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S&P 500 under Dynamic Gordon Model*

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Abstract

In this paper, we extend the Dynamic Gordon Model (Campbell and Shiller, 1988) with a semi-structural, medium-term macroeconomic model. The proposed framework allows us to analyze the relationship between output gap, inflation, stock prices, and interest rate, as in Blanchard (1981). We estimate the model using Bayesian techniques on data from 1984q1 to 2020q1. The decomposition of the unconditional variance of the variables shows that (i) demand shocks are relevant for most macroeconomic variables and stock prices; (ii) supply shocks affect inflation mainly; and (iii) shocks to the price-dividend ratio account for around 32%, 11% and 25% of the variability of the output gap, inflation, and interest rates, respectively, reflecting in this manner the importance of stock prices on the dynamics of macroeconomic variables.

Resumen

En este artículo, extendemos el Modelo Dinámico de Gordon (Campbell y Shiller, 1988) con un modelo macroeconómico, semi-estructural de mediano plazo. El marco propuesto nos permite analizar la relación entre la brecha de producto, inflación, precio de las acciones, y tasa de interés como en Blanchard (1981). Estimamos el modelo utilizando técnicas Bayesianas con datos del período 1984q1 a 2020q1. La descomposición de varianza incondicional de las variables muestra que (i) los shocks de demanda son relevantes para la mayoría de las variables macroeconómicas y el precio de las acciones; (ii) los shocks de oferta afectan mayormente a la inflación; y (iii) los shocks a la razón precio-dividendo explican cerca del 32%, 11% y 25% de las fluctuaciones en la brecha de producto, inflación y tasas de interés, respectivamente, lo cual refleja la importancia del precio de las acciones sobre la dinámica de variables macroeconómicas.

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1 Introduction

Gordon (1962) model is widely used for evaluating stock prices. The static version of this model provides a closed-form solution for the intrinsic value of a stock, which is determined by three key elements, namely future dividend payments, the dividend growth rate, and the relevant interest rate. However, the assumptions required for achieving the static version of the model are not realistic, neither useful for proper dynamic analysis. In this sense, Campbell and Shiller (1988) provide an alternative version, which is based on a first-order approximation of the log stock return. This alternative is known as Dynamic Gordon growth Model (DGM), and it has been applied to the US stock market to decompose the impact of dividend growth and interest rates over stock returns (Campbell and Ammer, 1993), or to analyze the impact of changes in monetary policy on equity prices (Rigobon and Sack, 2003; Bernanke and Kuttner, 2005), among other empirical applications. Nevertheless, the DGM lacks key economic variables such as output gap or GDP growth. In that sense, Blanchard (1981) provides a theoretical framework in which output gap, stock prices, and interest rates are included. This framework is based on the IS-LM model, which assumes that prices are fixed and, therefore, the output gap is determined by the aggregate demand.

In this paper, we propose to enrich the DGM with a rational expectations New-Keynesian macroeconomic model composed by an aggregate demand equation (or IS curve), an aggregate supply equation (or Phillips curve), and an equation that describes the dynamics of the short-term interest rate. We calibrate the model to assess its main properties and, then, we estimate it for the US economy. Our results show that an unanticipated monetary contraction —that increases the short-term interest rate— reduces the price-dividend (P-D) ratio on impact, but this initial effect dissipates as stock prices escalate. Further, a positive shock to inflation increases the short-term interest rate to reduce higher future inflation, which in turn curtails asset prices through a discounting effect. Lastly, a positive shock to stock prices —that can be associated, for instance, with an increase of risk appetite— implies a positive output gap.

The estimation of the model poses some challenges that we discuss in detail. In particular, the close-to-non-stationary dynamic of the P-D ratio suggests that results based solely on empirical approaches, such as VAR, should be taken with caution. Thus, we use Bayesian techniques to estimate the model using quarterly data from 1984 to the first quarter of 2020. Overall, the estimated model provides a good representation of the dynamics of key variables, although some sample moments related to the inflation rate are over-estimated. The decomposition of the unconditional variance of the variables in the proposed model shows that demand shocks are relevant for both the output gap and interest rates —explaining 35% to 72% of the total variance, respectively— and stock prices. Meanwhile, supply shocks affect inflation mainly. Finally, shocks to the price-dividend ratio account for roughly 32%, 11% and 25% of the fluctuations of the output gap, inflation and interest rates, respectively, hence highlighting the importance of stock prices on the dynamics of macroeconomic variables.

The paper is organized as follows. Section 2 presents the model, whereas Section 3 describes the elements involved in the estimation using a Bayesian approach. Lastly, Section 4 concludes.

2 Model Setup

The model consists of a set of four equations that we describe in detail in this section. The first three equations describe macroeconomic variables such as output gap, inflation, and the short-term interest rate. The last equation, on its part, defines the stock price dynamics. For simplicity, we assume that all variables are expressed as linear approximations around their long-run trends. Thus, they are all demeaned or detrended.

2.1 Equations

The aggregate demand equation, or IS curve, establishes that output gap (y_t) is a function of a mixed backward-forward specification, which allows for both inter-temporal optimization and some degree of inertia. The short-term real interest rate (r_t) has a negative impact on output gap through the investment channel, whereas the log P-D ratio (z_t) captures the positive impact of investment opportunities on y_t. Thus,

$$y_t = \lambda_0 y_{t-1} + (1-\lambda_0)E_t(y_{t+1}) - \lambda_1 r_t + \lambda_2 z_t + u_{1t}, \tag{1}$$

where u_{1t} is a structural aggregate demand shock. The lag and lead parameters of the output gap are forced to sum up to one, which is a standard constraint applied in practice to reduce the number of parameters.

The aggregate supply is a hybrid Phillips curve, where the inflation rate (π_t) is a rational expectations solution with inertia given by

$$\pi_t = \delta_0 \pi_{t-1} + (1-\delta_0)E_t(\pi_{t+1}) + \delta_1 y_t + u_{2t}, \tag{2}$$

where u_{2t} is a structural aggregate supply shock. As in the case of equation (1), we consider the same constraint on the lag and lead parameters of π_t.

To complete the macroeconomic model, we include an equation for the short-term interest rate (i_t). This equation relates the short-term interest rate with its own lag, the expectations about future inflation, and the output gap, as follows:

$$i_t = \kappa_0 i_{t-1} + \kappa_1 E_t(\pi_{t+1}) + \kappa_2 y_t + u_{3t}, \tag{3}$$

where u_{3t} is a structural short-term interest rate shock. It should be noted that we do not impose any particular restriction on the parameters of this equation because, in our empirical application, we use a short-term corporate bond interest rate. This modeling strategy responds to the fact that, after the Global Financial Crisis of 2007-2008, short-term risk-free rates in the US are truncated at 0% because of the Zero Lower Bound issue, implying that we would require a shadow rate instead. However, we note that previous to the crisis period, both premium corporate-bond and risk-free rates were similar[1]. Thus the former can be used as a valid proxy for the required shadow rate. Also, the short-term real interest rate is defined as follows: $r_t \equiv i_t - E_t(\pi_{t+1})$.

Finally, we consider a dynamic pricing equation that relates stock prices with expected future dividend payments in a similar way than Campbell and Shiller (1988). We use a log-linear approximation of the log stock return, which is $x_{t+1} = k + \rho p_{t+1} + (1-\rho)d_{t+1} - p_t$, where p_t is the log of stock price and d_t is the log of dividend payments, both in real terms, and k and ρ are parameters of the Taylor approximation. The parameter ρ, on its part, is related to the long run level of the price-dividend ratio. Thus, ignoring constant terms ($k = 0$), we have that $p_t = d_t + \rho E_t(p_{t+1} - d_{t+1}) + E_t(\Delta d_{t+1}) - E_t(x_{t+1})$. Further, we define $z_t = p_t - d_t$ as the log P-D ratio, and we also assume that dividends are related to the real economy as $E(\Delta d_t) = \phi_2 y_t$ and $E(x_{t+1}) = \phi_3 r_t + \phi_4 h_t$, where h_t is the log of VIX that characterizes the risk premium in the model. Taking together all previous elements, a rational-expectations arbitrage equation is given by $z_t = \rho E_t(z_{t+1}) + \phi_2 E_t(y_{t+1}) - \phi_3 r_t - \phi_4 h_t$. However, various related studies have documented a high persistence of the price-dividend ratio in small samples (see Lettau and van Nieuwerburgh, 2008; Chevillon and Mavroeidis, 2018; Golinski *et al.*, 2018; among others). Thus, to incorporate some degree of inertia in the behavior of the P-D ratio, we consider a hybrid version of the

[1] See the Appendix for a comparison of several US short-term interest rates previous to the crisis period.

arbitrage equation instead:

$$z_t = \phi_0 z_{t-1} + \phi_1 E_t(z_{t+1}) + \phi_2 E_t(y_{t+1}) - \phi_3 r_t - \phi_4 h_t + u_{4t}, \tag{4}$$

where u_{4t} is a structural shock to the log P-D ratio. To complete the model, we assume that each structural shock follows an uncorrelated, zero-mean AR(1) process as

$$u_{it} = \rho_i u_{i,t-1} + \sigma_i v_{it}, \tag{5}$$

for all $i = 1, ..., 4$, and v_{it} is a zero-mean, unit-variance shock. Also, we assume that h_t follows an AR(1) process.

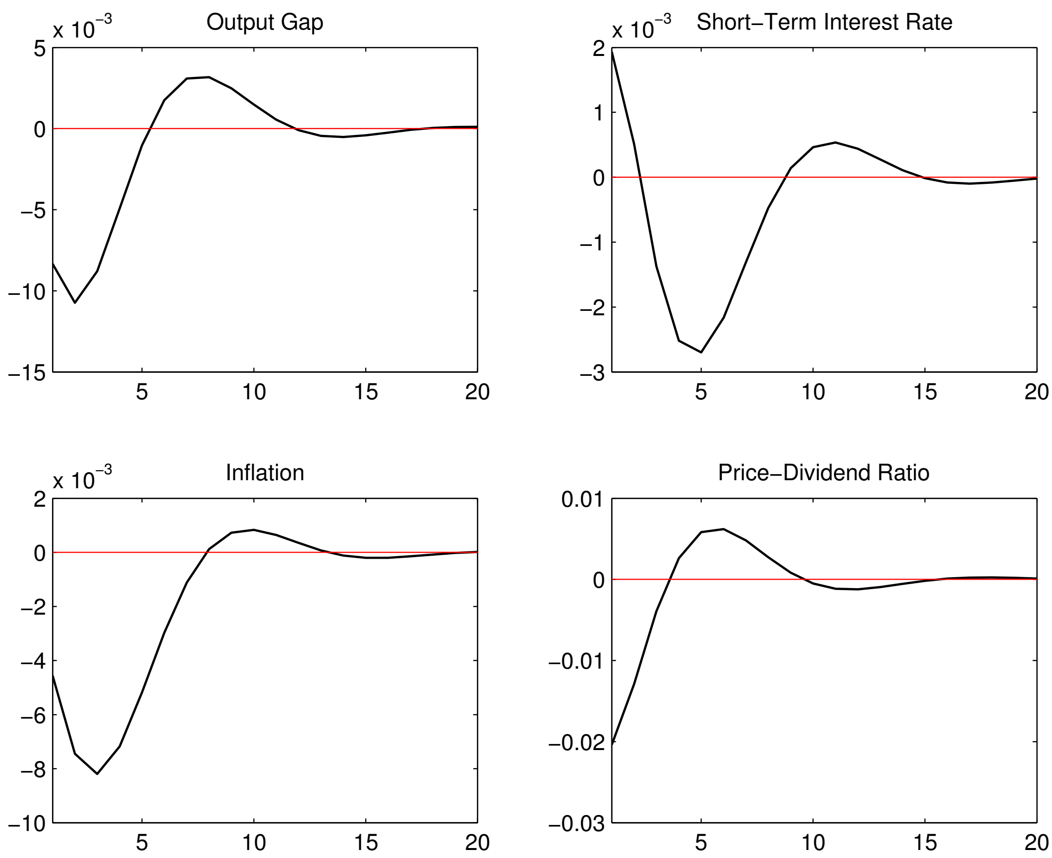
2.2 Key IRFs Under Calibration

Before entering into the estimation of the model, we analyze its properties using calibrated parameters. Hence, this section describes in detail the calibration and the results for a set of key Impulse Response Functions (IRFs).

Many parameters of the semi-structural macroeconomic model are well known from the monetary policy literature. Thus, in particular, we consider the calibration used by Fuhrer (2010) in his study of inflation persistence in the US economy. More precisely, for the case of the IS equation, we set $\lambda_0 = \delta_0 = 0.5$, which provides a balance between backward- and forward-looking dynamics of the output gap and inflation. Also, we use $\lambda_1 = \delta_1 = 0.1$, although, in practice, it is possible to have lower magnitudes. In the case of λ_2, we assume that the P-D ratio has a similar impact on the output gap than the short-term interest rate. For the short-term interest rate equation, we use $\kappa_0 = 0.8$, $\kappa_1 = (1 - 0.8) \times 1.5 = 0.3$, and $\kappa_2 = (1 - 0.8) \times 0.5 = 0.1$. For the price-dividend equation, we consider $\phi_0 = 0.05$ and $\phi_1 = 0.8$. There is no empirical counterpart for ϕ_2, ϕ_3, and ϕ_4, thus we use 0.5. Finally, we assume for simplicity that $\rho_i = 0.5$ and $\sigma_i = 0.005$ for all structural shocks and the dynamics of h_t.

Figure 1 shows the impact of an unanticipated increase in the short-term interest rate that reduces inflation, output gap, and the price-dividend ratio in the short term. The impact on the stock market is driven by both the output gap effect and the discounting effect. In the former case, it is clear that the higher interest rate will deteriorate the output gap for several periods through the investment channel, which in turn will narrow the growth rate of dividends and hence the P-D ratio. In the second case, the higher short-term interest rate and lower expectations about future inflation imply a higher rate at which future dividend payments are discounted. Therefore, the price-dividend ratio will fall below its steady-state value for several periods.

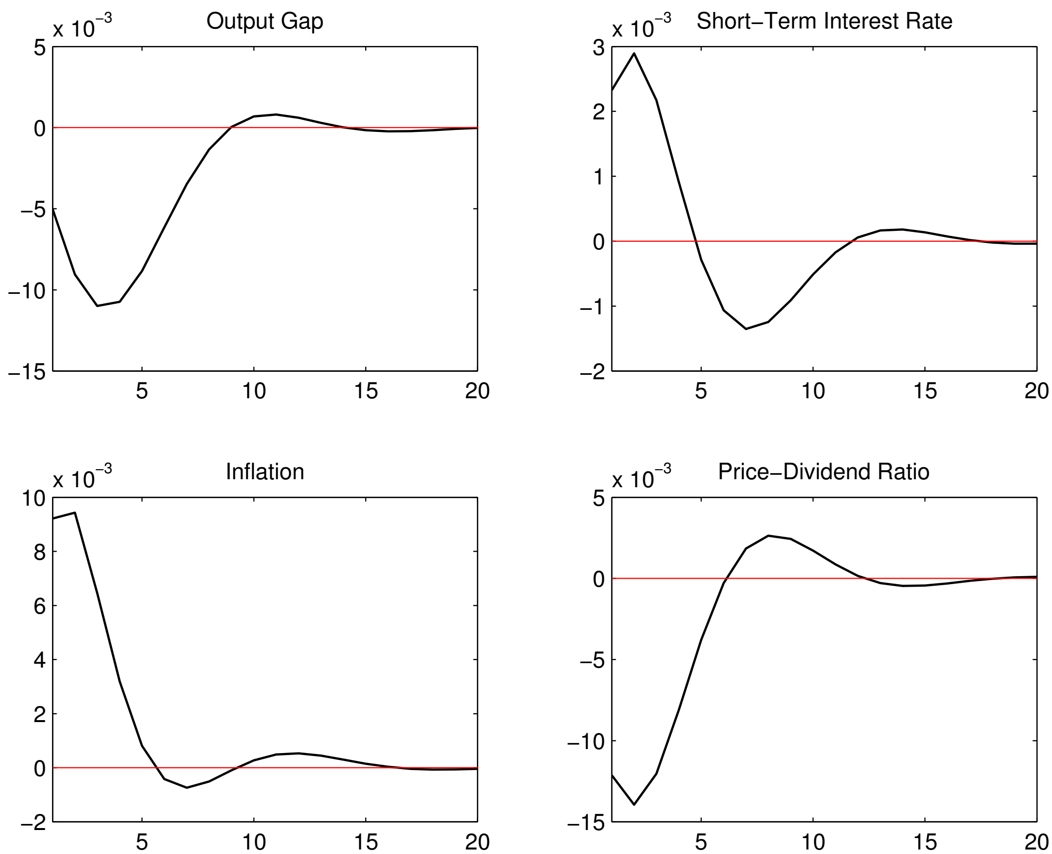
Figure 1: Responses to Short-Term Interest Rate Shock



Response of each variable to a one-standard-deviation shock in i_t.

Figure 2 shows that a positive shock in inflation will worsen both the output gap and the P-D ratio. This shock can be related, for instance, to an increase of oil prices, thus implying an inverse relationship with stock prices given the predominance of the real activity channel in the short-run. However, in the medium-run, the discounting effect becomes more relevant, and thus, the price to dividend ratio will start to increase because the short-term real interest rate is still below its steady-state value. In this context, stock prices return to its long-run value about twelve quarters after the shock occurred.

Figure 2: Responses to Inflation Rate Shock

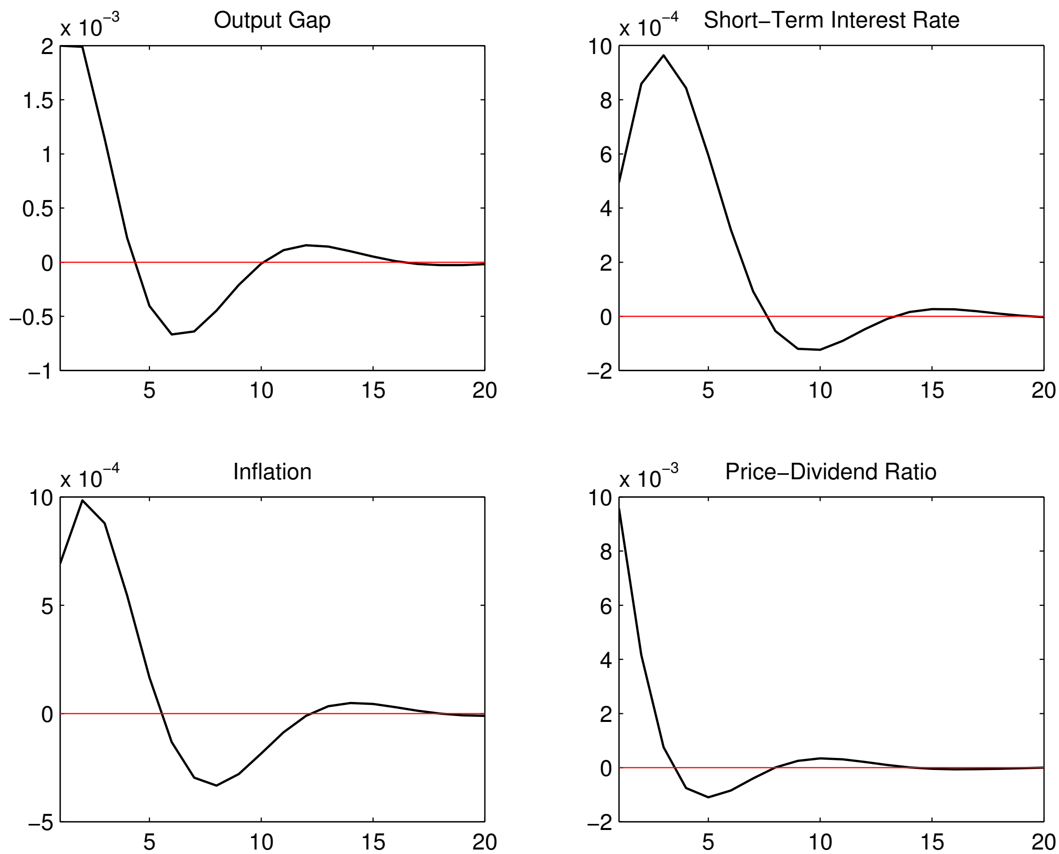


Response of each variable to a one-standard-deviation shock in π_t.

Figure 3 reports the impact of a positive, one-standard-deviation shock in the price-dividend ratio equation. This shock can be viewed, for example, as an increase in the risk appetite of investors.

The positive shock in the P-D ratio will stimulate aggregate spending, and lastly the output gap, through consumption and investment (Blanchard, 1981). Specifically, in the former case, since stock shares are part of the wealth, a higher valuation of the stock market will positively affect consumption. In the latter case, a larger price-dividend ratio will boost the value of capital in place relative to its replacement cost, hence expanding investment.

Figure 3: Responses to Price-Dividend Ratio Shock



Response of each variable to a one-standard-deviation shock in z_t.

3 Estimation

In this section, we introduce the elements for our estimation of the model using a Bayesian approach. First, we describe the data available, then the choice of priors, and we finish the section by discussing various results related to the simulations on the posterior distributions.

3.1 Data

We consider five US aggregate variables in quarterly frequency that span the period from 1984q1 to 2020q1: output gap, P-D ratio, annualized quarterly inflation rate, short-term interest rate, annualized quarterly dividend growth, and risk premium proxied by the log of the VIX (Table 1).

Table 1: Data Description and Sources

Variable	Description	Source	Observations
y	Output gap	FRED	HP-filtered real GDP with $\lambda = 1,600$
p	Price	Robert Shiller's webpage	Log of S&P 500 index divided by CPI
d	Dividend	Robert Shiller's webpage	Log of dividends per share divided by CPI
π	Inflation rate	FRED	Annualized quarterly growth of CPI
i	1-year high quality market corporate bond spot rate	FRED	Annual rate
h	Risk premium	FRED	Log of VIX

FRED stands for to the Federal Reserve Economic Data of the Federal Reserve Bank of Saint Louis; GDP stands for Gross Domestic Product; CPI stands for Consumer Price Index; VIX stands for Chicago Board Options Exchange Market Volatility Index.

Figure 4: Observables for the Dynamic Gordon Model

In particular, we compute the output gap (y_t) as the difference between real GDP and its HP-filtered trend component, where the smoothing parameter was set equal to 1,600. The price-dividend ratio (z_t) corresponds to the difference between the S&P 500 index and dividends per share (in real terms and in logarithms). The dataset is the same as in Shiller (1989) and is available online for download. The inflation rate (π_t) is the annualized quarterly variation of the Consumer Price Index, whereas dividend growth (Δd_t) is the annualized quarterly variation of real dividends per share. The short-term interest rate (i_t) corresponds to the yield on high-quality corporate bonds rated AAA, AA or A, with maturities of up to one year. Our measure of risk premium (h_t) is the log of the VIX. Since this variable is available from 1990q1, we extended the series back to 1984q1 by estimating a GARCH(1,1) model on monthly stock returns. Then, we relate the VIX with the 1-month-ahead predicted standard deviation to account for the former variable being the 30-day expected volatility of the S&P 500 returns. Lastly, we demean all variables in order to be consistent with the model described in the previous section.

In the sample, there is a declining trend in the short-term interest rate being below its average during the last decade (Figure 4). On the other hand, the price-dividend ratio has an increasing trend before 2000, followed by some mean-reversion and an important drop during the Global Financial Crisis of 2007-2008 that is also present in other stock price measures that consider cyclical adjustments[2]. Similarly, the dividend growth rate has a dramatic fall during the crisis period, where this variable reached levels around 30% below its historical average. Lastly, the measure of risk premium has a sharp upsurge during the crisis period and at the end of our sample, during the initial developments of the COVID-19 outbreak at a worldwide scale.

3.2 Posteriors

As we discussed in the calibration section, several parameters of the model are standard in the monetary policy literature. Thus, we draw priors for this set of parameters from the Beta, Normal, and Inverse Gamma distributions, where the prior mean was set equal to the calibrated values, and the prior standard deviations were chosen to contemplate plausible ranges for the parameters.

[2]For a comparison of these measures, see the Appendix.

Table 2: Posterior Estimate of Model Parameters

Parameter	Prior Distribution			Posterior Distribution		
	Distr.	Mean	Std. Dev.	Mode	Mean	90% PI
λ_0	Beta	0.500	0.100	0.439	0.435	[0.421, 0.452]
λ_1	Beta	0.100	0.050	0.033	0.035	[0.021, 0.045]
λ_2	Beta	0.100	0.050	0.025	0.026	[0.020, 0.032]
δ_0	Beta	0.500	0.100	0.224	0.211	[0.184, 0.232]
δ_1	Beta	0.100	0.050	0.212	0.206	[0.186, 0.230]
κ_0	Beta	0.800	0.150	0.926	0.919	[0.907, 0.926]
κ_1	Beta	0.300	0.100	0.382	0.396	[0.381, 0.409]
κ_2	Beta	0.100	0.050	0.220	0.226	[0.212, 0.239]
ϕ_0	Beta	0.050	0.010	0.043	0.044	[0.042, 0.046]
ϕ_1	Beta	0.800	0.050	0.890	0.889	[0.883, 0.896]
ϕ_2	Normal	0.500	0.150	0.539	0.537	[0.496, 0.574]
ϕ_3	Normal	0.500	0.150	0.803	0.793	[0.771, 0.819]
ϕ_4	Normal	0.500	0.150	0.028	0.026	[0.016, 0.035]
ρ_1	Beta	0.500	0.200	0.968	0.969	[0.954, 0.987]
ρ_2	Beta	0.500	0.200	0.039	0.038	[0.019, 0.053]
ρ_3	Beta	0.500	0.200	0.154	0.164	[0.115, 0.224]
ρ_4	Beta	0.500	0.200	0.931	0.933	[0.912, 0.957]
ρ_h	Beta	0.500	0.200	0.832	0.845	[0.789, 0.892]
σ_1	Inv. Gamma	0.005	∞	0.002	0.002	[0.002, 0.002]
σ_2	Inv. Gamma	0.005	∞	0.014	0.014	[0.013, 0.015]
σ_3	Inv. Gamma	0.005	∞	0.006	0.006	[0.006, 0.007]
σ_4	Inv. Gamma	0.005	∞	0.008	0.008	[0.007, 0.009]
σ_h	Inv. Gamma	0.005	∞	0.189	0.191	[0.175, 0.210]

The posterior distribution was obtained using the Metropolis-Hastings algorithm with 10,000 replications. PI stands for probability interval.

Table 2 reports the mode, the mean, and the 90% probability interval of the posterior distribution of the structural parameters obtained by the Metropolis-Hastings algorithm with 10,000 replications. Several aspects are worth highlighting from this table. First, the posterior mean of the parameters associated with the IS curve is somewhat similar from usual calibrations in standard semi-structural DSGE models and the one used in the previous section. The lag parameter of this curve is estimated to be 0.44, which is close to the calibrated value. In contrast, the output gap is almost insensitive to variations of the short-term real interest rate and the

P-D ratio. Second, the estimated parameters of the hybrid Phillips curve a forward-looking behavior of inflation. Further, our results also show that the output gap has relevant effects on inflation, which is more than twice as large as the calibrated value. Third, the posterior mean of the parameters associated with the equation for the short term interest rate shows an important backward-looking component that is consistent with the downward trend exhibited by the 1-year corporate bond interest rate during the whole sample (Figure 4). Also, the point estimate of the parameter κ_2 is roughly 2.3 times larger than its calibrated value, implying that the corporate rate is very sensitive to fluctuations of the output gap. Lastly, the estimates related to the pricing equation support the idea that there exists an interaction between the output gap and the stock market. In particular, the posterior mean of ϕ_2 is close to 0.54, suggesting that the P-D ratio reacts to changes in the expected value of future output growth.

3.3 Moment Comparison

To evaluate the performance of our proposed model, we compare some key sample moment conditions of the output gap, inflation, the P-D ratio, the short-term interest rate, and the measure of risk premium, with their corresponding moments derived from the estimated model. In particular, we focus our attention on the volatility, the first-order autocorrelation, and the cross-correlation between these variables.

Table 3 shows the results of our estimations. Overall, we note that the model is capable of capturing several univariate and multivariate dynamic behavior of the endogenous variables mentioned before. For instance, in our dataset, the price-dividend ratio is about 33 times more volatile than the output gap. In comparison, the estimated model delivers a P-D ratio that is roughly 23 times more volatile, although this difference is not statistically relevant at standard significance levels. Analogously, the sample autocorrelation of the output gap and the P-D ratio, and the cross-correlation between them is close to 0.88, 0.97 and 0.04, respectively, whereas the estimated model predicts values for these statistics of around 0.86, 0.97 and -0.12. However, the model fails to replicate some moments related to the inflation rate. More concretely, the volatility of π and the correlation between y and π predicted by the estimated model are significantly above their sample counterparts.

Table 3: Moment Comparison

Moment	Point Estimate	Std. Err.	Model Moment	$|z|$-stat
σ_y	0.010	0.001	0.012	2.99
σ_π	0.019	0.001	0.023	6.19
σ_z	0.334	0.034	0.272	1.81
σ_i	0.031	0.004	0.042	2.64
σ_h	0.334	0.021	0.362	1.26
$\varphi_y(1)$	0.881	0.041	0.858	0.56
$\varphi_\pi(1)$	0.333	0.078	0.473	1.78
$\varphi_z(1)$	0.968	0.015	0.973	0.34
$\varphi_i(1)$	0.970	0.015	0.983	0.86
$\varphi_h(1)$	0.825	0.048	0.848	0.48
$\varphi_{y,\pi}$	0.308	0.080	0.525	2.99
$\varphi_{y,z}$	0.037	0.084	-0.122	1.91
$\varphi_{y,i}$	0.369	0.078	0.339	0.39
$\varphi_{y,h}$	-0.070	0.093	-0.249	1.92

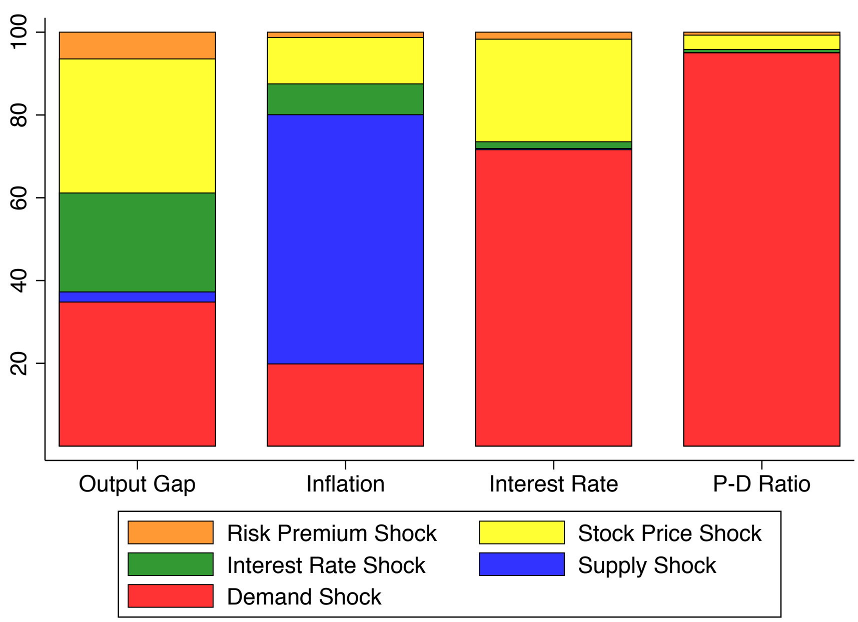
σ denotes volatility, $\varphi(1)$ denotes first-order serial correlation, and $\varphi_{a,b}$ denotes the cross-correlation between variables a and b. Model moments based on the posterior mean of the estimated parameters.

3.4 Variance Decomposition

Figure 5 shows the decomposition of the unconditional variance of the output gap, inflation, the short-term interest rate, and the price-dividend ratio based on the mean of the model posterior distribution shown in Table 2.

From this figure, we note that fluctuations of the output gap are primarily driven by demand, stock price, and interest rate shocks, thus reflecting the importance of the own dynamics of this variable, and the importance of stock prices and interest rates on aggregate demand through consumption and investment. A similar situation occurs when decomposing movements in the corporate rate, which are propelled mainly by demand and stock price shocks and, to a lesser extent, by interest rate shocks. In the case of supply shocks, they are more relevant on inflation in general, where their incidence is about 60% of the total variance due to the rather forward-looking nature of this variable. Finally, in the case of the P-D ratio, roughly all variations are explained by demand shocks, while stock price shocks account for about 4% of the total variance. To understand this result, we should look at the prior and posterior mean of ϕ_2. From our estimations, the sensitivity of the price-dividend ratio to changes in the expected value of future output gap is significantly higher than its prior value, which is in line with the fact that, previous to the Global Financial Crisis of 2007-2008, episodes of positive output gaps tend to coincide with stock market expansions.

Figure 5: Unconditional Variance Decomposition



4 Conclusions

In this paper, we extend the Dynamic Gordon growth Model (DGM) with a medium-term, semi-structural macroeconomic model. Thus, the proposed four-equations framework allows us to analyze the relationship between output gap, inflation, stock price, and interest rate as in Blanchard (1981). Calibrated with literature-based parameters, our DGM implies that an unanticipated monetary contraction depresses stock prices, meanwhile, a positive shock in the price-dividend equation —that could be associated with an increase in the risk appetite of investors, for instance— implies a positive output gap. Further, the estimation of the model using Bayesian techniques supports most of the calibrated parameters. However, it fails to fit some sample moments of the inflation rate. Lastly, the decomposition of the unconditional variance of the variables in the model shows that demand shocks are relevant for both all macroeconomic variables and stock prices. Moreover, shocks to the price-dividend ratio account for around 32%, 11%, and 25% of the variability of the output gap, inflation, and interest rates, respectively, hence highlighting, in turn, the importance of stock prices on the dynamics of macroeconomic variables.

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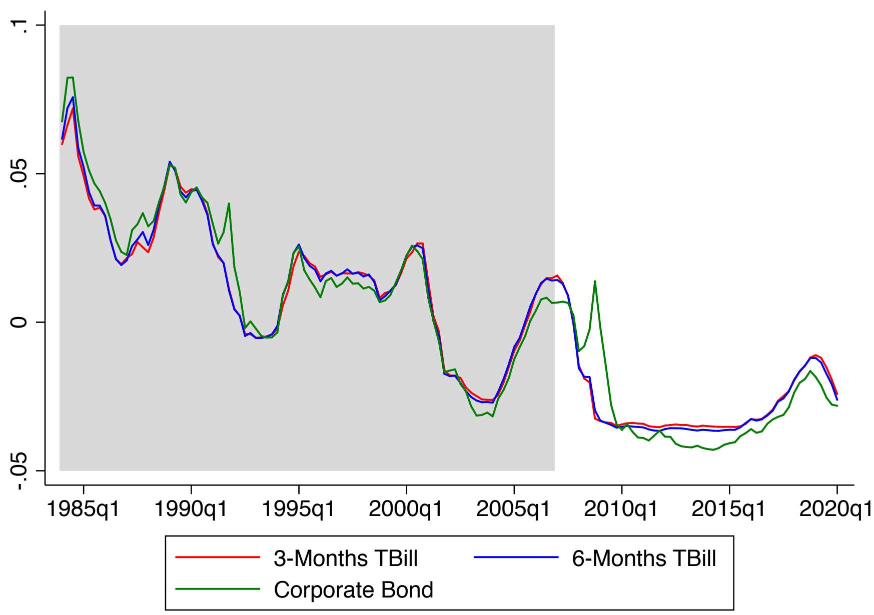
A Appendix

A.1 Comparison of US Short-Term Interest Rates

As mentioned in the main text, previous to the Global Financial Crisis of 2007-2008, short-term sovereign interest rates, and corporate bond interest rates were very similar. Figure 6 shows the evolution of the 3-months and 6-months T-Bill yields, as well as the 1-year high-quality corporate bond interest rate from 1984q1 onwards. All variables are demeaned.

Figure 6: Short-Term Interest Rates



All variables are demeaned. Shaded area corresponds to the pre-crisis period.

From this figure, we note that, during the pre-crisis period, the corporate bond rate closely follows the dynamics of the sovereign interest rates. In particular, the correlation between the corporate rate and the T-Bill yields is close to 0.98 during this period. After the crisis, the correlation between these variables drops to around 0.78.

A.2 Price-Dividend versus Cyclical-Adjusted Measures

In our model, we consider the elements of the P-D ratio in logs and demeaned. However, it is common in the financial industry to use an alternative measure by considering the price-earnings ratio, where earnings per share are smoothed over a moving window of ten years. This alternative measure of price pressures is called the Cyclical-Adjusted Price to Earnings (CAPE) ratio.

Figure 7: Comparison of Alternative Price Ratios

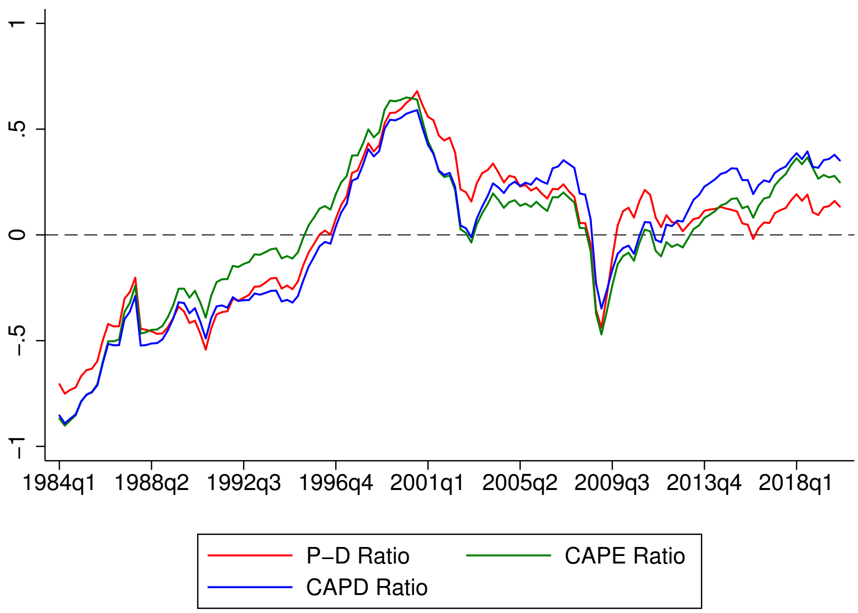


Figure 7 shows the P-D along with CAPE and the Cyclical-Adjusted Price to Dividend (CAPD) ratios, the latter being the traditional price-dividend ratio but with dividends per share smoothed over a moving window of ten years, all in logs. Note that, prior to the crisis period, all three indicators behave similarly. However, after that event, the smoothed ratios tend to exhibit a positive trend, in sharp contrast with the P-D ratio that remains relatively stable. This result suggests that CAPE and CAPD are strongly affected by the crisis period, where both earnings and dividends per share decreased significantly (Figure 4).

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