Steady state analysis of market fundamentals:

An exploration

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Abstract

The paper studies the volatility and correlation pattern of the fundamental valuation parameters (growth rate and its determinants, discount rate) calculated from widely used valuation ratios using the Gordon formula and relate them to some well-known results from the asset pricing literature. Our results reveal a substantially different picture of the volatility and cyclicality of the implied valuation parameters compared to estimates from econometric models using historical returns. We argue, in the spirit of Campbell (2008), that implied Gordon parameters can be interpreted as empirical proxies for conditional steady-state market fundamentals, which is supported by our findings.

Keywords: Stock market valuation, multiples, Gordon model

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Preliminary, incomplete, and comments highly welcome

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> “Steady-state valuation models are useful predictors of stock returns, given the persistence in valuation ratios.”
> Campbell (2008)

In times of low – and in Europe, negative – interest rates and high stock market valuations, the fundamental analysis of equities is becoming increasingly important. In a previous paper, Zimmermann (2018) suggested to estimate the three fundamental, unknown parameters of the Gordon equity valuation model from three fundamental valuation ratios widely used in the investment practice. While this approach is simple and obvious, it seems to be novel and provides interesting insights. For example, given the sensitivity of Gordon prices with respect to the input variables, the implied parameter estimates exhibit reasonable values and are surprisingly stable.

In this paper, we take this analysis a step further and study the volatility and correlation pattern of the implied Gordon-parameters (respectively, their first differences) and relate them to some well-known results from the asset pricing literature: the use of dividend-price ratios as proxies for expected returns, the cyclicality of risk premiums, and the predictions of the long-run risk (LRR) models.

Our empirical findings are in sharp contrast to the asset pricing literature: The implied Gordon parameters predict a substantially larger volatility of growth rates than most predictive models, and the growth rate is positively and occasionally extremely highly correlated with the discount rate. These observations have important implications for the valuation of equities: For example, the positive association between changes in growth and discount rates suggests a completely different interpretation of the cyclicity of risk premiums compared to, for example, conditional asset pricing models estimated with typical state variables (“business conditions”). We hypothesize that our risk premiums are related to long-run growth risk. However, the dynamic properties of our implied parameters even contrast the findings of the long-run risk models! Apparently, information extracted from valuation ratios, using simple valuation models, differs considerably from the estimates relying on econometric models using historical returns.

While our procedure may be justified by pragmatic or practical reasons, it however seems to suffer from a methodological problem: the derivation of time-varying parameters from a model which assumes that they are constant. We address this problem by building on an interesting insight from Campbell (2008) and interpret the implied parameters as proxies for steady-state market fundamentals. We observe that all parameters (in levels) are highly persistent which strongly supports our interpretation.

The paper is structured as follows: Section 1 starts with a numerical example illustrating the calibration of the Gordon formula with observed valuation ratios. Section 2 documents the statistical properties of the Gordon-implied parameters, and Section 3 highlights the implications for equity valuation, notably the size and cyclicality of discount rates and risk premiums. Section 4 discusses the adequacy and justification of the Gordon model for extracting time-varying parameters and their interpretation as steady-state valuation proxies. Section 5 concludes.

1. A numerical example to start

We estimate the three unobservable parameters from the Gordon constant growth valuation formula from three widely used valuation ratios applied to stock market indices (D/P, P/E and P/B). The Gordon model assumes that earnings and dividends grow with a constant rate $w = rb$, where b is the fraction of earnings reinvested at the end of each year, and r is the profitability of the reinvested earnings (i.e. the return on equity ROE). Therefore, $1 - b$ is the dividend payout ratio.

The stock price is then given by the present value of the perpetual stream of constantly growing dividends, using a constant discount rate k strictly smaller than the growth rate w:

$$P = \frac{D}{k - w} = \frac{E(1 - b)}{k - rb} \qquad \text{... [1]}$$

where D and E are the dividend and earnings levels at the end of the current period, which can be observed (or at least well estimated) using the valuation ratios. In contrast, the long-run parameters k, r and b are unknown and must be estimated.

From the Gordon formula, the implied D/P- and P/E-ratios can be easily derived, namely[1]

$$\frac{D}{P} = k - rb = k - w, \quad \frac{P}{E} = \frac{1 - b}{k - rb} \qquad \text{... [2]}$$

The book-to-price ratio requires an additional assumption: profitability is typically related to the book value by $r = E/B$, such that the B/P-ratio implied by the Gordon formula is

$$\frac{P}{B} = \frac{r - rb}{k - rb} \qquad \text{... [3]}$$

As shown in Zimmermann (2018), the three unknowns k, r and b in the Gordon formula (and w, which is however redundant) can be easily related to these ratios. The discount rate is given by

$$k = \frac{D}{P} + w = \frac{D}{P} + \frac{P}{B} \cdot \left(\frac{1}{\frac{P}{E}} - \frac{D}{P} \right) \qquad \text{... [4]}$$

which also defines the implied growth rate. The implied profitability is

[1] Notice that in the context of the Gordon formula, this ratio relates the end-of-period dividend (which is assumed to be known) to the current stock price; the expression is usually referred to as “dividend yield”. In the empirical specification of the variable, the variable is proxied by the Bloomberg “best estimate” dividend yield. However, in the wording of this paper, the term “dividend-price ratio” is used for consistency reasons with the other ratios.

$$r = \frac{E}{B} = \frac{P/B}{P/E} \qquad \ldots [5]$$

while the implied reinvestment rate can be recovered from $b = w/r$. For example, the year-end values as of December 2018, after a temporary decline of the stock markets, the ratios for the S&P500 index as released by Bloomberg (see the Appendix for details) are

$$\frac{D}{P} = 0.0217, \quad \frac{P}{E} = 15.4, \quad \frac{P}{B} = 2.9$$

which imply the following parameters:

$$r = 0.187, b = 0.665 \text{ implying } w = 0.124, k = 0.146$$

The implied payout ratio is 33.5%.

Figure 1 and Figure 2 display the evolution of the three valuation ratios for the S&P500 valuation multiples and their implied parameters. For consistency with the other two ratios, the inverse of the D/P is displayed. At the first glance, the implied growth rate and discount rate are highly correlated, which mirrors the low variability of the D/P-ratio. This observation is further analyzed in the next section.

The joint interpretation of the valuation ratios with respect to the underlying fundamental parameters is a key feature of that approach and was discussed in Zimmermann (2018). While it is common practice to base fundamental views on individual ratios (e.g. an increase of the P/E-ratio to indicate accelerated growth), the approach here shows different results. For example, take the year-end valuation ratios one year earlier in the previous example, at the end of December 2017:

$$\frac{D}{P} = 0.0186, \quad \frac{P}{E} = 19.9, \quad \frac{P}{B} = 3.2$$

The Gordon formula implies

$$r = 0.160, b = 0.629 \text{ implying } w = 0.100, k = 0.119$$

The P/E-ratio declined from 19.9 to 15.4, but the implied growth rate experienced an increase from 10% to 12.4%! Therefore, neglecting the information from the other two ratios can lead to misinterpretation. The P/E-ratio in isolation does not reveal that the anticipated profitability of US firms increased from 16% to 18.7% during that year, and neglecting the D/P-ratio makes it impossible to infer the implied growth and discount rates, and their change.

2. Statistical properties of Gordon-implied parameters

The descriptive statistics of the first differences of the implied parameters are displayed in Tables 1 and 2.[2] The same four stock markets are analyzed as in the earlier study (US, Germany, Switzerland and Europe). The overall observation is that the implied parameters behave quite smoothly over time, which is not an obvious result given the strong sensitivity of the Gordon-implied prices and price-ratios with respect to the underlying parameters, in particular if the denominator of the formula, the dividend-price ratio, is small.

A key observation is that the dividend-price ratio is much more stable than the underlying Gordon parameters, i.e. the discount rate and the growth rate, as summarized in Table 3. For the US market, the D/P-ratio exhibits a volatility of 0.098% or approximately 0.1%, while the implied growth rate has a volatility of 0.31% which is in the same order of magnitude as the volatility of the discount rate (0.32%). This observation is most pronounced for the US and Switzerland, and less for the German and European markets. For the first two markets, the volatilities of the implied parameters are sizeable compared to the relative stability of the D/P-ratio. The explanation can be immediately seen from variance decomposition[3]

$$\begin{aligned} Var\left(\Delta \frac{D}{P}\right) &= Var(\Delta k) + Var(\Delta w) - 2Cov(\Delta k, \Delta w) \qquad \ldots [6] \\ &= 0.09418 + 0.09959 - \mathbf{0.18412} \\ &= 0.009653 \end{aligned}$$

which reveals the role of the positive covariance (the correlation is 0.95) between the two parameters. For the Swiss stock market, the correlation is even close to one, while it is close to 0.8 for the German market and slightly above 0.6 for the Eurostoxx50.

Two observations are important from these results: First, there is a substantial variation in implied growth rates, and second, the growth rate is positively and occasionally extremely highly correlated with the discount rate. This has important implications with respect to the valuation of equities and contrasts similar findings in the empirical literature:

3. Implications for equity valuation

3.1 Changes of k as a proxy for revisions in expected returns?

First, the variability of w is often ignored – or played down – in the empirical asset pricing literature. In an important paper about the equity premium in the second half of the 20th century, Fama and French (2002) concluded that the high average returns over the observed period are mainly

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[2] All the subsequent results are related to first differences, which is however not explicitly

[3] For better readability, all number are multiplied by 10'000 in the variance expression.

driven by declining expected returns, extracted e.g. from the D/P-ratio, so that the average returns are largely interpreted as unexpected. Of course, the variability of the expected growth rate invalidates the interpretation of variations of D/P-ratios as a direct proxy of revisions in expected returns.

The implications can be illustrated using two examples displayed in Table 4. The first example highlights the valuation of the Swiss stock market (proxied by the SMI) at the end of 2006 and 2008, i.e. the period covering the outbreak of the financial crisis with substantial drop of stock prices. The D/P-ratio sharply increased over the two years from 2% to 3.1% suggesting that down-revisions of stock prices were stronger than declines in dividends. This increase was, however, not paralleled by an upward revision of the expected return (discount rate), quite the contrary can be observed: it declined from 14.6% to 7.1%. How can this be reconciled with a substantial drop in stock market prices? Apparently, the expected growth rate declined even more, namely from 12.6% to 4%.[4]

The second example relates to the valuation of the German stock market (proxied by the DAX) at the end of 2010 and 2017, a period when the index more than doubled. The D/P-ratio declined from 3.7% to 2.8%, while the expected return remained constant (9.9%). The rise of the stock market was exclusively caused by a moderate increase in growth expectations from 6.2% to 7.1%. Again, a shorthand interpretation based on changes in the D/P-ratio is misleading.

The examples highlight how important it is to incorporate the interaction of several valuation multiples in a model-based approach to reach meaningful conclusions about the fundamental forces driving equity values.

3.2 Cyclicality of risk premiums

The preceding analysis has direct implications for the interpretation of risk premiums over stock market cycles. The conventional message from the Conditional Asset Pricing Model as pioneered by Ferson and Harvey (1991) and others is that risk premiums are high in bad economic states and low in good states. State variables such as interest rate spreads (long minus short, credit, TED), valuation multiples or macroeconomic data are used for modelling the time-varying state of the economy.

The positive correlation coefficients between the changes in discount and growth rates ($\Delta k, \Delta w$) as shown in Table 2 (and 3) already indicates a different pattern in our data. On average, good news, i.e. more optimistic growth rates, occur together with positive revisions in expected returns. Table 5 reveals that this pattern also translates to the risk premiums as exemplified by the 1994-2004 decade covering a remarkable stock market boom and the subsequent dotcom-crash.

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[4] The figures moreover reveal very high fluctuations in the dividend payout. As discussed in Zimmermann (2018), the payout policy in Switzerland was rather special over the analyzed time period, due to special fiscal circumstances. For the other countries, the dividend payout ratios are rather stable.

The expected risk premium is calculated as the discount rate minus the long-run T-Bond yield.[5] The figures reveal an increasing – not decreasing – in the years before 2000 which is paralleled by an increase of the expected growth rate. With regard to Fama and French (2002), at last some of the sizeable stock market returns of the roaring nineties were expected, not unexpected! This misattribution is a consequence of assuming constant (or "stationary") growth expectations.

The years of the burst of the dotcom bubble reveal a mixed picture. In 2001, the risk premium sharply declined, along with the growth expectation, but the subsequent reversals are difficult to reconcile with a simple theory. But still, we observe a strong positive association between expected risk premiums and growth expectations, which completely contradicts – at least at first sight –the standard explanation for the fluctuation of risk premiums.

But it is not necessarily inconsistent because the expected returns, and risk premiums, are related to different time horizons. The forecast horizon of conditional asset pricing models is typically a month, or one year at most. The implied Gordon parameters, however, are related to an infinite time horizon. Therefore, the information extracted from the Gordon model need not to be consistent with the short-run expectations modelled by standard asset pricing models with conditioning information. Rather, the expected returns – respectively risk premiums – identified in the Gordon setting are most likely related to long-run growth risk. The intuition may be as follows: The sensitivity of the Gordon equity price with respect to a small change in the underlying growth rate is

$$\frac{\partial P}{\partial w} = \frac{D}{(k-w)^2} = P\frac{1}{k-w}$$

and the relative sensitivity, i.e. growth risk of equity, is

$$\frac{\partial P/P}{\partial w} = \frac{1}{k-w} \qquad \text{... [7]}$$

Notice that the denominator is the dividend-price ratio. Typically, the D/P-ratio decreases during a boom and increases in economic downturns. Therefore, if business conditions improve (worsen), the denominator gets smaller (larger) and growth risk increases (decreases). After all, it's an empirical question whether the variability of the Gordon-implied growth factor w is a "priced" risk factor and explains expected returns.

[5] Notice that the implied Gordon parameters refer to an infinite horizon.

3.3 Long-run risk (LRR): A comparison

Following the excess volatility dispute originated by Shiller (1981), a large body of research has analyzed the long-run effects of small, but persistent fundamental shocks in the modelling of security prices and cross-sectional returns; the shorthand LRR-models is used subsequently.[6] A particularly interesting strand of research demonstrates that excess volatility of prices with respect to fundamental factors (dividends, earnings) can be tested using valuation ratios, and the variability of these ratios is related to the predictability of the underlying fundamentals in a rational market. Following the decomposition developed by Campbell and Shiller (1988), a large number of papers has empirically analyzed the predictive power of valuation ratios, in particular the D/P-ratio, with respect to long-run (infinite horizon) discount rates and growth rates. The tests have been conducted in various econometric settings (simple predictive regressions, VAR-systems, advanced predictive systems) and generated rather contradictory results. A particularly interesting test is presented by Cochrane (2008) who finds that dividend growth (w) is not predictable from D/P-ratios, which he interprets -- armed with Sherlock Holmes' line of reasoning – as indirect but strong evidence for predictability of discount rates (k). While not directly comparable with our results, it is a surprising finding in the light of the strong volatility of the implied grow rates shown in Table 1. However, recent studies such as Chen, Da and Priestley (2012) demonstrate that dividend smoothing masks a substantial part of the predictability of w, should it exist.

A related test approach is proposed by Campbell (1991) where predictability of valuation ratios is tested by a variance decomposition of asset returns. This decomposition is derived from the residuals of a vector autoregressive (VAR) model which includes, apart from asset returns and dividend growth rates, state variables for modelling conditional expectations over time such as valuation ratios or macroeconomic indicators. A major output of this model are so called ``news'', i.e. updates of conditional expectations about an infinite sequence of future discount rates (DR) and growth rates (of cash-flow, CF).[7] This approach seems, at first sight, closely related to the approach of this paper because our implied parameters can be interpreted as periodic updates of long-run expectations about the underlying fundamentals. We are therefore tempted to associate Campbell's DR-news with updates for k and CF-news with updates for w.

However, the empirical findings differ substantially, in particular with respect to the correlation coefficients between the news. This is a key magnitude for analyzing D/P- and return volatilities. In his original study (Table 2), Campbell finds strongly negative correlations, over the overall time period (-0.53) and two subperiods (-0.66, -0.16). The explanation is straightforward and in the spirit of conditional asset pricing models: Good news about future growth imply lower expected returns. However, this contradicts our findings from Sections 2 and 3.2 where we report (strong)

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[6] The term "long-run risk models" is not an established wording, but is mostly related to the research following Banasal and Yaron (2004). Here, the term is used for all papers following Campbell and Shiller (1988), Campbell (1991), and subsequent paper, including statistical models as well as equilibrium models.

[7] The term "cash-flow" news (or CF risk) is used in models for explaining the variability of fundamental stock valuation ratios, while "growth" news (or growth risk) is used in macroeconomic models about the variability of consumption growth or consumption-wealth ratios (Campbell 1996, Bansal and Yaron 2004 etc.).

positive correlations between Δw and Δk. Such negative values would be entirely inconsistent with the low volatility of the D/P-ratio observed in our data, as can be seen from our numerical example in equation [6].

Campbell uses real data in his original paper from 1926 to 1988, while our analysis is based on nominal magnitudes for a more recent time period. We therefore take the nominal news-data (which are available online) of Campbell and Vuolteenaho (2004) and provide a variance decomposition in the Campbell (1991)-style. The results are displayed in Table 6 and reveal correlation coefficients between -0.057 and 0.140, depending on the time-period. While not strongly negative, the coefficients are substantially smaller than those reported for the implied Gordon parameters (between Δw and Δk).[8]

The correlation between the updates of fundamental expectations – be it news or implied Gordon parameters – is an important determinant of the variability of the D/P-ratio, but also determines the volatility of stock returns. The simple reason is that the D/P-ratio shows up in the denominator of the Gordon price-formula (k-w), so that even small variations are associated with large price adjustments, i.e. volatile returns. A strong negative correlation between CF- und DR-news would inflate the volatility of D/P-ratios and therefore increase the variability of stock returns. In contrast, our correlations which are higher than 0.9 for the US and Swiss stock market exert a damping influence on the stock return volatilities. Thus, stock returns may still be very volatile relative to the underlying economic fundamentals and their expectations, but the correlation pattern seems to have a stabilizing effect. This insight is all the more interesting as the Gordon model assumes an infinitely long time horizon.

Although the models discussed in this Section seem to be closely related to the Gordon-approach, it is important to notice that the LRR-models rely on simple return-identities complemented by an expectation formation mechanism, and cannot be regarded as valuation models. They are based on estimates from historical data, dividend growth, asset returns, and state variables (as proxies for the conditioning information set of expectations) – which is distinct from our approach which rests entirely on observed valuation ratios and an explicit valuation model. The Gordon formula may be oversimplified and inadequate, but it allows to calibrate the parameters without relying on historical data and estimation issues. As Campbell (2008) puts it, "the approach is analogous to the familiar procedure of forecasting the return on a bond, using its yield rather than its historical average return" (p. 8). This is exactly the intuition underlying our approach.

[8] Still, the period of the Campbell and Vuolteenaho (2004) study is from 1928 to 2001 and does not overlap with our sample period. In unpublished results by Séchaud and Zimmermann (2019), DR- and CF-news are calculated more recent years. The correlations for the US stock market are unstable across subperiods, but not substantially larger than those reported before. Also, the results are not different if real data is used. However, the correlations are substantially larger (up to 0.79) for the correlation between DR- and CF-news in the US REIT-market.

4. Gordon model and steady state dynamics

Is there a way to reconcile the Gordon formula with the LRR-models? Even more fundamentally: Is the Gordon model an adequate framework at all for extracting time-varying parameters? After all, the model assumes constant parameters, and unlike the LRR-models, no uncertainty enters the formula. When using the Gordon formula, it is just common practice to specify k and w as long-run expected returns and dividend growth, but this is done on an ad-hoc basis without modelling the underlying uncertainty – and the same is done in this paper by extracting the "implied" parameters and by interpreting them as long-term expectations. Is there a theoretical basis for such an interpretation? After all, there are theorical papers addressing the impact of uncertainty in the dividend growth process on the level of stock prices – e.g. Ziegler (2001) in an attempt for explaining the dot-com bubble – but they do not offer a simple justification for such an interpretation.

Geometric vs. arithmetic interpretation of the Gordon parameters

The paper by Campbell (2008) seems to provide the missing link. The starting point of the model is the empirical observation that the (logarithmic) dividend-price process is typically very close to a Random Walk, i.e. shocks to D/P-levels are expected to be largely permanent. The autocorrelations in Table 7 support this observation, although the coefficients at the first lag are well below unity.[9] However, they are declining slowly, and the ADF-test cannot reject a unit root on a 90% confidence level. Therefore, D/P-processes exhibit a high degree of persistence.

Two assumptions are key in Campbell's model: First, the log D/P-process follows a Random Walk; and second, the two sources of uncertainty, log D/P growth and log dividend growth, are conditionally normally distributed.[10] The non-stationarity of the D/P-ratio invalidates the usual log-linear approximations underlying the Campbell-Shiller or Campbell-decompositions, but instead, a strikingly simple approximation can be derived which relates the conditional expectations of logarithmic returns (r_{t+1}) and logarithmic dividend growth (Δd_{t+1}), namely

$$e^{E_t(r_{t+1})} \approx \frac{D_{t+1}}{P_t} + e^{E_t(\Delta d_{t+1})} \qquad \dots [8]$$

[9] Notice that in finite samples, the persistence of a process is underestimated by the autocorrelation coefficients.

[10] A third assumption is trivial in our setting, namely that the end-of-period dividend is known one period in advance. See Footnote (1). Notice that the Random Walk assumption for the D/P-ratio is not uncritical. Some authors see a non-stationary dividend as a proof of bubbles (e.g. Craine 1993), while others claim that this conclusion is invalid (e.g. Bidian 2014).

The approximation [8] is a restatement of Campbell's eq. (21):[11] The l.h.s. is the geometric analogue to (one plus) the expected return or discount rate, the second expression of the r.h.s. the geometric analogue to (one plus) the expected dividend growth rate.

The two geometric expression can be extended over an infinite future time horizon by applying the Law of Iterated Expectations and recognizing that the statistical relationship between the expectation of a geometric average, $\bar{X}_g$, and and the expectation of the natural logarithm, $x = \ln(1 + X)$, is given by

$$\lim_{n\to\infty} E_t(1 + \bar{X}_g) = e^{E_t(\bar{x})} = e^{E_t(x)}$$

where averages are computed from n realizations, equation [8] can also be expressed as

$$\lim_{n\to\infty} E_t\left(1 + \bar{R}_g\right) \approx \frac{D_{t+1}}{P_t} + \lim_{n\to\infty} E_t\left(1 + \overline{\frac{\Delta D}{D}}_g\right) \quad \text{... [9]}$$

where $\bar{R}_g$ is the geometric average of discrete (arithmetic) returns, and $\overline{\Delta D / D}_g$ is the geometric average of relative (percentage) changes in dividends.[12] In terms of the implied Gordon parameters the equation reads as

$$k_t = \frac{D_{t+1}}{P_t} + w_t \quad \text{... [10]}$$

which corresponds to the Campbell's characterization: although the setting is stochastic, a Gordon-like relationship is valid: the parameters can be interpreted as long-run conditional expectations, but in terms of geometric averages resp. logarithmic growth rates. This is a very simple way to incorporate parameter uncertainty and a volatile D/P-ratio into the Gordon formula.

Steady-state interpretation

The original Gordon formula is often interpreted as a conditional steady-state expression for the market value of equities: while the parameters are time-dependent, the D/P-ratio must be stationary in the sense that it exhibits no volatility if the valuation time-horizon goes to infinity:

$$Var\left(\frac{D}{P}\right) = 0 \quad \text{... [11]}$$

This is Campbell's interpretation of the "original" Gordon model and represents a limiting case of his model. This interpretation has an interesting implication:

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[11] The restatement uses (a) the relation between the log of expectations and the expectation of logs, which is given by half of the variance of the log; and (b) the linear approximation $1 + y \approx \exp(y)$. Notice that Campbell (2008) does not distinguish between the conditional one-period expectation and the expectation of geometric averages; he interprets the expectations in equation (7) directly as "geometric averages", which is not exactly correct.

[12] To clarify the notation: $r = \ln(1 + R)$ and $\Delta d = \ln(1 + \Delta D / D)$. Notice that the bar and the subscript g in $\overline{\Delta D / D}_g$ are both related to the entire ratio.

In Campbell's model, a zero variance of the D/P-ratio[13] implies that the stock returns and dividend growth have the same variance. This relies on an approximation in Campbell's derivation, namely that the variability of the D/P-ratio does not add substantially to the variability of returns compared to the volatility of dividend growth. In the steady-state context, however, it is even not an approximation but an exact result since the variance of D/P is zero! This moreover implies that, in the steady-state, return and dividend growth levels are perfectly correlated. As shown in Table 8, this is not far away from what we observe empirically in our implied parameters, except for Germany, where the correlation coefficient is well below 0.9 (0.84).

If the stock returns and dividend growth have the same variance, it follows that equation [8] holds with arithmetic – not geometric – averages

$$\lim_{n\to\infty} E_t(\bar{R}_a) \approx \frac{D_{t+1}}{P_t} + \lim_{n\to\infty} E_t\left(\overline{\frac{\Delta D}{D}}_a\right) \quad \ldots [12]$$

which Campbell calls the "arithmetic implementation" which is consistent with the traditional interpretation of the original Gordon model. The reason is that a geometric average of a variable equals approximately the arithmetic average minus one-half the variance, i.e.

$$\bar{X}_g \approx \bar{X}_a - \frac{1}{2} Var(\ln(1 + X)) \quad \ldots [13]$$

This substitution is made for both geometric averages in equation [9], and since both variances are equal under the steady-state assumption [11], they cancel out and the arithmetic interpretation of formula [12] follows.

Implications for steady-state parameters and valuation

A direct implication is that the implied Gordon-parameters in our preceding analysis (w_{imp}, k_{imp}) which we extract from the observed ratios cannot be interpreted as steady-state proxies per sè, but as their geometric counterparts. For extracting implied steady-state values, the stationarity or zero D/P-variance assumption [11] is needed which necessitates the arithmetic interpretation of the parameters. This can be calculated with the approximation in [13], i.e. by adding half a variance to the implied parameters.

Taking the implied Gordon-parameters of the S&P500 as of December 2018 (see Section 1) and the volatilities from Table 8,[14] we calculate the steady-state values for the US market as

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[13] Remember that there are two sources of uncertainty in the model: log D/P growth and dividend growth. The variance of the returns (discount rate) is derived endogenously from the model.

[14] Notice that these are conditional means and variances, since the historical values of implied parameters are conditional expectations, i.e. reflect the current state of information about the future.

$$w_{SS} = \underbrace{0.1240}_{w_{imp}} + \frac{1}{2}\,0.0129^2 = 0.1241$$

$$k_{SS} = \underbrace{0.1460}_{k_{imp}} + \frac{1}{2}0.0115^2 = 0.1461$$

and reveals that the absolute numerical effects are negligible, at least with our empirical estimates. It also reflects the observation that the volatilities of the implied k and w are roughly the same for the analyzed markets. This contrasts Campbell's claim that "returns are much more volatile" (p. 11) compared to growth rates, but confirms our earlier finding that the volatility of growth rates and their change are often underestimated.

While the geometric vs. arithmetic interpretation matters for the individual parameters in principle (but is not empirically relevant in our data), it has no consequences for the valuation effects in the steady-state because only the difference $k - w$ enters the Gordon formula in the denominator which is unaffected by the variances of k and w: an increase in the dividend variance leads to an identical increase of the return variance. This is a key property of Campbell's stochastic version of the Gordon model, and might either be regarded as a major limitation or as a major strength of the model: what, assuming rational market valuation, should variations of steady-state discount rates reflect other than variations of steady-state dividend growth? More advanced models and a more elaborated steady-state characterization than [11] should eventually be able to disentangle the return variance from the dividend growth variance in the steady-state, but the present framework does not allow this.[15]

Another question relates to the valuation bias if Campbell's geometric interpretation of the Gordon formula is used in empirical work for inferring steady-state values instead the arithmetic interpretation. A high return volatility increases k_{SS} relative to the implied parameter and lowers equity values, i.e. steady-state values are overestimated by geometric parameters. The reverse bias results for dividend growth: a high variability increases w_{SS} relative to the implied parameter, but increases asset values. Thus, steady-state values are underestimated if geometric parameters are inadequately used. However, given the small values and, in particular, the small differences between the return and growth volatilities as shown in Table 8, the bias is very small in general. Therefore, the implied Gordon-parameters can be regarded as sufficiently good empirical proxies for steady-state values.

Persistence

Finally, Table 9 displays the time-series properties of the implied Gordon-parameters (levels): They are highly persistent, and the null hypothesis of a unit root cannot be rejected in almost all series. Highly persistent parameters should definitely be expected for conditional steady-state

[15] A dynamic choice model which characterizes a ``risky steady-state'' can be found in Coeurdacier, Rey and Winant (2011); it predicts a positive impact of income (dividend) uncertainty on steady-state wealth in the cross-section of households or countries.

magnitudes. It strongly supports our claim that implied Gordon parameters, as extracted by our approach, provide insight into the steady-state properties of market fundamentals.

5. Summary and perspectives for future research

Market fundamentals (discount rates, growth rates, profitability, etc.) extracted from widely used valuation ratios using the Gordon model provide insight into the long-run expectations implicit in market prices. In this paper, several key statistical properties of the implied market parameters are analyzed and put into relation to well-known results from the asset pricing literature. Our key finding is that the statistical behavior differs in several important ways. The implied Gordon parameters predict a substantially larger volatility of growth rates than most predictive models, and the growth rate is positively and occasionally extremely highly correlated with the discount rate.

These properties have important implications for the valuation of equities and are in stark contrast to similar findings in the empirical literature. For example, the variability of the expected growth rate invalidates the interpretation of variations of D/P-ratios as a direct proxy of revisions in expected returns. And the positive association between changes in growth and discount rates suggests a completely different interpretation of the cyclicity of risk premiums compared to, for example, conditional asset pricing models estimated with typical state variables ("business conditions"). This also leads to a different interpretation of expected and unexpected returns over valuation cycles: e.g., if accelerated growth expectations are neglected in the roaring 1990s, expected returns and risk premiums must be larger to be consistent with observed dividend-price ratios, hence a smaller fraction of observed large returns is unexpected.

Of course, one might object that the (long) time horizon to which the implied Gordon parameter refer are distinct to the (short) horizon of many asset pricing models. Therefore, we hypothesize that our risk premiums are related to long-run growth risk. However, it is interesting to observe that the dynamic properties of the implied Gordon estimates are also in contrast to the results found in the "long-run risk" (LRR) literature. There, we observe slightly positive correlations between discount-rate and cash-flow (growth) "news" at best, but mostly zero or even negative correlations. High correlations between discount rates and growth rates exert a damping influence on the stock return volatilities. Hence, stock returns may still be very volatile relative to the underlying economic fundamentals and their expectations, but the correlation pattern suggested by the implied Gordon parameters suggests a stabilizing effect for the relevant – infinitely long – time horizon.

These observations suggest that information extracted from valuation ratios, using simple valuation models, differs from the estimates relying on econometric models using historical returns. We argue, in the spirit of Campbell (2008), that implied Gordon parameters can be interpreted as empirical proxies for conditional steady-state market fundamentals. Campbell's model which assumes a Random Walk for the dividend-price ratio also provides a justification for using the Gordon formula – which in its original version assumes constant parameters – for extracting time-varying parameters. The steady-state can then be defined as limiting case where the D/P-ratio is stationary in the sense that it exhibits no volatility if the valuation time-horizon goes to infinity.

Of course, empirically, the D/P-ratio is volatile which is a violation of the steady-state condition per sè. Our interpretation of the implied Gordon-parameters as good empirical proxies of steady-state fundamentals is reinforced by the highly persistent behavior of the parameters which be expected for conditional steady-state variables.

The empirical insights of this paper have many interesting implications: How are the implied parameters, which represent conditional expectations, related to actual future returns and growth rates? Campbell and Thomson (2008) provide encouraging evidence that prior's from fundamental ratios significantly improves predictability of returns: "Even better results can be obtained by imposing the restrictions of steady-state valuation models, thereby removing the need to estimate the average from a short sample of volatile stock returns." Lettau and Van Nieuwerburgh (2008) find that inconsistent results between in-sample and out-of-sample predictability tests can be explained by parameter instability and claim that "these seemingly incompatible results can be reconciled if the assumption of a fixed steady state mean of the economy is relaxed." An even more interesting question is how well steady-state risk factors – i.e. growth risk and its components – perform in cross-sectional asset pricing tests compared to LRR-related news factors. Therefore, steady-state analysis of market fundamentals offers an interesting and important field for future empirical research.

Appendix: Data

Valuation multiples:

Valuation multiples are downloaded from Bloomberg. P/E-ratios (BEST_PE_RATIO) rely on estimated earnings (Bloomberg estimates) of the 4 subsequent quarters. P/D-ratios are the reciprocal values of the dividend yields (BEST_DIV_YLD) which relate the dividends in a specific month to the market price at the beginning of that month. P/B-ratios (BEST_PX_BPS_RATIO) relate market prices to estimated book values (Bloomberg estimates). End-of-month values are used throughout the analysis.

Riskfree interest rates:

Swiss-franc denominated riskfree interest rates are spot rates for a time-horizon of 20 years calculated from government bonds. End-of-month observations are used (source: Swiss National Bank). A long-run maturity is selected since the discounting horizon of the Gordon model is infinite. For Germany and the Eurostoxx50 countries, Euro-denominated riskfree interest rates are spot rates for a time-horizon of 20 years extracted from listed Federal securities. End-of-month observations are used (source: Deutsche Bundesbank).

USD-denominated riskfree interest rates are yields on government bonds with a maturity of 20 years. Only monthly averages are available (source: FRED database, Federal Reserve Bank of St. Louis). Thus, riskfree interest rates – and thus risk premiums – are not directly comparable to the spot rates used for Switzerland, Germany and the Eurostoxx50 countries.

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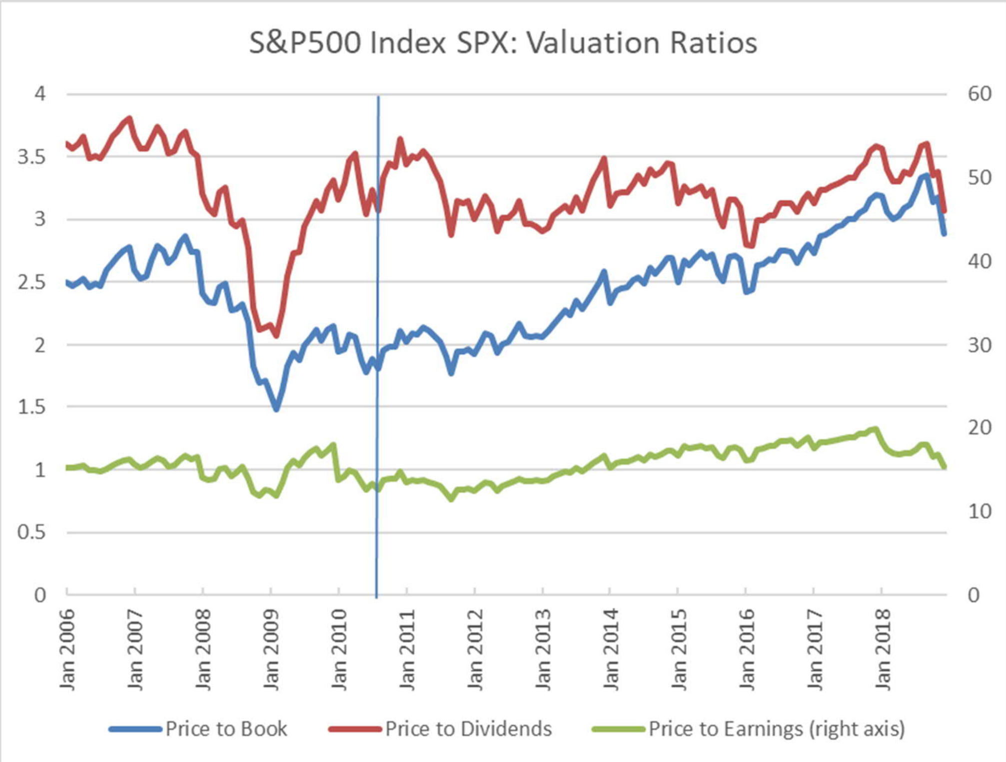
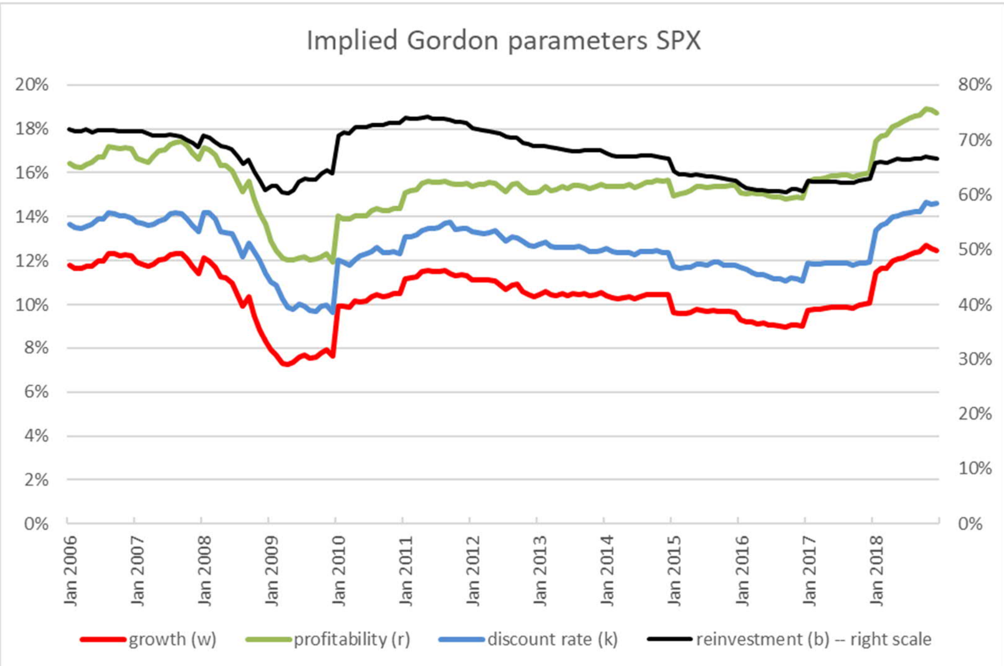
Figure 1 Valuation ratios and implied parameters from the Gordon-formula





The reinvestment rate (b), profitability (r), growth (w) and discount rate (k) are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. S&P500 multiples are downloaded from Bloomberg. Monthly data are used from January 2006 to December 2018.

Table 1 Descriptive statistics of implied Gordon parameters, first differences

		mean	volatility	AC(1)	AC(2)	AC(3)	AC(6)	AC(12)	*p(LB,12)*
Reinvestment Δb	SMI	-0.0016	0.0219	-0.13	-0.07	-0.08	0.04	**0.30**	***0.000***
	S&P500	-0.0003	0.0082	0.08	0.07	**0.24**	0.06	0.21	***0.004***
	DAX	-0.0004	0.0104	0.11	0.10	**0.30**	0.11	0.09	***0.002***
	EUROSTOXX50	-0.0006	0.0077	0.11	0.07	0.09	-0.09	-0.04	*0.351*
Profitability Δr	SMI	-0.0003	0.0072	-0.10	-0.02	-0.09	**0.23**	**0.26**	***0.001***
	S&P500	0.0001	0.0030	0.09	0.13	0.20	0.11	0.09	*0.094*
	DAX	-0.0001	0.0030	0.17	0.10	**0.31**	0.20	-0.06	***0.000***
	EUROSTOXX50	-0.0003	0.0025	**0.30**	**0.25**	**0.29**	0.02	-0.03	***0.000***
Growth Δw	SMI	-0.0004	0.0067	-0.11	-0.02	-0.09	0.17	**0.32**	***0.000***
	S&P500	0.0000	0.0031	0.07	0.10	**0.22**	0.09	0.14	*0.057*
	DAX	-0.0001	0.0026	0.19	0.10	**0.29**	0.19	0.01	***0.000***
	EUROSTOXX50	-0.0002	0.0020	0.21	0.18	0.21	-0.02	-0.03	***0.011***
Discount rate Δk	SMI	-0.0003	0.0072	-0.12	-0.05	-0.12	0.11	**0.39**	***0.000***
	S&P500	0.0001	0.0032	0.01	0.00	0.17	-0.01	0.16	*0.158*
	DAX	0.0000	0.0034	0.08	-0.11	**0.22**	-0.03	0.12	*0.062*
	EUROSTOXX50	-0.0002	0.0032	0.08	-0.06	0.12	**-0.21**	0.06	***0.019***

The displayed statistics are means, volatilities, and autocorrelations (AC) at lags 1, 2, 3, 6, and 12 of first differences of reinvestment rate (b), profitability (r), growth (w) and discount rate (k) which are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018. Bold figures indicate 95% significance. p(LB) is the p value of the Ljung-Box test for 12 lags, bold values: AC=0 rejected.

Table 2 Correlations between implied Gordon parameters, first differences

	Δ b	Δ r	Δ w	Δ k	Δ b	Δ r	Δ w	Δ k
	SMI				S&P500			
Δ b	1.000				1.000			
Δ r	0.865	1.000			0.836	1.000		
Δ w	0.940	0.976	1.000		0.928	0.979	1.000	
Δ k	0.923	0.963	0.981	1.000	0.881	0.932	0.951	1.000
	DAX				EUROSTOXX50			
Δ b	1.000				1.000			
Δ r	0.778	1.000			0.681	1.000		
Δ w	0.907	0.962	1.000		0.868	0.948	1.000	
Δ k	0.749	0.774	0.790	1.000	0.499	0.643	0.625	1.000

The reinvestment rate (b), profitability (r), growth (w) and discount rate (k) are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018.

Table 3 Volatility of the dividend-price ratio and its constituents (k, w)

	volatility Δ D/P	Δk	Δw	correlation (Δk, Δw)
SMI	0.147%	0.723%	0.666%	0.981
S&P500	0.098%	0.316%	0.307%	0.951
DAX	0.206%	0.336%	0.261%	0.790
EUROSTOXX50	0.249%	0.318%	0.199%	0.625

The reinvestment rate (b), profitability (r), growth (w) and discount rate (k) are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018.

Table 4 Are changes in D/P a good proxy for changes in discount rates?

		Valuation ratios			Implied Gordon parameters			
		P/E	P/B	D/P	1-b	r	w	k
SMI	Dec 2006	16.8	3.2	2.0%	33.6%	19.0%	12.6%	14.6%
	Dec 2008	19.3	1.9	3.1%	59.8%	9.8%	4.0%	7.1%
DAX	Jan 2010	12.1	1.4	3.7%	45.0%	11.3%	6.2%	9.9%
	Dez 2017	14.6	1.8	2.8%	41.5%	12.1%	7.1%	9.9%

The reinvestment rate (b), profitability (r), growth (w) and discount rate (k) are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018.

Table 5 Implied Gordon parameters and expected risk premiums S&P500, 1994-2004

Year	Index	Valuation ratios			Implied Gordon parameters				exp risk premium	
	S&P500	D/P	P/E	P/B	k	w	r	1-b	int	rp
1994	459	1.71%	16	1.7	9.2%	7.5%	10.3%	27.4%	7.8%	1.4%
1995	616	1.52%	18.9	2.1	9.4%	7.8%	11.0%	28.7%	5.7%	3.7%
1996	741	1.49%	19.2	2.3	9.9%	8.4%	11.8%	28.6%	6.3%	3.6%
1997	970	1.10%	23.7	3.3	11.3%	10.2%	13.8%	26.1%	5.8%	5.5%
1998	1229	1.44%	22.7	3.5	11.8%	10.4%	15.4%	32.7%	4.7%	7.2%
1999	1469	1.28%	20.5	3.3	13.0%	11.8%	16.0%	26.2%	6.3%	6.8%
2000	1320	1.38%	19.5	3.3	13.8%	12.4%	17.0%	26.9%	5.2%	8.6%
2001	1148	1.92%	19.4	2.6	10.3%	8.4%	13.4%	37.2%	5.1%	5.2%
2002	880	1.48%	16.3	2.5	13.0%	11.5%	15.2%	24.1%	4.0%	8.9%
2003	1112	1.53%	21	2.4	9.4%	7.9%	11.6%	32.1%	4.3%	5.1%
2004	1212	1.66%	14.4	2.4	13.0%	11.4%	15.3%	25.6%	4.2%	8.8%

The fundamental ratios are from Datastream and are year-end values of the S&P500 index. The reinvestment rate (b), profitability (r), growth (w) and discount rate (k) are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. “int” denotes the yield on US government bonds with a maturity of 20 years and is used as proxy for the long-run riskfree rate; “rp” is the expected risk premium.

Table 6 A detailed analysis of the Campbell- Vuolteenaho CF- and DR-news

	Variance decomposition						Autocorrelation					
	N	var CF_N	var DR_N	-2cov	corr		AC(1)	AC(2)	AC(3)	AC(6)	AC(12)	*p(LB)*
Full time period, 12:1928-12:2001	876	0.064	0.267	-0.030	0.114	CF_N	**-0.289**	0.061	-0.012	0.020	0.049	***0.000***
						DR_N	-0.054	-0.033	-0.064	0.007	0.004	***0.007***
Subperiod 1, 12:1928-12:1952	288	0.110	0.405	0.024	-0.057	CF_N	**-0.294**	0.054	-0.004	0.078	0.064	***0.000***
						DR_N	-0.006	-0.039	**-0.143**	0.010	-0.010	*0.131*
Subperiod 2, 01:1953-12:1977	300	0.035	0.166	-0.043	0.140	CF_N	**-0.282**	0.079	0.103	-0.084	-0.082	***0.000***
						DR_N	**-0.133**	-0.021	0.080	-0.076	0.027	*0.102*
Subperiod 3, 01:1978-12:2001	288	0.047	0.236	-0.068	0.082	CF_N	**-0.293**	0.057	**-0.129**	-0.044	**0.112**	***0.000***
						DR_N	-0.090	-0.033	-0.049	0.049	-0.017	*0.306*

The monthly “news” data are downloaded from the AEA (American Economic Association) website and cover the time period 1928 to 2001. CF_N denote cash-flow news, DR_N denote discount rate news. Variances and covariances are multiplied by 100.

p(LB) is the p value of the Ljung-Box test for 12 lags, bold values: AC=0 rejected.

Table 7 (Non-) Stationarity of log dividend-price ratios

		autocorrelations					unit root test	
		AC(1)	AC(2)	AC(3)	AC(6)	AC(12)	t(ADF)	p(ADF)
ln D/P	SMI	0.94	0.89	0.84	0.71	0.49	-2.60	> .1
	S&P500	0.92	0.82	0.73	0.45	0.00	-2.89	> .1
	DAX	0.92	0.84	0.78	0.61	0.27	-2.42	> .1
	EUROSTOXX50	0.93	0.85	0.80	0.60	0.28	-2.53	> .1

ln D/P denotes the logarithmic dividend-price ratio. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018.

ADF: Augmented Dickey-Fuller test, constant and trend, Lags=0, BIC-criterion
p(ADF)>0.1 indicates that the null hypothesis of a unit root cannot be rejected on a 90% confidence level.

Table 8 Conditional means, variances and correlations of implied Gordon parameters: Levels

		mean	volatility	correlation (k,w)
Growth w	SMI	8.14%	2.39%	
	S&P500	10.48%	1.29%	
	DAX	7.16%	1.01%	
	EUROSTOXX50	6.05%	1.52%	
Discount rate k	SMI	11.38%	2.10%	0.984
	S&P500	12.57%	1.15%	0.985
	DAX	10.52%	0.92%	0.842
	EUROSTOXX50	10.12%	1.64%	0.911

Dividend growth (w) and the discount rate (k) are extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018.

Table 9 Time series properties of implied Gordon parameters: Levels

		autocorrelations					unit root test	
		AC(1)	AC(2)	AC(3)	AC(6)	AC(12)	t(ADF)	p(ADF)
Reinvestment b	SMI	0.96	0.93	0.90	0.81	0.64	-3.09	> .1
	S&P500	0.98	0.95	0.92	0.80	0.48	-1.32	> .1
	DAX	0.97	0.93	0.88	0.70	0.27	-1.82	> .1
	EUROSTOXX50	0.96	0.92	0.88	0.72	0.46	-2.21	> .1
Profitability r	SMI	0.92	0.86	0.80	0.67	0.27	-3.12	> .1
	S&P500	0.96	0.92	0.87	0.68	0.26	-0.76	> .1
	DAX	0.96	0.91	0.85	0.59	-0.08	-2.03	> .1
	EUROSTOXX50	0.98	0.96	0.93	0.84	0.64	-1.46	> .1
Growth w	SMI	0.95	0.91	0.87	0.77	0.51	-2.98	> .1
	S&P500	0.96	0.92	0.87	0.67	0.19	-1.03	> .1
	DAX	0.96	0.92	0.86	0.62	0.04	-1.95	> .1
	EUROSTOXX50	0.98	0.95	0.92	0.82	0.60	-1.71	> .1
Discount rate k	SMI	0.93	0.88	0.84	0.74	0.52	-3.37	0.06
	S&P500	0.95	0.90	0.85	0.65	0.19	-1.12	> .1
	DAX	0.93	0.86	0.79	0.49	-0.04	-2.56	> .1
	EUROSTOXX50	0.97	0.94	0.92	0.81	0.62	-1.79	> .1

Autocorrelations (AC) at lags 1, 2, 3, 6, and 12 of levels of reinvestment rate (b), profitability (r), growth (w) and discount rate (k) extracted from three valuation ratios (price-earnings, price-dividend, price-book) using the Gordon model. SMI refers to the Swiss stock market, S&P500 to the US stock market, DAX to the German stock market and EUROSTOXX50 to the major stocks of the Euro area. Monthly data are used from January 2006 to December 2018. ADF: Augmented Dickey-Fuller test, constant and trend, Lags=0, BIC-criterion. p(ADF)>0.1 indicates that the null hypothesis of a unit root cannot be rejected on a 90% confidence.