.4509	-0.3726	-0.2779
		[-1.01][-0.14]	[-0.82][-0.17]	[-0.75][-0.14]	[-0.58][-0.10]	[-0.46][-0.10]
Correlation between expected returns and expected dividend growth						
$\rho_{\mu_t g_t}$		0.8307	0.8092	0.7852	0.7490	0.7181
		[0.74][0.95]	[0.69][0.93]	[0.67][0.92]	[0.67][0.90]	[0.65][0.86]

Table OA.5

Alternative ways to estimate implied dividend yield

This table reports summary statistics for implied dividend growth rates (Panel A); regression results for predicting annual S&P 500 dividend growth rates (Panel B); regression results for predicting S&P 500 monthly returns (Panel C); and present value model estimates (Panel D). Predictive regressions are based on monthly frequency. Hodrick (1992) t-statistics are reported in parentheses. Panel D reports the mean for the parameters estimated across 12 successive non-overlapping annual samples. The corresponding 25^{th} and 75^{th} percentile are reported in brackets. Variance decomposition of the dividend-price ratio is based on equation (24). Delta one δ_1 is annual persistence of expected returns μ_t, and gamma one γ_1 is annual persistence of expected dividend growth rates g_t. Implied dividend growth rates are defined as: $idg_t = idy_t - dp_t$, where idy_t is log-implied dividend yield, and dp_t is the standard dividend-price ratio. In Column (1) implied dividend yield is estimated from options in combination with LIBOR. In Column (2) implied dividend yield is estimated from options in combination with the implied interest rate. In Column (3) implied dividend yield is estimated from futures in combination with LIBOR. In Column (4) implied dividend yield is estimated from futures in combination with the implied interest rate. In Column (5) implied dividend yield is estimated simultaneously from futures and options (as in the baseline case). The corrected dividend-price ratio is defined as $dp_t^{Corr} = dp_t + AF \times idg_t$, where AF is the adjustment factor. The period is from January 1994 through June 2011.

	(1)	(2)	(3)	(4)	(5)
Panel A: Summary statistics for idg_t					
Mean	0.0567	0.0851	0.0493	0.0731	0.0731
Stdev	0.1460	0.1596	0.1664	0.1747	0.1810
Panel B: Predicting annual dividend growth rates					
idg_t	0.0958	0.1896	0.1138	0.1961	0.1957
	(1.84)	(4.42)	(2.45)	(4.61)	(4.82)
$adj.\ R^2$	0.0246	0.1384	0.0495	0.1788	0.1916
Panel C: Predicting monthly returns					
dp_t^{Corr}	0.0012	0.0059	0.0013	0.0051	0.0073
	(0.50)	(2.15)	(0.59)	(2.33)	(3.22)
$adj.\ R^2$	-0.0034	0.0181	-0.0029	0.0223	0.0493
Panel D: Present value model estimates					
δ_1	0.8437	0.7654	0.8357	0.7742	0.7838
	[0.82][0.86]	[0.71][0.82]	[0.81][0.87]	[0.74][0.84]	[0.76][0.84]
γ_1	0.2948	0.1758	0.2599	0.2379	0.2155
	[0.15][0.46]	[-0.01][0.32]	[0.17][0.40]	[0.13][0.39]	[0.08][0.39]
Discount rate	1.4616	1.2405	1.4826	1.3116	1.3422
	[1.24][1.61]	[1.04][1.50]	[1.26][1.65]	[1.13][1.60]	[1.11][1.52]
Cash-flow	-0.4616	-0.2405	-0.4826	-0.3116	-0.3422
	[-0.61][-0.24]	[-0.50][-0.04]	[-0.65][-0.26]	[-0.60][-0.13]	[-0.52][-0.11]
Correlation between expected returns and expected dividend growth					
$\rho_{\mu_t g_t}$	0.8316	0.6576	0.8229	0.7093	0.7361
	[0.75][0.91]	[0.51][0.88]	[0.75][0.90]	[0.68][0.89]	[0.67][0.89]

Table OA.6

Synchronicity issues

This table reports summary statistics for implied dividend growth rates (Panel A); regression results for predicting annual S&P 500 dividend growth rates (Panel B); regression results for predicting S&P 500 monthly returns (Panel C); and present value model estimates (Panel D). Predictive regressions are based on monthly frequency. Hodrick (1992) t-statistics are reported in parentheses. Panel D reports the mean for the parameters estimated across 12 successive non-overlapping annual samples. The corresponding 25^{th} and 75^{th} percentile are reported in brackets. Variance decomposition of the dividend-price ratio is based on equation (24). Delta one δ_1 is annual persistence of expected returns μ_t, and gamma one γ_1 is annual persistence of expected dividend growth rates g_t. Implied dividend growth rates are defined as: $idg_t = idy_t - dp_t$, where idy_t is log-implied dividend yield, and dp_t is the standard dividend-price ratio. The corrected dividend-price ratio is defined as $dp_t^{Corr} = dp_t + AF \times idg_t$, where AF is the adjustment factor. The period is from January 1994 through June 2011. In Column (1) implied dividend yield is estimated from end-of-day options and futures data (as in the baseline case). In Column (2) implied dividend yield for the period from January 2010 through June 2011 is replaced by the implied dividend yield estimated from intra-daily options and futures data. In Column (3), implied dividend yield for the period from July 2004 through June 2011 is replaced by the implied dividend yield estimated from intra-daily options data in combination with the implied interest rate.

	(1)	(2)	(3)
Panel A: Summary statistics for idg_t			
Mean	0.0731	0.0610	0.0735
Stdev	0.1810	0.1921	0.1797
Panel B: Predicting annual dividend growth rates			
idg_t	0.1957	0.1779	0.1889
	(4.82)	(4.71)	(4.79)
adj. R^2	0.1916	0.1674	0.1762
Panel C: Predicting monthly returns			
dp_t^{Corr}	0.0073	0.0071	0.0075
	(3.22)	(3.50)	(3.13)
adj. R^2	0.0493	0.0620	0.0460
Panel D: Present value model estimates			
δ_1	0.7838	0.7945	0.7784
	[0.76][0.84]	[0.75][0.86]	[0.75][0.83]
γ_1	0.2155	0.2557	0.1920
	[0.08][0.39]	[0.09][0.39]	[0.06][0.42]
Discount rate	1.3422	1.3407	1.3585
	[1.11][1.52]	[1.11][1.52]	[1.08][1.54]
Cash-flow	-0.3422	-0.3407	-0.3585
	[-0.52][-0.11]	[-0.52][-0.11]	[-0.54][-0.08]
Correlation between expected returns and expected dividend growth			
$\rho_{\mu_t g_t}$	0.7361	0.7627	0.7369
	[0.67][0.89]	[0.65][0.89]	[0.64][0.89]

Table OA.7

Options moneyness and backward-looking data

This table reports summary statistics for implied dividend growth rates (Panel A); regression results for predicting annual S&P 500 dividend growth rates (Panel B); regression results for predicting S&P 500 monthly returns (Panel C); and present value model estimates (Panel D). Predictive regressions are based on monthly frequency. Hodrick (1992) t-statistics are reported in parentheses. Panel D reports the mean for the parameters estimated across 12 successive non-overlapping annual samples. The corresponding 25^{th} and 75^{th} percentile are reported in brackets. Variance decomposition of the dividend-price ratio is based on equation (24). Delta one δ_1 is annual persistence of expected returns μ_t, and gamma one γ_1 is annual persistence of expected dividend growth rates g_t. Implied dividend growth rates are defined as: $idg_t = idy_t - dp_t$, where idy_t is log-implied dividend yield, and dp_t is the standard dividend-price ratio. In Column (1) implied dividend yield is estimated as in the baseline case using ten days of data at the end of each month and options across all moneyness levels. In Column (2) implied dividend yield is estimated using ten days of data at the end of each month and options with moneyness levels between 0.6 and 1.3. In Column (3) implied dividend yield is estimated using ten days of data at the end of each month and options with moneyness levels between 0.8 and 1.1. In Column (4) implied dividend yield is estimated using 15 days of data at the end of each month and options across all moneyness levels. In Column (5) implied dividend yield is estimated using five days of data at the end of each month and options across all moneyness levels. The corrected dividend-price ratio is defined as $dp_t^{Corr} = dp_t + AF \times idg_t$, where AF is the adjustment factor. The period is from January 1994 through June 2011.

	(1)	(2)	(3)	(4)	(5)
Panel A: Summary statistics for idg_t					
Mean	0.0731	0.0736	0.0598	0.0698	0.0748
Stdev	0.1810	0.1827	0.2225	0.1668	0.2232
Panel B: Predicting annual dividend growth rates					
idg_t	0.1957	0.1897	0.1247	0.2277	0.1183
	(4.82)	(4.79)	(4.29)	(4.68)	(5.16)
$adj.\ R^2$	0.1916	0.1830	0.1157	0.2218	0.1050
Panel C: Predicting monthly returns					
dp_t^{Corr}	0.0073	0.0077	0.0093	0.0071	0.0051
	(3.22)	(3.21)	(3.16)	(3.05)	(2.32)
$adj.\ R^2$	0.0493	0.0507	0.0607	0.0463	0.0227
Panel D: Present value model estimates					
δ_1	0.7838	0.7794	0.7828	0.7771	0.8005
	[0.76][0.84]	[0.76][0.84]	[0.73][0.85]	[0.73][0.84]	[0.76][0.85]
γ_1	0.2155	0.1987	0.0905	0.2510	0.1518
	[0.08][0.39]	[0.06][0.36]	[-0.14][0.29]	[0.13][0.42]	[-0.03][0.38]
Discount rate	1.3422	1.3291	1.3825	1.3370	1.2960
	[1.11][1.52]	[1.13][1.49]	[1.22][1.52]	[1.13][1.55]	[1.05][1.47]
Cash-flow	-0.3422	-0.3291	-0.3825	-0.3370	-0.2960
	[-0.52][-0.11]	[-0.49][-0.13]	[-0.52][-0.22]	[-0.55][-0.13]	[-0.47][-0.05]
Correlation between expected returns and expected dividend growth					
$\rho_{\mu_t g_t}$	0.7361	0.7318	0.7486	0.7458	0.7722
	[0.67][0.89]	[0.66][0.88]	[0.73][0.87]	[0.68][0.89]	[0.71][0.86]

Table OA.8

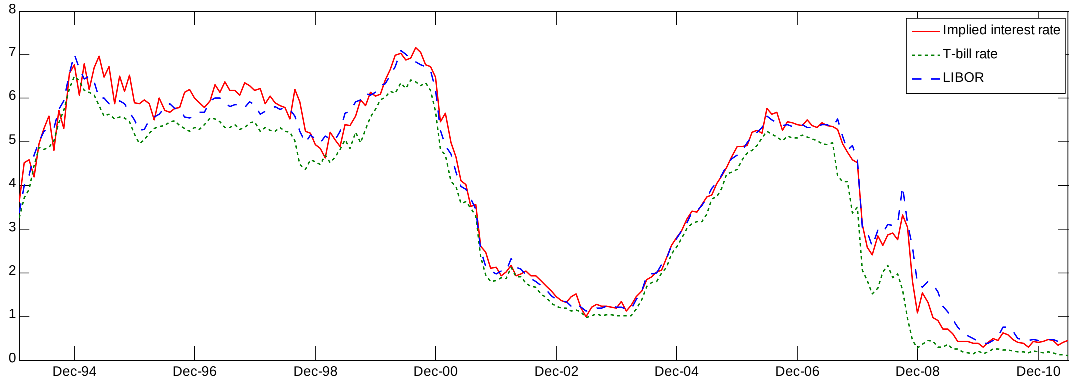
Extended sample (January 1990-June 2011)

This table reports summary statistics for implied dividend growth rates (Panel A); regression results for predicting annual S&P 500 dividend growth rates (Panel B); regression results for predicting S&P 500 monthly returns (Panel C); and present value model estimates (Panel D). Predictive regressions are based on monthly frequency. Hodrick (1992) t-statistics are reported in parentheses. Panel D reports the mean for the parameters estimated across 12 successive non-overlapping annual samples. The corresponding 25^{th} and 75^{th} percentile are reported in brackets. Variance decomposition of the dividend-price ratio is based on equation (24). Delta one δ_1 is annual persistence of expected returns μ_t, and gamma one γ_1 is annual persistence of expected dividend growth rates g_t. Implied dividend growth rates idg_t are restricted to be between -0.5 and 0.5. The corrected dividend-price ratio is defined as $dp_t^{Corr} = dp_t + AF \times idg_t$, where AF is the adjustment factor. Time period is either from January 1994 through June 2011 (Column 1) or from January 1990 through June 2011 (Column 2 and 3).

	(1)	(2)	(3)
Panel A: Summary statistics for idg_t			
Mean	0.0744		0.0821
Stdev	0.1759		0.1998
Panel B: Predicting annual dividend growth rates			
dp_t		-0.0438	
		(-1.69)	
idg_t	0.2047		0.1205
	(4.91)		(4.38)
$adj.\ R^2$	0.1980	0.0326	0.1067
Panel C: Predicting monthly returns			
dp_t		0.0137	
		(1.45)	
dp_t^{Corr}	0.0074		0.0064
	(3.23)		(3.05)
$adj.\ R^2$	0.0481	0.0060	0.0338
Panel D: Present value model estimates			
δ_1	0.7812		0.8511
	[0.76][0.84]		[0.83][0.89]
γ_1	0.2178		0.1440
	[0.08][0.51]		[-0.09][0.41]
Discount rate	1.3294		1.2655
	[1.11][1.46]		[1.01][1.43]
Cash-flow	-0.3294		-0.2655
	[-0.46][-0.11]		[-0.43][-0.01]
Correlation between expected returns and expected dividend growth			
$\rho_{\mu_t g_t}$	0.7333		0.6800
	[0.67][0.87]		[0.51][0.85]

Figure OA.1

Implied interest rate, T-bill rate, and LIBOR



This figure plots the 6-month implied interest rate along with the 6-month T-bill rate and 6-month LIBOR. All rates are in percentages. The period is from January 1994 through June 2011.