Asset Prices and Credit with Diagnostic Expectations[*]

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Abstract

Using long-run cross-country panel data, we document that (i) contemporaneous credit growth strongly predicts contemporaneous equity returns with positive sign, and (ii) lagged credit growth strongly predicts contemporaneous equity returns with negative sign. This correlation reversal is robust to added controls for contemporaneous and lagged consumption growth and these credit factors have greater explanatory power than the consumption factors. We find that a general equilibrium model with financial frictions and rational expectations fails to match the empirically estimated sign on regression coefficients. Diagnostic expectations, instead, help recover the empirically estimated contemporaneous sign as well as the reversal observed in the data. The two features of diagnostic expectations - extrapolation and systematic reversal – are key to improving the asset pricing implications of the general equilibrium model.

Keywords: financial frictions, diagnostic expectations, asset prices, credit growth

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I. Introduction

Since the Great Recession, there has been a revival of research on the role of credit in the economy. Schularick and Taylor (2012) showed that since World War II, credit relative to gross domestic product (GDP) had exploded relative to the norms observed before. They further showed the role of credit growth in predicting financial crises. Research from BIS and others have similarly emphasized the financial cycle as an important consideration when considering the business cycle. It is, therefore, natural to ask what role credit plays in asset pricing. Traditionally, we think asset prices reflect the future stream of cash flows moderated by consumers' attitudes towards risk aversion. Credit affects a consumer's ability to engage in trades that will diminish her exposure.

We first document novel empirical regularities linking asset returns and credit using long-run historical data spanning sixteen advanced economies. We find that (i) contemporaneous credit growth strongly predicts contemporaneous equity returns with positive sign, and (ii) lagged credit growth strongly predicts contemporaneous equity returns with negative sign. This correlation reversal is robust to added controls for contemporaneous and lagged consumption growth and these credit factors have greater explanatory power than the consumption factors.

Given these empirical findings that we document, we then assess whether a workhorse model with financial frictions *à la* Gertler and Karadi (2011) can replicate these moments. A model with financial frictions features a meaningful role for credit and has been at the core of research on the role of credit in macroeconomics. Traditionally, such a class of models has agents that form beliefs using the rational expectations paradigm.

However, for typical calibration of parameters, we find that this model does poorly at replicating the empirical regularities we documented. Specifically, we find two puzzles: (1) that credit growth negatively co-moves with contemporaneous equity returns in a rational expectations model and (2) that lagged credit growth strongly predicts equity returns with a positive sign. These moments are at odds with the data, and the negative relationship between credit and asset returns is consistent with a problem noted by Shi (2015) in a wide class of models with financial frictions. Namely, a credit tightening induces higher asset returns (Kiyotaki and Moore, 2019; Del Negro, Eggertsson, Ferrero, and Kiyotaki, 2017).

Various changes to the model could resolve the puzzles. For example, Shi (2015) noted that one way would be to require a credit tightening event to coincide with a negative income or a productivity shock that amplifies negative wealth effects. This paper presents a different explanation: we argue that diagnostic expectations (Bordalo, Gennaioli, and Shleifer, 2018) offers a novel and simple way to resolve this problem and the two empirical puzzles we have documented. In particular, two properties make diagnostic expectations particularly attractive – extrapolation and systematic reversal.

Firstly, when agents form beliefs with diagnostic expectations, they extrapolate from current negative news to become more pessimistic about the future state of the world. In particular, they extrapolate today's credit tightening into the future. This extrapolation leads them to perceive a much more persistent credit tightening than would prevail under the true distribution. Such a pessimistic perception activates a negative income effect amplification of credit tightening.

Secondly, a key property of diagnostic expectations is that after the initial extrapolation, agents' beliefs systematically revert to rational expectations. This belief reversal allows the model to generate the empirically documented reversal in the sign on lagged credit growth.

A key takeaway from our exercise is that diagnostic expectations can not only explain tail events, like booms and busts, as shown by Bordalo et al. (2018), but they also help explain key statistical properties of asset returns in normal times.

A. Related Literature

This paper speaks to the large literature on macroeconomics with financial frictions. Seminal works here include Bernanke and Gertler (1989), Holmstrom and Tirole (1997), Kiyotaki and Moore (1997, 2019), Fostel and Geanakoplos (2008); Adrian and Shin (2010a,b),and Gertler and Kiyotaki (2010); Gertler and Karadi (2011). As a laboratory to replicate the empirical asset pricing moments, we build on the workhorse Gertler and Karadi (2011) model to include diagnostic expectations.

We are related to recent literature that uses the long-run historical data to document facts about the interaction of the macro economy with finance. See for example, Schularick and Taylor (2012); Jordà, Schularick, and Taylor (2016, 2017), Baron and Xiong (2017), Mian, Sufi, and Verner (2017), Muir (2017), and Müller and Verner (2024) among others. Our empirical results are most closely related to results in Schularick and Taylor (2012), Mian, Sufi, and Verner (2017) and Greenwood, Hanson, Shleifer, and Sørensen (2022) tying credit to economic growth. We are also related to a dominant literature that connects macro factors to equity returns. See for example, Lettau and Ludvigson (2001), Bianchi, Lettau, and Ludvigson (2022), Bordalo, Gennaioli, La Porta, and Shleifer (2024b), Greenwald, Lettau, and Ludvigson (2025).

There is a similarly large literature emphasizing the role of leverage as a pricing factor, with a notable focus on intermediary leverage. See for example, Gromb and Vayanos (2002); Brunnermeier and Pedersen (2009), Adrian and Boyarchenko (2012); Adrian, Crump, and Moench (2013); Adrian, Etula, and Muir (2014), and He and Krishnamurthy (2013). We contribute to this literature by showing the importance of macro credit growth as a pricing factor for equity returns.

Relatedly, Shiller (1983, 2000); Barberis, Shleifer, and Vishny (1998); Cecchetti, Lam, and Mark (2000) have emphasized the role of sentiment or distorted beliefs in asset pricing. The role of extrapolation in pricing asset returns has been emphasized in a growing literature in behavioral finance. See for example, Barberis (2018); Greenwood and Shleifer (2014); Barberis, Greenwood, Jin, and Shleifer (2015, 2018); Hirshleifer, Li, and Yu (2015); Bordalo et al. (2018); Bordalo, Gennaioli, La Porta, and Shleifer (2019); Bordalo, Gennaioli, Shleifer, and Terry (2021); Nagel and Xu (2022); Wachter and Kahana (2023); and Bordalo, Gennaioli, La Porta, and Shleifer (2024a). Closely related to us, Maxted (2023) and Krishnamurthy and Li (2025) study the implications of extrapolation/diagnostic expectations for financial crises.

Behavioral departures from rational expectations in macroeconomics have also become prominent recently. See for example, work by Gabaix (2020); Farhi and Werning (2019). Our work builds on the seminal insights from psychology by Kahneman and Tversky (1972), and Kahana (2012) on the representativeness heuristic. We take the formulation of diagnostic expectations proposed by Bordalo et al. (2018) for dynamic settings. The diagnostic expectations in dynamic macro settings have been shown to have many desirable applications as seen in the work of Greenwood and Hanson (2015), Bordalo, Gennaioli, Ma, and Shleifer (2020), Angeletos, Huo, and Sastry (2020), Afrouzi, Kwon, Landier, Ma, and Thesmar (2023), and Bianchi, Ilut, and Saijo (2024). Bordalo, Gennaioli, and Shleifer (2022) provide a recent literature review of these applications. We particularly use the linear solution methods of Bianchi, Ilut, and Saijo (2023) and L'Huillier, Singh, and Yoo (2024).

II. Empirics

A. Data

We use annual frequency data for sixteen advanced economies from the Jórda-Schularick-Taylor macrohistory database. Data on macro aggregates and financial variables can be found in www.macrohistory.net/data. Our baseline sample covers the post-World War II sample from 1950 to 2015. The countries in our sample are Australia, Belgium, Denmark, Finland, FRance, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the U.K., and the U.S.

The three variables of interest are cumulative total equity returns up to a period t, credit measured with total loans to non-financial private sector deflated by the consumer price index, and real aggregate consumption per capita. Given differences in inflation across countries, we use real total equity returns, computed using the realized consumer price index inflation in a given country at a particular time. We denote the cumulative real total equity return upto time t for a country i, the real per-capita consumption, and the real credit for a country i at time t with $\mathrm{ETR}_{i,t}$, $\mathrm{Cons}_{i,t}$, and $\mathrm{Cred}_{i,t}$ respectively. All variables are in logs.

B. Empirical Specification

The empirical approach relies on estimating the following asset returns regression:

$$\begin{aligned}\text{ETR}_{i,t+k} - \text{ETR}_{i,t} = \alpha_{i,k} \quad &+ \quad \beta_k \underbrace{(\text{Cons}_{i,t+k} - \text{Cons}_{i,t})}_{\text{Contemp. Consm. Growth}} + \gamma_k \underbrace{(\text{Cred}_{i,t+k} - \text{Cred}_{i,t})}_{\text{Contemp. Credit Growth}} \\ &+ \quad \zeta_k \underbrace{(\text{Cred}_{i,t} - \text{Cred}_{i,t-k})}_{\text{Lagged Credit Growth}} + \epsilon_{i,t+k} \end{aligned} \tag{1}$$

The left hand side is the cumulative total equity return between time t and $t+k$ where $k \in [1,2,3]$ denotes horizons in years. The specification includes horizon k specific country fixed effects. The contemporaneous factors considered are real consumption growth and real credit growth over k years, and the lagged factor is the credit growth in the preceding k years.

C. Main Empirical Results

Table 1 reports the main empirical results. The first three columns report results from a specification with the contemporaneous consumption growth as the only pricing factor. We refer to that model with only consumption factor as the consumption-based asset pricing model (CAPM). The final three columns report results from estimating equation 1. The horizons reported are from year 1 to year 3. In the appendix, we report analogous results for up to a five year horizon. Note that the asterisks denote the statistical significance at 5%, 1% and 0.1% levels. The t-statistics are reported in parentheses below the estimated coefficients.

When looking at columns (i)–(iii), we find that consumption growth is a significant pricing factor for contemporaneous equity returns in the data. However, results in columns (iv)–(vi) show that this pricing relationship loses statistical significance once contemporaneous and lagged credit growth are introduced as factors. Instead, we find a robust relationship between credit growth and equity returns.

Contemporaneously, credit growth is an important factor in pricing equities. Strong credit growth is associated with higher contemporanoues equity returns. Lagged credit growth, in addition, strongly forecasts equity returns as well. This relationship indicates a reversal to the pattern found with the contemporaneous credit growth variable.

In Table 2, we report results for $k = 1$ horizon with various permutations of factors. These results show that contemporaneous credit growth and contemporaneous consumption growth unconditionally are strong pricing factors for equity returns. However, when used jointly to price equity returns, consumption growth loses statistical significance. Columns (iv)-(vi) show that lagged credit growth emerges as an important pricing factor conditional on contemporaneous credit growth. We report analogous results for horizons 2 to 5 years in the appendix, and find qualitatively a similar pattern.

In the cross-country asset returns data, we thus find that (i) contemporaneous credit growth is an important factor in pricing equity returns, (ii) conditional on contemporaneous credit growth, lagged credit growth is also an important factor, and (iii) contemporaneous consumption growth is a less influential factor once we control for credit growth.

III. A General Equilibrium Model with Financial Frictions

We now describe an off-the-shelf quantitative general equilibrium model with a meaningful role for credit. The model we work with is the one developed by Gertler and Karadi (2011, GK henceforth) to study unconventional monetary policy. The model includes

Table 1: *Asset returns regressions: consumption and credit factors*

	Only Consumption			Consumption & Credit (Eq 1)		
	$k=1$	$k=2$	$k=3$	$k=1$	$k=2$	$k=3$
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β_k	1.208***	1.541***	1.380***	0.637	0.607	0.458
Cons. Growth	(4.21)	(6.19)	(6.07)	(1.81)	(1.89)	(1.51)
γ_k				0.930***	0.927***	0.652***
Credit Growth				(5.85)	(6.82)	(5.31)
ζ_k				-0.772***	-1.062***	-0.944***
Lag Credit Growth				(-5.40)	(-10.00)	(-10.17)
constant	2.893**	4.141**	7.266***	3.358**	10.14***	18.05***
	(2.98)	(2.65)	(3.57)	(3.22)	(5.93)	(7.82)
R^2	0.017	0.037	0.036	0.056	0.127	0.125
N	1034	1017	1000	1018	985	952

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: *Asset returns regressions for $k = 1$: consumption and credit factors*

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β_k	1.208***		0.472			0.637
Cons. Growth	(4.21)		(1.37)			(1.81)
γ_k		0.632***	0.524***		1.057***	0.930***
Credit Growth		(5.50)	(3.77)		(7.41)	(5.85)
ζ_k				-0.120	-0.744***	-0.772***
Lag Credit Growth				(-1.02)	(-5.23)	(-5.40)
constant	2.893**	2.327*	1.816	6.225***	3.989***	3.358**
	(2.98)	(2.49)	(1.80)	(6.47)	(4.05)	(3.22)
R^2	0.017	0.029	0.031	0.001	0.056	0.127
N	1034	1034	1034	1018	1018	1018

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

frictions standard in a monetary dynamic stochastic general equilibrium model (Christiano, Eichenbaum, and Evans, 2005; Smets and Wouters, 2007) but extended to include financial frictions. We abstract from nominal rigidities since our focus is not on monetary policy.

There are five types of agents in the model: (i) representative household, (ii) perfectly competitive non-financial goods producers who produce using capital and labor, (iii) perfectly competitive capital producers, (iv) financial intermediaries who intermediate household deposits to goods' producers, and (v) a government who conducts credit policies. The economy is subject to three exogenous shock processes: (i) a capital quality shock at the beginning of period that affects the effective capital owned by the intermediaries, (ii) a productivity shock to the non-financial goods producers, and (iii) a credit policy shock to government's credit interventions. The credit policy shock is introduced as a stand-in for shocks to financial frictions while keeping the model as close as possible to the formulation of Gertler and Karadi (2011) .

Since the model is largely off-the-shelf, we will briefly describe the problems faced by various agents, and refer the reader to Gertler and Karadi (2011) for detailed exposition. The main departure from Gertler and Karadi (2011) that we consider is in the modeling of expectations formed by various agents in the economy. The subjective expectations operator $\tilde{\mathbb{E}}_t[\cdot]$ can either be (i) the rational expectations, or (ii) the diagnostic expectations operator as in the work by Bordalo et al. (2018). We follow the solution method in L'Huillier et al. (2024) to apply diagnostic expectations to linear general equilibrium models. After describing the model environment, we will discuss these alternate expectations and the solution method.

A. Households

There are representative households who decide consumption, saving, and how much labor to supply. Households have access to short-term deposits with financial intermediaries as well as short-term government bonds. Within a household, there are two types of members: workers and bankers. Workers supply labor at the posted wage. Bankers manage a financial intermediary. Both workers and bankers transfer their earnings to the household. There is perfect consumption insurance within the family.

At a given point in time, a fraction f of the household members are bankers, and the remaining $1-f$ fraction are workers. There is stochastic transition between occupations. With iid probability Ω, a banker retains their occupational status. With probability $1-\Omega$, a banker loses their banker status. This "death" probability ensures that bankers do not outgrow the financial friction over time. Every period $(1-\Omega)f$ bankers exit and become workers, and the same number of workers randomly become bankers. Exiting bankers give their retained earnings to their respective household. The household provides new bankers with startup funds as described shortly.

The households' objective is to maximize the following life-time utility function

$$\left[\ln\left(C_t - hC_{t-1}\right) - \frac{\chi}{1+\varphi}L_t^{1+\varphi}\right] + \tilde{\mathbb{E}}_t \left[\Sigma_{i=1}^{\infty} \beta^i \left[\ln\left(C_{t+i} - hC_{t+i-1}\right) - \frac{\chi}{1+\varphi}L_{t+i}^{1+\varphi}\right]\right] \tag{2}$$

subject to their per-period budget constraint given by

$$C_t = W_t L_t + \Pi_t + T_t + R_t B_t - B_{t+1} \tag{3}$$

where $0 < \beta < 1$ is the discount factor, C_t is the consumption, L_t is the family labor supply,

$0 < h < 1$ regulates habits in consumption, $\chi > 0$ is a scaling paramaeter used to target steady state labor supply, $\varphi > 0$ is (inverse of) the Frisch elasticity of labor supply, B_{t+1} is the total quantity of one-period debt acquired by the household in the form of real deposits and real government bonds both paying gross real return of R_t, W_t is the real wage, Π_t are net payouts to the household from ownership of both financial and non-financial firms, and T_t are lumpsum taxes. Let $M_{t,t+1}$ denote the stochastic discount factor of the household between t and $t+1$.

B. Financial Intermediaries

Each financial intermediary has the following balance sheet:

$$Q_t S_{jt} = N_{jt} + B_{jt+1} \tag{4}$$

where N_{jt} is the net worth of banker j at end of period t, B_{jt+1} are the deposits the bank obtains from households, S_{jt} is the quantity of financial claims on non-financial firms held by the banker, and Q_t is the relative price of each claim. Intermediary assets earn stochastic return R_{kt+1} while their debt in the form of deposits from households accrues gross interest R_{t+1}. Their net worth thus evolves as

$$N_{jt+1} = R_{kt+1} Q_t S_{jt} - R_{t+1} B_{jt+1} \tag{5}$$

which depends on the premium they earn on their assets above the risk-free return as well as the quantity of assets held by them. For financial intermediary to operate, it must be that their risk-adjusted premium be non-negative:

$$\tilde{\mathbb{E}}_t \; \beta^i M_{t,t+1+i}(R_{kt+1+i} - R_{t+1+i}) \geq 0; \; i \geq 0$$

With limits on intermediary's ability to obtain funds, i.e. imperfect capital markets, this premium may be positive.

The intermediary's objective is therefore to maximize their expected terminal wealth given by

$$V_{jt} = \max \tilde{\mathbb{E}}_t \Sigma_{i=0}^{\infty} (1-\Omega)\Omega^i \beta^{i+1} M_{t,t+1+i} N_{jt+1+i}$$

Their ability to expand their assets by borrowing additional funds from the household is assumed to be constrained by a moral hazard problem. At beginning of period, the banker can divert a fraction λ of available funds from the project and transfer them back to the household of which they are a member. However, depositors can force bank into bankruptcy and recover the remaining fraction $1-\lambda$ of assets. Therefore, for the household to supply deposits to the banker, the following incentive constraint must be satisfied:

$$V_{jt} \geq \lambda Q_t S_{jt} \tag{6}$$

Gertler and Karadi (2011) show that this value function can be expressed as

$$V_{jt} = \nu_t \cdot Q_t S_{jt} + \eta_t N_{jt} \tag{7}$$

with

$$\nu_t = \tilde{\mathbb{E}}_t\{(1-\Omega)\beta M_{t,t+1}(R_{kt+1} - R_{t+1}) + \beta M_{t,t+1}\Omega x_{t,t+1}\nu_{t+1}\}$$

$$\eta_t = \tilde{\mathbb{E}}_t\{(1-\Omega) + \beta M_{t,t+1}\Omega z_{t,t+1}\eta_{t+1}\}$$

where $x_{t,t+1} \equiv Q_{t+1}S_{jt+1}/Q_tS_{jt}$ is gross growth rate in assets, and $z_{t,t+1} \equiv N_{jt+1}/N_{jt}$ is gross growth rate of net worth. v_t may be interpreted as the expected marginal gain to banker of expanding their assets by a unit holding their net worth constant, and η_t is the expected gain from another unit of net worth while holding their quantity of claims fixed. When capital markets are frictionless, the intermediaries will expand borrowing such that $v_t = 0$.

When the incentive constraint (6) binds, $\nu_t \cdot Q_tS_{jt} + \eta_t N_{jt} = \lambda Q_t S_{jt}$. Then the assets a banker can acquire will depend positively on their equity capital:

$$Q_tS_{jt} = \frac{\eta_t}{\lambda - \nu_t}N_{jt} \equiv \phi_t N_{jt}$$

where ϕ_t is the private leverage ratio. After some algebra, Gertler and Karadi (2011) show that the demand for intermediary assets can be aggregated across intermediaries to arrive at the total intermediary demand for assets given by:

$$Q_tS_t = \phi_t N_t \tag{8}$$

where S_t is the aggregate quantity of intermediary assets, and N_t is the aggregate intermediary capital.

C. Credit Policy

As in Gertler and Karadi (2011) , we assume that the government can intermediate funds directly to the non-financial firms. Now, let S_t be the total intermediated assets, S_{gt} be the assets intermediated by the government, and S_{pt} be the assets intermediated by the financial sector:

$$S_t = S_{pt} + S_{gt}$$

Government can intermediate funds to producers with efficiency cost of τ per unit supplied. Also, assume that the government intermediation is not balance sheet constrained. Suppose the government is willing to fund a fraction ψ_t of the total value of intermediated assets

$$Q_t S_{gt} = \psi_t Q_t S_t$$

It issues government bonds $B_{gt} = \psi_t Q_t S_t$ to fund this intermediation. Taking this credit policy into account, we can rewrite equation 8 as

$$Q_t S_t = \phi_{ct} N_t$$

where $\phi_{ct} = \frac{1}{1-\psi_t}\phi_t$ is leverage ratio for total intermediated funds. We will later specify how the government chooses ψ_t.

D. Non-financial goods producers

Competitive non-financial firms produce the final goods. At the end of period t, these firms acquire capital K_{t+1} used for production in the following period. After production, the firms may sell capital in the open market. To acquire this capital, these firms obtain funds from the financial intermediaries by selling claims equal to the number of units of capital acquired:

$$Q_t K_{t+1} = Q_t S_t$$

The financial intermediary is assumed to have perfect information about the firm and payoff enforcement is costless and frictionless. The producers use capital and labor L_t, with variable capital utilization U_t, and aggregate total factor productivity A_t to produce the final output

$$Y_t = A_t \left(U_t \xi_t K_t\right)^{\alpha} L_t^{1-\alpha}$$

where ξ_t is capital quality shock. The producing firm chooses the utilization rate U_t subject to cost $\delta(U_t)$, and labor demand.

E. Non-financial capital producers

Capital producing firms operate in perfectly competitive environment. They buy capital from goods' producing firms at the end of period t, repair depreciated capital, and build new capital. They then sell new and re-furbished capital. The cost of replacing worn-out capital is unity. In addition, there are adjustment costs associated with production of new capital.

Let I_t be the gross capital created, and $I_{nt} \equiv I_t - \delta(U_t)\xi_t K_t$ be net capital created, and I_{ss} be steady state investment. The capital goods producers solve the following problem:

$$\begin{aligned} \max \ & (Q_t - 1) I_{nt} - f\left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}}\right)(I_{nt} + I_{ss}) \\ & + \tilde{\mathbb{E}}_t \left[\sum_{\tau=t+1}^{\infty} \beta^{\tau-t} M_{t,\tau} \left\{(Q_\tau - 1) I_{n\tau} - f\left(\frac{I_{n\tau} + I_{ss}}{I_{n\tau-1} + I_{ss}}\right)(I_{n\tau} + I_{ss})\right\}\right], \end{aligned} \tag{9}$$

with

$$I_{nt} = I_t - \delta(U_t)\xi_t K_t$$

, where $f(1) = f'(1) = 0$, $f''(1) > 0$.

F. Resource Constraints and Government

Output is divided between consumption, investment, government expenditures (fixed exogenously at level of G), and expenditures on government intermediation. The economy-wide resource constraint is thus:

$$Y_t = C_t + I_t + f(I_{nt}) + G + \tau\psi_t Q_t K_{t+1}$$

where the law of motion of capital is given by

$$K_{t+1} = \xi_t K_t + I_{nt}$$

Government expenditures are financed by lump sum taxes and government intermediation. The government budget constraint is thus given by

$$G + \tau\psi_t Q_t K_{t+1} = T_t + (R_{kt} - R_t)B_{gt-1}$$

Finally, we assume that the government credit policy is conducted with the following rule:

$$\psi_t = \psi + \nu\tilde{\mathbb{E}}_t\left[(\log R_{kt+1} - \log R_{t+1}) - \underbrace{(\log R_k - \log R)}_{\text{steady state premium}}\right] + \epsilon_{\psi,t}; \nu > 0$$

where *psi* is the steady state fraction of publicly intermediated assets. $\epsilon_{\psi,t}$ is a shock process to credit policy with persistence ρ_ψ and iid mean zero normally distributed shocks.

We provide the complete list of the equilibrium conditions in the appendix. Assuming that the financial constraint is binding, we take a first-order approximation of the model equilibrium conditions around the deterministic steady state, and consider the linearized equilibrium in rest of the paper.

G. Expectations Formation

We solve the model under two assumptions on expectations formation. First, as in Gertler and Karadi (2011), we assume rational expectations (RE). Then, for some normally distributed random variable x_t, the subjective expectations operator is replaced with the rational expectations operator:

$$\tilde{\mathbb{E}}_t[x_{t+1}] = \mathbb{E}_t[x_{t+1}]$$

An alternate expectations-formation process we consider is that of diagnostic expectations (Bordalo et al., 2018). Following the method of L'Huillier et al. (2024) of solving diagnostic expectations (DE) in linear general equilibrium models, we replace the subjective expectations operator with the diagnostic expectations operator

$$\tilde{\mathbb{E}}_t[x_{t+1}] = \mathbb{E}^{\theta}_t[x_{t+1}]$$

where diagnostic expectations map to rational expectations in the following equation:

$$\mathbb{E}_t[x_{t+1}] + \theta\left(\mathbb{E}_t[x_{t+1}] - \mathbb{E}_{t-1}[x_{t+1}]\right);\ \theta > 0$$

where $\theta > 0$ is the diagnosticity paramater. When $\theta = 0$, DE simplify to RE.

Table 3: *Steady State Calibration from Gertler and Karadi (2011)*

		Households
β	0.990	Discount rate
h	0.815	Habit parameter
χ	3.409	Relative utility weight of labor
φ	0.276	Inverse Frisch elasticity of labor supply
		Financial intermediaries
λ	0.381	Fraction of capital that can be diverted
ω	0.002	Proportional transfer to the entering bankers
Ω	0.972	Survival rate of the bankers
		Intermediate good firms
α	0.330	Effective capital share
U	1.000	Steady state capital utilization rate
$\delta(U)$	0.025	Steady state depreciation rate
ζ	7.200	Elasticity of marginal depreciation with respect to utilization rate
		Capital Producing firms
η_i	1.728	Inverse elasticity of net investment to the price of capital
		Government
$\frac{G}{Y}$	0.200	Steady state proportion of government expenditures

IV. Calibration, Simulation, and Results

A. Calibration and Simulation

Table 3 reports the calibration for the baseline model These parameters are directly taken from the steady state calibration set by Gertler and Karadi (2011). Time frequency in the model is quarterly.

The persistence for the TFP and the capital quality shock processes is set to values same as in Gertler and Karadi (2011). Namely, $\rho_A = 0.95$, and $\rho_\xi = 0.66$. For the persistence of credit policy shock, we pick a value of 0.75 which is in the range of the other two persistence parameters. When solving the model with diagnostic expectations, we set the diagnosticity parameter $\theta = 1$ (Bordalo et al., 2018, 2020; L'Huillier et al., 2024).

We set the standard deviation of all three shock processes to 0.05 for simulation purposes. We do a stochastic simulation for 10,000 draws. We drop the first 1,000 draws and transform the quarterly data generated from the model simulations to annual frequency to make it comparable to our empirical results. With the simulated data, we run asset return regressions as in the empirical results. Credit in the model is defined as the difference between the market value of capital and the intermediary net worth.

B. Model comparison with consumption and credit factors

Using the simulated data from the model, we estimate the regression specification in equation (1) for the two model variants: (i) rational expectations (RE), and (ii) diagnostic expectations (DE).

Table 4 reports the results for the two model variants along with the empirical results for comparison.

The top panel of the table compares results for horizon $k = 1$ years. In the RE model, the regression coefficient on consumption growth takes the same sign as in the data. Credit growth and lagged credit growth are statistically significant pricing factors, although with the opposite sign relative to what is observed in the data. Instead, the DE model (third column), generates the correct pattern for all three variables.

The medium and the bottom panels confirm that RE model continues to get the incorrect

Table 4: *Asset returns regression coefficients in the model: Baseline specification*

$k = 1$	Data	RE	DE
Cons. Growth	0.637	0.209	0.302**
	(1.81)	(1.13)	(2.80)
Credit Growth	0.930***	-0.615***	0.524***
	(5.85)	(-11.43)	(21.11)
Lag Credit Growth	-0.772***	0.292***	-0.453***
	(-5.40)	(5.84)	(-26.39)
$k = 2$	Data	RE	DE
Cons. Growth	0.607	2.162***	-0.366***
	(1.89)	(15.61)	(-3.56)
Credit Growth	0.927***	-0.721***	0.481***
	(6.82)	(-21.46)	(17.04)
Lag Credit Growth	-1.062***	0.0566*	-0.306***
	(-10.00)	(2.16)	(-23.49)
$k = 3$	Data	RE	DE
Cons. Growth	0.458	2.958***	0.0693
	(1.51)	(22.89)	(0.59)
Credit Growth	0.652***	-0.761***	0.283***
	(5.31)	(-25.57)	(9.08)
Lag Credit Growth	-0.944***	-0.0892***	-0.203***
	(-10.17)	(-4.55)	(-17.13)

Notes: The entries report the regression coefficients from the data, and the two models – rational expectations (RE), and diagnostic expectations (DE) for three horizons $k = 1, 2, 3$ years. The regression specification is given in equation 1. t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

sign on credit growth and lagged credit growth at longer horizons. While the DE model is able to generate the empirically observed sign. It is noteworthy that the DE model is able to generate the empirically observed reversal in sign on credit growth.

C. Only Consumption Factor

When the asset price regressions are run using only the consumption growth as a pricing factor, we find that both the RE and the DE models tend to perform well. At short horizons, the RE model does offer worse predictions for the coefficients, at horizons of 3 years or above, both models are able to capture the empirical predictability relatively well.

Table 5: *Asset returns regression coefficients in the model: consumption factor only*

Cons. Growth	$k=1$	$k=2$	$k=3$	$k=4$	$k=5$
Data	1.208***	1.541***	1.380***	1.174***	0.980***
	(4.21)	(6.19)	(6.07)	(5.48)	(4.86)
RE	-0.620***	0.205	0.487***	0.709***	0.868***
	(-3.62)	(1.77)	(5.33)	(8.26)	(10.61)
DE	1.126***	1.020***	1.045***	1.110***	1.176***
	(15.05)	(19.51)	(23.05)	(25.56)	(27.14)

Notes: The entries report the regression coefficients from the data, and the two models (rational expectations, and diagnostic expectations). The regression specification is a variation of equation 1, where we only include consumption growth on the right hand side and country fixed-effects. t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D. Credit factor only

When the asset price regressions are run using only the contemporaneous credit growth as a pricing factor, we find that both the RE model gives incorrect asset pricing implication for the sign of the co-movement. The DE model, instead, performs remarkably well in correctly recovering the relevance of the credit factor.

Table 6: *Asset returns regression coefficients in the model: credit factor only*

Credit Growth	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$
Data	0.632***	0.635***	0.545***	0.483***	0.457***
	(5.50)	(6.60)	(6.33)	(5.98)	(6.01)
RE	-0.417***	-0.390***	-0.258***	-0.153***	-0.0717***
	(-10.47)	(-15.27)	(-12.09)	(-7.65)	(-3.64)
DE	0.488***	0.310***	0.272***	0.275***	0.284***
	(28.60)	(22.52)	(22.74)	(24.33)	(25.46)

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The entries report the regression coefficients from the data, and the two models (rational expectations, and diagnostic expectations). The regression specification is a variation of equation 1, where we only include contemporaneous credit growth on the right hand side and country fixed-effects. t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

V. Conclusion

In this paper, we use long-run cross country panel data to document novel asset pricing facts. We find that (i) contemporaneous credit growth strongly predicts contemporaneous equity returns with positive sign, and (ii) lagged credit growth strongly predicts contemporaneous equity returns with negative sign. This correlation reversal is robust to added controls for contemporaneous and lagged consumption growth and these credit factors have greater explanatory power than the consumption factors.

We find that a general equilibrium model with financial frictions and rational expectations fails to match the empirically estimated sign on regression coefficients. Diagnostic expectations, instead, help recover the empirically estimated contemporaneous sign as well as the reversal observed in the data. The two features of diagnostic expectations - extrapolation and systematic reversal – are key to improving the asset pricing implications of the general equilibrium model.

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A. Appendix: Additional Empirical Results

Table 7: *Asset returns regressions: consumption factor only*

	k=1	k=2	k=3	k=4	k=5
β_k	1.208***	1.541***	1.380***	1.174***	0.980***
Cons. Growth	(4.21)	(6.19)	(6.07)	(5.48)	(4.86)
γ_k					
Credit Growth					
ζ_k					
Lag Credit Growth					
_cons	2.893**	4.141**	7.266***	11.13***	15.26***
	(2.98)	(2.65)	(3.57)	(4.47)	(5.32)
R^2	0.017	0.037	0.036	0.030	0.024
N	1034	1017	1000	983	967

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: *Asset returns regressions: consumption and credit factors*

	k=1	k=2	k=3	k=4	k=5
β_k	0.637	0.607	0.458	0.419	0.272
Cons. Growth	(1.81)	(1.89)	(1.51)	(1.43)	(0.96)
γ_k	0.930***	0.927***	0.652***	0.442***	0.365**
Credit Growth	(5.85)	(6.82)	(5.31)	(3.82)	(3.29)
ζ_k	-0.772***	-1.062***	-0.944***	-0.789***	-0.657***
Lag Credit Growth	(-5.40)	(-10.00)	(-10.17)	(-9.00)	(-7.82)
_cons	3.358**	10.14***	18.05***	24.87***	30.28***
	(3.22)	(5.93)	(7.82)	(8.41)	(8.56)
R^2	0.056	0.127	0.125	0.102	0.081
N	1018	985	952	919	887

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: *Asset returns regressions for k = 2: consumption and credit factors*

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β_k	1.541^{***}		0.828^{*}			0.607
Cons. Growth	(6.19)		(2.56)			(1.89)
γ_k		0.635^{***}	0.428^{***}		1.89^{***}	0.927^{***}
Credit Growth		(6.60)	(3.40)		(9.92)	(6.82)
ζ_k				-0.585^{***}	-1.071^{***}	-1.062^{***}
Lag Credit Growth				(-5.92)	(-10.08)	(-10.00)
constant	4.141^{**}	4.466^{**}	2.874	17.40^{***}	11.38^{***}	10.14^{***}
	(2.65)	(3.03)	(1.80)	(11.37)	(7.20)	(5.93)
R^2	0.037	0.042	0.048	0.035	0.124	0.127
N	1017	1017	1017	985	985	985

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: *Asset returns regressions for k = 3: consumption and credit factors*

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β_k	1.380^{***}		0.755^{*}			0.458
Cons. Growth	(6.07)		(2.47)			(1.51)
γ_k		0.545^{***}	0.352^{**}		0.773^{***}	0.652^{***}
Credit Growth		(6.33)	(3.04)		(8.31)	(5.31)
ζ_k				-0.677^{***}	-0.955^{***}	-0.944^{***}
Lag Credit Growth				(-7.57)	(-10.31)	(-10.17)
constant	7.266^{***}	8.075^{***}	5.952^{**}	26.73^{***}	19.46^{***}	18.05^{***}
	(3.57)	(4.27)	(2.87)	(13.40)	(9.20)	(7.82)
R^2	0.036	0.039	0.045	0.058	0.123	0.125
N	1000	1000	1000	952	952	952

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: *Asset returns regressions for $k = 4$: consumption and credit factors*

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β_k	1.174***		0.564			0.419
Cons. Growth	(5.48)		(1.93)			(1.43)
γ_k		0.483***	0.337**		-0.544***	0.442**
Credit Growth		(5.98)	(3.05)		(6.43)	(3.82)
ζ_k				-0.644***	-0.794***	-0.789***
Lag Credit Growth				(-7.47)	(-9.07)	(-9.00)
constant	11.13***	11.67***	9.573***	34.37***	26.48***	24.87***
	(4.47)	(5.10)	(3.79)	(13.75)	(9.68)	(8.41)
R^2	0.030	0.036	0.039	0.058	0.100	0.102
N	983	983	983	919	919	919

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: *Asset returns regressions for $k = 5$: consumption and credit factors*

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β_k	0.980***		0.280			0.272
Cons. Growth	(4.86)		(1.01)			(0.96)
γ_k		0.457***	0.383***		0.437***	0.365**
Credit Growth		(6.01)	(3.63)		(5.32)	(3.29)
ζ_k				-0.562***	-0.655***	-0.657***
Lag Credit Growth				(-6.74)	(-7.80)	(-7.82)
constant	15.26***	14.39***	13.12***	39.96***	31.43***	30.28***
	(5.32)	(5.49)	(4.51)	(13.49)	(9.45)	(8.56)
R^2	0.024	0.037	0.038	0.050	0.080	0.081
N	967	967	967	887	887	887

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Model: Additional Results

Table 13: *Asset returns regression coefficients in the model: Baseline specification for horizons 4 & 5*

$k = 4$	Data	RE	DE
Cons. Growth	0.419	3.572^{***}	0.432^{***}
	(1.43)	(27.51)	(3.39)
Credit Growth	0.442^{***}	-0.848^{***}	0.167^{***}
	(3.82)	(-28.41)	(5.12)
Lag Credit Growth	-0.789^{***}	-0.171^{***}	-0.176^{***}
	(-9.00)	(-9.85)	(-15.92)

$k = 5$	Data	RE	DE
Cons. Growth	0.272	4.039^{***}	0.714^{***}
	(0.96)	(29.74)	(5.19)
Credit Growth	0.365^{**}	-0.937^{***}	0.0880^{*}
	(3.29)	(-29.62)	(2.54)
Lag Credit Growth	-0.657^{***}	-0.236^{***}	-0.178^{***}
	(-7.82)	(-14.25)	(-16.44)

Notes: The entries report the regression coefficients from the data, and the two models – rational expectations (RE), and diagnostic expectations (DE) for two horizons $k = 4$ and $k = 5$ years. The regression specification is given in equation 1. t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C. Equilibrium Conditions

We describe the equilibrium conditions for the model with diagnostic expectations. When the diagnosticity parameter θ is set to zero, these equilibrium conditions characterize the rational expectations equilibrium.

I. Equilibrium of the Model

Equilibrium is defined as sequence of eighteen variables $\{Y_t, K_{t+1}, L_t, I_{nt}, I_t, C_t, R_t, R_{kt}, Q_t, u_{C_t}, x_{t-1,t}, z_{t-1,t}, \nu_t, \eta_t, \phi_t, N_t, N_{et}, N_{nt}\}$ in eighteen equations for a given exogenous sequence of $\{\xi_t, A_t, \epsilon_{\psi,t}\}$ and initial K_1, C_0, I_{n0}, N_0.

$$u_{C_t} = (C_t - hC_{t-1})^{-1} - \beta h \mathbb{E}_t^\theta \left[(C_{t+1} - hC_t)^{-1} \right] \tag{10}$$

$$\beta \mathbb{E}_t^\theta \left[u_{C_{t+1}} R_{t+1} \right] = u_{C_t} \tag{11}$$

$$(1-\alpha) \frac{Y_t}{L_t} u_{Ct} = \chi L_t^\varphi \tag{12}$$

$$\nu_t = \frac{\beta}{u_{C_t}} \left[\mathbb{E}_t^\theta \left[(1-\Omega) u_{C_{t+1}} (R_{kt+1} - R_{t+1}) + u_{C_{t+1}} \Omega x_{t,t+1} \nu_{t+1} \right] \right] \tag{13}$$

$$\eta_t = (1-\Omega) + \frac{\beta}{u_{C_t}} \mathbb{E}_t^\theta \left[u_{C_{t+1}} \Omega z_{t,t+1} \eta_{t+1} \right] \tag{14}$$

$$\phi_t = \frac{1}{1-\psi_t} \frac{\eta_t}{\lambda - \nu_t} \tag{15}$$

$$z_{t,t+1} = (R_{kt+1} - R_{t+1})(1-\psi_t)\phi_t + R_{t+1} \tag{16}$$

$$x_{t,t+1} = \frac{(1-\psi_{t+1})\phi_{t+1}}{(1-\psi_t)\phi_t} z_{t,t+1} \tag{17}$$

$$Q_t K_{t+1} = \phi_t N_t \tag{18}$$

$$N_t = N_{et} + N_{nt} \tag{19}$$

$$N_{et} = \Omega z_{t-1,t} N_{t-1} \tag{20}$$

$$N_{nt} = \omega (1-\psi_{t-1}) Q_t \xi_t K_t \tag{21}$$

$$R_{kt+1} = \frac{[\alpha \frac{Y_{t+1}}{\xi_{t+1} K_{t+1}} + (Q_{t+1} - \delta)]\xi_{t+1}}{Q_t} \tag{22}$$

$$Y_t = A_t (\xi_t K_t)^\alpha L_t^{1-\alpha} \tag{23}$$

$$Q_t = 1 + f(\cdot) + \frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}} f'(\cdot) - \frac{\beta}{u_{C_t}} \mathbb{E}_t^\theta u_{C_{t+1}} \left(\frac{I_{nt+1} + I_{ss}}{I_{nt} + I_{ss}} \right)^2 f'(\cdot) \tag{24}$$

$$I_{nt} = I_t - \delta \xi_t K_t \tag{25}$$

$$K_{t+1} = \xi_t K_t + I_{nt} \tag{26}$$

$$Y_t = C_t + I_t + f\left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}} \right)(I_{nt} + I_{ss}) + G_{ss} + \tau \psi_t Q_t K_{t+1} \tag{27}$$

$$\text{where } f(1) = f'(1) = 0, f''(1) > 0$$

$$\psi_t = \kappa \mathbb{E}_t \left[\log\left(\frac{R_{kt+1}}{R_k} \right) - \log\left(\frac{R_{t+1}}{R} \right) \right] + \epsilon_{\psi,t} \tag{28}$$

The limits to arbitrage condition must hold:

$$\mathbb{E}_t^\theta u_{C_{t+1}} R_{t+1} \le \mathbb{E}_t^\theta u_{C_{t+1}} R_{kt+1}$$

I.1 Steady State

$$Q = 1; I_n = 0; R = \beta^{-1} \tag{29}$$
$$R_k = \alpha\frac{Y}{K} + (1-\delta) \tag{30}$$
$$u_C = \frac{1}{C}\frac{1-\beta h}{1-h} \tag{31}$$
$$(1-\alpha)\frac{Y}{C}\frac{1-\beta h}{1-h} = \chi L^{1+\varphi} \tag{32}$$
$$\nu = \frac{\beta(1-\Omega)(R_k - R)}{1-\beta\Omega x} \tag{33}$$
$$\eta = \frac{1-\Omega}{1-\beta\Omega z} \tag{34}$$
$$\phi = \frac{1}{1-\psi}\frac{\eta}{\lambda-\nu} \tag{35}$$
$$z = (R_k - R)\phi + R \tag{36}$$
$$x = z \tag{37}$$
$$QK = \phi N \tag{38}$$
$$N = N_e + N_n \tag{39}$$
$$N_e = \Omega z N \tag{40}$$
$$N_n = \omega(1-\psi_{t-1})QK \tag{41}$$
$$R_k = \alpha\frac{Y}{K} + (1-\delta) \tag{42}$$
$$Y = K^\alpha L^{1-\alpha} \tag{43}$$
$$I = \delta K \tag{44}$$
$$Y = C + I + G \tag{45}$$

From the financial intermediation equations, we can derive the quadratic in ϕ for a given value of R_k:

$$\underbrace{\lambda\beta\Omega(R_k - R)}_{\mathbb{A}}\phi^2 - \underbrace{(1-\Omega)[\lambda - \beta(R_k - R)]}_{\mathbb{B}}\phi + \underbrace{(1-\Omega)}_{\mathbb{C}} = 0$$

the solution of which is

$$\phi = \frac{\mathbb{B} + \sqrt{\mathbb{B} - 4\mathbb{A}\mathbb{C}}}{2\mathbb{A}}$$

Then we can solve for the remaining variables.

Algorithm: Guess K and L in the steady state. Calculate Y, R_k, C, with given guess. Solve for ϕ using the above quadratic, and then impute N. Equilibrium values of K and L solve the following two equations:

$$\phi N - K = 0; \qquad (1-\alpha)\frac{Y}{C}\frac{1-\beta h}{1-h} = \chi L^{1+\varphi}$$

I.2 Log-linearized Equations

$$\hat{u}_{C_t} = -\frac{\hat{c}_t - h\hat{c}_{t-1}}{(1-h)(1-\beta h)} + \frac{\beta h \mathbb{E}_t^\theta \left[\hat{c}_{t+1} - \hat{c}_t\right]}{(1-h)(1-\beta h)} \tag{46}$$

$$\mathbb{E}_t^\theta \left[\hat{u}_{C_{t+1}} + \hat{R}_{t+1}\right] = \hat{u}_{C_t} \tag{47}$$

$$\hat{Y}_t + \hat{u}_{C_t} = (1+\varphi)\hat{L}_t \tag{48}$$

$$\hat{v}_t + \hat{u}_{C_t} = \mathbb{E}_t^\theta \left[\hat{u}_{C_{t+1}} + \frac{1-\beta\Omega x}{R_k - R}(R_k \hat{R}_{kt+1} - R\hat{R}_{t+1}) + \beta\Omega x(\hat{x}_{t,t+1} + \hat{v}_{t+1})\right] \tag{49}$$

$$\hat{\eta}_t = -\beta\Omega x \hat{u}_{C_t} + \beta\Omega x \mathbb{E}_t^\theta \left[\hat{u}_{C_{t+1}} + \hat{z}_{t,t+1} + \hat{\eta}_{t+1}\right] \tag{50}$$

$$\hat{\phi}_t = \hat{\eta}_t + \frac{\nu}{\lambda - \nu}\hat{v}_t - \psi_t \tag{51}$$

$$\hat{z}_{t,t+1} = \frac{(R_k - R)\phi}{z}(\hat{\phi}_t - \psi_t) + \frac{\phi R_k}{z}\hat{R}_{kt+1} + \frac{(1-\phi)R}{z}\hat{R}_{t+1} \tag{52}$$

$$\hat{x}_{t,t+1} = \hat{\phi}_{t+1} - \hat{\phi}_t - (\psi_{t+1} - \psi_t) + \hat{z}_{t,t+1} \tag{53}$$

$$\hat{Q}_t + \hat{K}_{t+1} = \hat{\phi}_t + \hat{N}_t \tag{54}$$

$$\hat{N}_t = \Omega z \hat{N}_{et} + (1 - \Omega z)\, \hat{N}_{nt} \tag{55}$$

$$\hat{N}_{et} = \hat{z}_{t-1,t} + \hat{N}_{t-1} \tag{56}$$

$$\hat{N}_{nt} = \hat{Q}_t + \hat{\xi}_t + \hat{K}_t - \psi_{t-1} \tag{57}$$

$$\hat{R}_{kt+1} = \frac{\alpha Y}{R_k K}\left(\hat{Y}_{t+1} - \hat{\xi}_{t+1} - \hat{K}_{t+1}\right) + \frac{1}{R_k}\hat{Q}_{t+1} + \hat{\xi}_{t+1} - \hat{Q}_t \tag{58}$$

$$\hat{Y}_t = \hat{A}_t + \alpha\left(\hat{\xi}_t + \hat{K}_t\right) + (1-\alpha)\hat{L}_t \tag{59}$$

$$\hat{Q}_t = f''(1)\left(\hat{I}_{nt} - \hat{I}_{nt-1}\right) - \beta f''(1)\mathbb{E}_t^\theta \left[\hat{I}_{nt+1} - \hat{I}_{nt}\right] \tag{60}$$

$$\hat{I}_{nt} = \hat{I}_t - \hat{\xi}_t - \hat{K}_t \tag{61}$$

$$\hat{K}_{t+1} = \hat{\xi}_t + \hat{K}_t + \delta\hat{I}_{nt} \tag{62}$$

$$\hat{Y}_t = \frac{C}{Y}\hat{C}_t + \frac{I}{Y}\hat{I}_t + \frac{\tau K}{Y}\psi_t \tag{63}$$

$$\psi_t = \kappa\mathbb{E}_t\left[\hat{R}_{kt+1} - \hat{R}_{t+1}\right] + \epsilon_{\psi,t} \tag{64}$$

where $\hat{I}_{nt} \equiv \frac{I_{nt}}{I_{ss}}$.