

ESSAYS ON MACROECONOMICS

A Ph.D. Dissertation

by
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Ankara
May 2018

To my family and beloved husband,



ESSAYS ON MACROECONOMICS

The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

by

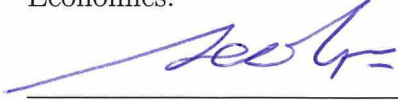
HATİCE GÖKÇE KARASOY CAN

In Partial Fulfillment of the Requirements for the Degree of
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THE DEPARTMENT OF
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İHSAN DOĞRAMACI BİLKENT UNIVERSITY
ANKARA

May 2018

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy in Economics.



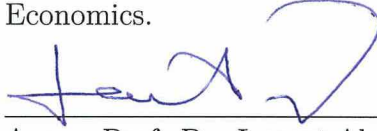
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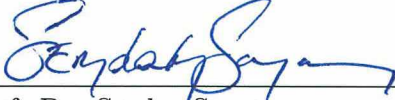
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ABSTRACT

ESSAYS ON MACROECONOMICS

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This dissertation consists of four essays on macroeconomics with a special emphasis on monetary economics and corporate finance. It presents empirical evidence for the floating rate channel in monetary policy transmission, highlighting the role of debt maturity when measuring cash flow exposure and its association with future path of policy. It then builds a theoretical model with New Keynesian properties in which endogenous borrowing constraints are source of amplification of fundamental shocks. The two blocks of the thesis, both empirical and theoretical essays, uncover the floating rate channel of monetary policy, with a comprehensive understanding and interpretation of corporate debt maturity, nature of repayment structure and forward guidance.

The first essay investigates firm level stock price changes around monetary policy announcements in an event study framework, and finds that firms that have issued more floating rate debt see their stock prices affected more. Importantly,

it shows that debt maturity is a crucial component of cash flow exposure. The firms with floating rate liabilities at longer maturities experience steeper fall in their stock prices. In addition to this, it provides further evidence regarding the floating rate channel by demonstrating that for the firms which hedge themselves against interest rate risk, the effect of the policy shock is mitigated. This indicates financial market sophistication, which is further explored in the form of statistical tests.

Further, it is the path, or forward guidance component of monetary policy shock that triggers this channel since this is the aspect of the policy that shapes expectations about future short rates hence future floating rate debt payments. The results show that, in the zero lower bound period the floating rate channel continued to be effective because of forward guidance surprises.

It is shown that this effect is not a result of rule of thumb behavior, and that the marginal stock market participant actually studies and correctly interprets the liability side of firm balance sheets. The tests of financial market sophistication, which are novel, contribute to the empirics of market rationality. Furthermore, the floating rate exposure at the time of monetary policy surprises predicts future investment and profitability, verifying the pricing decision and also providing evidence of another channel for monetary policy, due to financial effects. In short, this essay provides a detailed analysis of neo-classical monetary policy transmission involving firm balance sheets and provides a small glimpse of what lies behind Bernanke and Gertler's (1995) "black box".

The second essay provides additional robustness checks and considers alternative

regression model specifications to those in the first essay. This essay discusses the existence of floating rate channel for samples of different firm size classes, and for samples including or excluding specific sub-sectors. It shows that for small-sized firms, the channel is not evident, presumably resulting from the fact that their access to floating rate debt market is limited. This warrants further analysis, which will be taken up in the future. It confirms the cash flow effect and the protective power of hedging increases when the analysis excludes both financials and utilities sectors. Furthermore, it analyzes various specifications with additional control variables, time fixed effects, and provides further evidence for the zero lower bound period.

The third essay builds a simple model in which both short term and long term debt co-exist. The essay is motivated by empirical papers which show that firms match their debt maturity structure and asset maturity. The model assumes that the sector which has long-lived capital is financed by long term debt, and the sector which has short-lived capital is financed by short term debt. The simple model provides an environment to discuss the sector-specific effects of the aggregate shocks and macro-prudential policies.

In the second part of the essay, the simple real model is extended to a New Keynesian dynamic stochastic general equilibrium model which embeds nominal frictions due to price stickiness, which creates a role for monetary policy. The extended model has various policy implications. The impulse response functions to a similar monetary policy shock show that floating rate debt might be more disruptive for consumption. Moreover monetary policy is less effective in the

floating rate case. These are in accordance with the findings of floating rate debt literature.

Moreover it shows that lengthening the maturity of floating rate debt puts long term debt financed entrepreneurs into a more vulnerable position. This supports empirical findings in the first and second essay. The specific type of corporate debt that is used to finance investment, which eventually turns into production, plays a significant role in determining future cash flows, and that in turn is quite important for understanding monetary policy transmission.

The fourth essay, which is the final essay of the thesis, is included to fulfill the publication requirement. It assesses empirically whether consumer confidence indices contain information about future private consumption growth in Turkey. To this end, empirical models for quarterly total, durable and nondurable consumption growth with and without sentiment indicators are presented, and in-sample forecasts and one-step-ahead out-of-sample forecasts from recursive OLS estimates are evaluated. It is demonstrated that consumer confidence indices are informative about consumption, however once other macro economic variables (e.g., exchange rate, labor income, real interest rate etc.) are included, gains from them in out-of-sample forecasts decrease significantly. Moreover there is no clear evidence for either precautionary savings motive or permanent income hypothesis.

Keywords: Cash flow effect of monetary policy, Financial frictions, Floating rate debts, Interest rate risk hedging, New Keynesian models with debt maturity.

ÖZET

MAKROEKONOMİ ÜZERİNE MAKALELER

Karasoy Can, Hatice Gökçe

Doktora, İktisat Bölümü

Tez Danışmanı: Dr. Öğr. Üyesi Sang Seok Lee

Mayıs 2018

Bu tez, özellikle parasal iktisat ve kurumsal finans alanı ile ilgili dört makaleden oluşmaktadır. Tezde, parasal aktarımda değişken faizden borçlanmanın rolü ile ilgili deneysel bulgular ortaya konmuş ve yatırımların bir kısmının borçlanarak karşılandığı teorik bir modelde, uzun dönemli ve değişken faizli borçların rolü, yeni Keynesgil bakış açısı ile tartışılmıştır. Para politikasının geleceğe ilişkin sürprizlerinin (sözlü yönlendirme), mevcut faiz oranına ilişkin sürprizlerinden farkı ve nakit akışı beklentilerinde borç vadesinin önemi gösterilmiş; hem deneysel hem de teorik olarak değişken faizli borçlanmanın parasal aktarımdaki etkisi tartışılmıştır.

İlk makalede, hisse senedi piyasasında işlem gören büyük ölçekli firmaların hisse senedi fiyatlarının para politikasından nasıl etkilendikleri incelenmiştir. Vaka analizi çerçevesinde incelenen bulgular, para politikası karar günlerinde (Federal Open Market Committee meeting days) değişken faizden borçlanan firmaların

hisse senedi fiyatlarının, politika şoklarına daha yüksek tepki verdiğini göstermektedir. Beklenen nakit akışı değişiminin ölçümünde, değişken faizli borç tutarı kadar borcun vadesinin de önemli olduğu vurgulanmaktadır. Ayrıca, kendisini faiz oranı riskine karşı korumaya alan (hedging) firmalar, şoklardan da daha az etkilenmektedir. Bu kanalın işlerliğinin, para politikasının bugünkü faiz oranına ilişkin sürprizlerinden ziyade; geleceğe yönelik sürprizlerine (sözlü yönlendirme) bağlı olduğu gösterilmiştir. Bu etkinin piyasa katılımcıları tarafından benimsenmiş bir ataletten kaynaklanmadığı; yatırımcıların, firmaların bilançolarını, borç ve faiz oranı riskine karşı korunma bilgilerini gerçekten takip edip etmedikleri çeşitli istatistiksel testlerle tartışılmıştır. Son olarak, para politikası şokuna maruz kaldığı esnada sahip olunan değişken faizli borcun yarattığı nakit akışı beklentisinin, sonraki dönemlerdeki sermaye yatırımı, stok ve karlılık gibi değişkenleri anlamlı ölçüde etkilediği gösterilmiştir.

İkinci makalede, ilk makaleye ilave deneysel testler sunulmaktadır. Bu bölümde firma örnekleminin orta ve küçük ölçekli firmaları da içerek şekilde genişletilmesi, finansal ya da elektrik, su, gaz dağıtımı gibi sektörlerin dahil edilip edilmemesi durumunda ortaya çıkan sonuçlar tartışılmıştır. Ayrıca ilk makalede tartışılan parasal aktarım mekanizmasının, sıfır alt tabanı döneminde de (2009-2014) çalışmaya devam ettiğine ilişkin ek analizler yapılmıştır.

Üçüncü makalede, kısa ve uzun vadeli firma borcunun birlikte incelenebildiği basit bir teorik model kurulmuştur. Literatürde, firmaların borçlanacakları vadeyi seçerken önemli motivasyonlarından birisinin varlık ve nakit akışlarının vadesi olduğu gösterilmektedir. Buradan hareketle uzun ömürlü sermayeye sahip olan

firmaların uzun vadeli borçlanabileceği, kısa ömürlü sermayeye sahip olan firmaların ise kısa vadeli borçlanabileceği bir yaklaşım benimsenmiştir. Böylece her iki borçlanma tipine karşı makro ihtiyati tedbirler dahil olmak üzere çeşitli şokların tartışılabilmesi bir temel hazırlanmıştır.

Bu makalenin ikinci kısmında, modele fiyat katılıkları gibi Yeni Keynesyen özellikler eklenmiş ve para politikasının rolü incelenmiştir. Genişletilmiş model, pek çok politika sorusunun tartışılabilmesi bir yapıdadır. Benzer sıkılaştırıcı para politikası şoklarına maruz kalan, sabit faizli ve değişken faizli uzun dönemli borçlanma araçlarını kullanan modeller kendi aralarında kıyaslandığında; değişken faizli ekonomide tüketimin daha kötü etkilendiği ve para politikasının daha etkisiz olduğu gözlenmektedir. Bu bulgu, değişken faiz ve parasal aktarımı inceleyen literatür ile uyumludur. Ayrıca, değişken faizli borcun ortalama vadesinin uzun ve kısa olduğu modeller birbirleri ile kıyaslandığında; daha uzun vadenin, firmaları şoklardan daha fazla etkilenir hale getirdiği gösterilmiştir. Bu bulgular, ilk makaledeki ampirik sonuçlar ile uyumludur.

Son makale ise yayın zorunluluğunu yerine getirmek amacı ile teze eklenmiştir. Türkiye ekonomisine ilişkin olan bu bölüm, tüketici güven endekslerinin özel tüketim büyümesini tahmin etme gücünü değerlendirmektedir. Buna göre, toplam tüketim, dayanıklı mal tüketimi ve dayanıksız mal tüketimindeki büyümeler için, çeyreklik veri ile en küçük kareler yöntemi kullanılarak güven endekslerini dahil eden ve etmeyen tahmin modelleri oluşturulmuştur. Ayrıca ihtiyati tasarruf hipotezi de test edilmiştir. Sonuçlar, güven endekslerinin özel tüketim büyümesine ilişkin bilgi içerdiğine; ancak bu bilginin, diğer makro değişkenler tahmin

modellerine eklendiğinde önemini büyük ölçüde kaybettiğine işaret etmektedir.

Anahtar Kelimeler: Borçlanma vadesi, Finansal friksiyonlar, Para politikası, Vaka analizi, Yeni Keynesyen modeller.



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CHAPTER 1

INTRODUCTION

Monetary policy is transmitted through real economy by various channels. There has been continuous effort to explore these channels, in order to examine their empirical relevance by both academics and policy makers. Theoretical models with financial frictions have put forward the balance sheet channel and proposed to explain long-lasting effects of monetary policy through this. A contractionary monetary policy shock affects balance sheet of firms in two ways. First, it weakens the net worth of the firm and destroys firm's borrowing capacity. Second, it affects the value of outstanding debts and assets, and as a result of this total cash flow becomes reduced (Bernanke and Gertler, 1995). This thesis is mainly concerned with the second aspect of the balance sheet channel, and explores the cash flow effects of outstanding debt.

The thesis contributes to the empirical and theoretical literature on the transmission mechanisms of monetary policy. When there is an interest rate hike, the cash flow effect of monetary policy does not work only through the total value of debt or leverage. Instead, I argue that maturity also matters. Monetary policy shock

affects the future repayments of debt through i) changes in the present value of debt and ii) changes in expected interest rates in the future periods. Specifically, if the debt is written down on the floating rate basis, changes in expected interest rates directly affect cash (out)flows, whereas the present value of the debt changes slightly or does not change at all.

The empirical chapters in the thesis pursue detailed investigations on the floating rate debt channel and show that this channel operates with surprises regarding to the future path of monetary policy. Then, it turns to a deeper question: should monetary policy makers be concerned with corporate debt maturity ? To this end, the theoretical chapter builds a simple general equilibrium model featuring debt maturity and various policy instruments.

The second chapter studies stock market reaction to monetary policy at the level of individual firms' equity prices. This chapter uses an event study approach to test whether the stock prices of firms, who have more cash flow exposure due to having issued more floating rate debts, respond more to monetary policy surprises in high frequency. It offers strong evidence on the floating rate debt channel, with a novel "cash flow exposure" measure. To identify firm's exposure to floating rate debts, this measure takes into account the maturity of each debt item and multiplies it by the corresponding leverage ratio, and sums across them for each balance sheet period. It is shown that this measure is indeed the one that stock market participants react to. In addition to this, we provide further evidence for the floating rate channel by demonstrating that the negative effects of a contractionary surprise is reduced for the firms which engage in hedging

activities against interest rate risk of their floating rate obligations.

This chapter also highlights how and what kind of monetary policy surprises matters. It points out an important role played by surprises about future path of interest rates, and the interaction of this surprise with cash flow exposure. Among the empirical papers which study the relationship between asset prices and monetary policy, this study is the first one to present the transmission channel which works through expected cash flow exposure and future path of interest rates. The analysis also shows that floating rate channel was just as effective inside the zero lower bound on the nominal interest rate, which strengthens my case.

Next, we investigate whether the marginal stock market investor truly distinguishes firms based on their balance sheet conditions, (e.g., how much floating rate exposure they have, how much of them are hedged etc.) and correctly prices, or learns rules of thumb where certain firms fare worse in reaction to policy surprises. Using formal statistical tests, we conclude that marginal stock market investor is quite sophisticated.

We then turn to the real effects. Switching from the event study approach to standard regressions, we show that the cash flow channel impinges on future capital investment, inventories and profitability. Here again, we demonstrate the empirical relevance of “exposure” over leverage in accounting for the real effects.

Our analysis of the cash flow channel of monetary policy in the second chapter provides a new context to the old and well-known relationship between asset prices and monetary policy, and offers a glimpse of what lies behind Baranke

and Gertler's (1995) "black box".

The third chapter then extends the analysis in the second chapter and conduct additional robustness tests.

Small and medium sized firms are different from larger firms in many ways. Their phase in life cycle, investment and growth prospects, access to finance (debt and equity markets) are all significantly different. In the third chapter, I extend the sample to include medium sized firms as well. I show that the evidence for the floating rate channel is intact but weaker. In particular, the inclusion of small firms introduce a large noise, due to more volatile nature of their stock prices and the fact that their access to floating rate debt (e.g., long term bank debt) could be very limited.

The empirical finance literature does not combine financial firms with non-financial firms for empirical analysis because the former's nature and balance sheets are completely different from latter's. In the third chapter, I experiment with this type of idea by dropping utilities sector in addition to financial sectors. I show that the cash flow effect is even stronger for the sample which does not include these sectors.

The third chapter also discusses various ways to deal with extreme values in the data, time fixed effects, and control variables related to debt structure. It also presents additional evidence for the floating rate channel in the zero lower bound period.

As discussed above, the empirical results highlight the role of debt maturity in

monetary policy transmission. However, the current literature still lacks a proper framework to analyze the effect of corporate debt maturity choice on the cash flow channel. Because of the difficulty in modeling and investigating maturity choice in settings where different kinds of financial instruments with different maturities are available, the literature has been hampered to develop in this direction.

Nevertheless, one can investigate the role of debt maturity in response to aggregate shocks in a stylized model. This is how I approach the question in the fourth chapter. This chapter uses a short-cut for modeling a set of frictions that affect maturity choice. The firms which are able to reach long term debt finance are the firms which expect returns from their assets at a longer horizon. Servaes et al. (2009) also point out that, when choosing debt maturity, the main determinants are the firm's expected cash flows and asset maturity.

With such motive, I build a two sector real business cycle model in which production sectors differ in the longevity of their capital that the financially constrained entrepreneurs possess. The model consists of entrepreneurs and households. Two types of entrepreneurs have technologies that produce two different types of consumption goods which households consume. To increase their capital stock, which is their sole production factor, they need to make investment. Endogenous borrowing constraints limit the amount of investment, and serve as an amplification mechanism. By assumption, the sector that has long-lived capital use long-term debt and the sector that has short-lived capital use short-term debt. The simple model embeds macro prudential instruments such as borrowing limit ratios or average maturity of long term debt, and shows the sector-specific effects of

aggregate shocks and macro-prudential policies.

Then, I extend the analysis to New Keynesian (NK) models which features nominal rigidities. The extension helps identify the credit channel and the net worth channel. The second part of the fourth chapter is more interesting because it is more related to empirical findings. The model structure allows to study the distributional effects of policy shocks as well as effects of different repayment structures.

The results in this chapter has implications for macro-prudential and monetary policy. In a NK model with two sectors, a tightening of monetary policy causes inflation to fall as in standard models. However, the effect is more disruptive for the sector that relies on long-term debt finance. Since the cash outflow, regarding future obligations rise, the production and new investment in this sector fall. As a result, the ratio of short term debt to long term debt in the economy goes up.

Fourth chapter provides a theoretical analysis of floating rate debt as well. I show that floating rate debt exacerbates the adverse effects of monetary policy contraction relative to those for fixed rate debt. In the real model, extending the maturity of the long term debt benefits the sector, because it corresponds to a form of financial development. Remarkably, in the extended model, with NK features, increasing the maturity of floating rate debt amplifies the effects of adverse shocks. Increased maturity means being more exposed to future cash out flows. This rationalizes our empirical findings in Chapter 2 and 3.

This chapter also experiments with some macro-prudential policy shocks such as tightening financial conditions or extending the average maturity for long term

debt. It shows that these kind of shocks are not the main drivers of business or credit cycles because they generate opposing effects on borrowers and lenders. For example, a shock to borrowing limit, which tightens the financial conditions for entrepreneurs, leaves households (who also happen to be lenders) with more resources to consume for themselves. Moreover, the impulse response analyses show that the effect of a tightening financial shock is mitigated by a expansionary monetary policy shocks.

The model in the fourth chapter can be easily extended in many directions, for instance equity finance or a combined portfolio choice with micro-founded motives by the same firm. This will be investigated in the future research.

The fifth chapter constitutes the final chapter of the thesis and is included to fulfill the publication requirement. It tests the relevance of consumer confidence indices having information about future private consumption growth in Turkey. To this end, the estimation models for quarterly total, durable and nondurable consumption growth with and without sentiment indicators are built, and in-sample forecasts and one-step-ahead out-of-sample forecasts from recursive OLS estimates are compared. It is shown that when other macro economic variables like real labour income, real stock price, real interest rate and exchange rate are taken into account the estimation power of confidence indices decreases.

Overall contributions of this thesis can be summarized as follows: First, it provides evidence for the floating rate channel of monetary policy by constructing a novel measure of cash flow exposure and highlights that the relevant monetary policy surprise is about the future path of interest rates rather than current sur-

prises. Second, it gives further evidence on the floating rate debt channel with real consequences for capital investment, inventory investment and profits in upcoming quarters. Third, it builds a simple theoretical framework to analyze the monetary transmission and the floating rate channel. Fourth, it discusses the policy implications of floating rate debts and their maturities.



CHAPTER 2

STOCK MARKET'S ASSESSMENT OF MONETARY POLICY TRANSMISSION: THE CASH FLOW EFFECT

2.1 Introduction

In VAR studies, monetary policy appears to have large and long-lasting effects on real activity. In standard macroeconomic models, it is very hard to generate monetary policy effects that are nearly as pronounced or persistent. An influential branch of the literature has focused on financial conditions to amend the standard models to better fit the data, which also helps explain why financial markets are so important and financial crises so destructive. These models, in which the Modigliani-Miller theorem fails, collectively require cash in the firm (or other decision-making unit) to have a lower opportunity cost than cash outside the firm. These financial accelerator models tell a compelling story, but the literature remains thin on empirical evidence for many of these financial conditions-based

This work is a coauthored paper with Refet Gürkaynak and Sang Seok Lee.

channels.

Similarly, our understanding of the effects of monetary policy on stock prices remains much weaker than that of monetary policy effects on bond prices. This is at least in part because individual stocks, unlike Treasury bonds which differ in coupon rates, maturity, and inflation protection but not much else, are heterogeneous in many dimensions and the interaction of monetary policy with firm heterogeneity and how these are reflected in stock pricing is only a nascent literature. Monetary policy effects on stock prices are more often studied in terms of aggregate or industry-level stock responses, as in the influential work of Bernanke and Kuttner (2005).

In this paper, we study stock market reaction to monetary policy at the level of individual firms' equity prices, which reflects the stock market participants' beliefs about monetary policy's effects on the performances of different firms. Our object of interest is the difference caused by fixed versus floating rate obligations of otherwise similar firms. Fixed rate liabilities are, in a net present value sense, lowered by higher interest rates, and their future cash flows are unchanged by these. However, for floating rate liabilities, their net present values are either unchanged or mildly lowered, but future cash flow obligations increase, with higher interest rates. This creates two effects. The first one is mechanical: higher interest rates cause a transfer from equity holders to bond (or loan) holders if debt is a floating rate one, which should lower firm value. It is an interesting question whether this effect is priced in at high frequency, in response to monetary policy surprises.

The second effect arises due to firms' future cash flow exposures. Expected future cash flows change in response to monetary policy surprises based on the amount and maturity of floating rate liabilities on their balance sheets (and whether these liabilities are hedged). Financial accelerator channels require cash in the firm to be more valuable than cash outside it. As higher interest rates increase cash outflows, firms with more floating rate cash flow exposure should be more adversely affected by higher interest rates. This again should lower firm values for firms with high cash flow exposures, but also leads to changes in real outcomes for these firms.

The first effect is a financial effect that leads to a redistribution. But, if the Modigliani-Miller theorem holds, it will not have direct effects on firm behavioral reshuffling of liabilities between loan and bond holders and residual claimants, stock holders, have no real effects. To the extent that changes in stock prices lead to wealth effects and there is heterogeneity between stock and bond holders' wealth effects, this may lead to changes in consumption at aggregate level and be a channel of monetary policy effectiveness in itself. But, we do not test this in this paper. However, the second possible effect of monetary policy surprises on stock prices of floating rate debt issuing firms, which leads to changes in real outcomes at the firm level due to cash flow exposure, is a direct channel of monetary policy transmission and also a test of the Modigliani-Miller theorem, which we study in this paper.

We proceed in two steps. Our first test is whether firms that have more cash flow exposure due to having issued more floating rate debts see their stock prices

respond more to monetary policy surprises in high frequency. This is a joint test of monetary policy having an impact on profitability and market participants correctly pricing this at high frequency. This is indeed the case. We further show that the relevant measure of monetary policy is not the surprise in the current setting of interest rates but surprises about future path of rates, and that it is the interaction of this surprise with floating rate exposure, which depends not only on the amount but also on the maturity of floating rate debts. When measured this way, stock market reactions to monetary policy surprises as a function of floating rate exposure of firms have not changed during the Zero Lower Bound (ZLB) period: forward guidance has been as effective during the ZLB as monetary policy has been before it.

Before proceeding to real effects, we take a detour and ask what we find to be an interesting question: is it the case that the marginal stock market investor actually knows the balance sheet of the relevant firm, how much floating rate exposure it has, and correctly prices in the interaction of floating rate exposure and monetary policy at high frequency, or is it that because floating rate exposure is quite persistent for most firms, stock market participants learn rules of thumb where certain firms fare worse in, say, tightening cycles? In other words, is the marginal stock market investor sophisticated enough to know firm balance sheets and understand the present value effects of their interactions with monetary policy? We devise simple tests to answer this question and find that what drives these stock price effects in high frequency is knowledge of balance sheets and understanding of their interactions with monetary policy rather than rules of thumb. The marginal stock market investor is quite sophisticated.

Lastly, we show that firms that have issued more floating rate debts fare worse in real outcomes in the quarters following monetary policy changes. In particular, we show that the profits after interest payments are lower and their capital investments are correspondingly lower, verifying the repricing of their stocks at the time of monetary policy surprises and providing evidence for a floating rate channel of monetary policy transmission.

The paper is structured as follows: Section 2.2 describes the literature we build on and highlight our contributions. Section 2.3 describes our data set and provides relevant summary statistics; Section 2.4 presents the main results of our paper concerning the cash flow effect of monetary policy; Section 2.5 asks whether stock market participants understand the cash flow channel or use rules of thumb when differentially repricing firms' stocks in response to monetary policy surprises. Section 2.6 carries out various robustness checks; Section 2.7 extends the analysis in Section 2.4 to real effects on investments and profits; Section 2.8 concludes.

2.2 Related Literature

Our work, which is at the intersection of several strands of the literature, brings together methods and ideas from the monetary policy event study literature, the firm valuation and stock pricing sub-strands of corporate finance and asset pricing literatures, and the literature on the role of financial frictions in monetary policy transmission.

Our finding that stock prices of firms that have higher cash flow exposures are

more sensitive to monetary policy is subtly but importantly different from the findings of Ippolito et al. (2017) who study a similar question, but is nonetheless consistent with their conclusions. We differ in our focus, and our preferred measures of monetary policy surprises and cash flow exposures. In particular, we show that cash flow exposure should be measured taking into account the maturity of liabilities, not only leverage; that the relevant measure of monetary policy is the guidance about future interest rates, which drive future floating rate payments; and that when exposure and policy surprises are measured as described, one sees that the differential effect of monetary policy surprises on stock prices of firms with different cash flow exposures have not changed during the zero lower bound period. What mattered has always been forward guidance, and forward guidance worked the same way when the policy rate was stuck at zero. We further differ in the real effects we are interested in, and also our study of sophistication of stock market participants.

Looking at the broader body of work that we build on, we recognize that the theoretical literature on financial accelerator models is rich, and there is an increasing literature on the empirics of many specific channels. In their influential paper, Bernanke and Gertler (1995), referring to the transmission mechanism of monetary policy as a “black box”, urged macroeconomists to uncover what lies behind empirical regularities concerning monetary policy actions and the real economy. The profession responded to the plea emphatically and produced many important contributions to enhance our understanding of monetary policy transmissions, especially in connection with the credit channel of monetary policy. (Gertler and Gilchrist, 1994; Kiyotaki and Moore, 1997; Bernanke et al. 1999).

The interest in this quest was rekindled by the economic crisis of 2008 as the world witnessed the ineffectiveness of conventional monetary policy at stabilizing macroeconomic fluctuations. Some examples of this work include Gertler and Kiyotaki (2010), Adrian et al. (2013), Ciccarelli et al. (2013), and Gertler and Karadi (2015). However, as Boivin et al. (2010) argue, the literature on less conventional or non-neoclassical transmission mechanisms is still thin, and this is mainly due to the lack of the supporting empirical evidence. We help fill that gap and add to the contributions of Ippolito et al. (2017), Hughson et al. (2016), Vestman et al. (2016) that are examples that explore similar or related questions.

There is also an extensive literature investigating the relationship between asset prices and monetary policy. Some examples are Thorbecke (1997), Kuttner (2001), Ehrmann and Fratzscher (2004), Gürkaynak et al. (2005), D'amico and Farka (2011), Campbell et al. (2017), Gorodnichenko and Weber (2016), Eijffinger et al. (2017), and Swanson (2017). Our analysis of the cash flow channel of monetary policy provides a new context to this old and well-known relationship, and in the process of doing so offers a glimpse of what lies behind Bernanke and Gertler's (1995) "black box".

Lastly and obviously, we contribute to the literature of stock price determination. This is a very large literature with important contributions in different dimensions including Capital Asset Pricing Model of Sharpe (1964) and Lintner (1965), determinants of firm performance and stock prices such as Fama and French (1992) and Fama and French (1995), and responses of stock prices to monetary policy such as Bernanke and Kuttner (2005). Another strand of the literature is on

stock prices that are driven by non-fundamental effects such as momentum trading (Hong and Stein, 1999), rational bubbles (Diba and Grossman, 1988; D'amico and Farka, 2011), and the like. Our work is related to Bernanke and Kuttner (2005) in that we study stock price changes at high frequency conditional on monetary policy surprises and find evidence of pricing based on fundamentals, as firm balance sheet is part of the fundamentals. This does not rule out non-fundamental influences, but provides evidence for the presence of market participants who are sizable enough to have pricing effects and trade on the fundamentals even when those are buried in the firms balance sheets, such as liability structure and hedging behavior.

The relationship between monetary policy and stock prices is interesting for a variety of reasons, including for portfolio investment purposes, financial stability considerations, and so on. Here, our interest is on the stock market participants' perceptions of monetary policy effects on different firms, based on the changes in their future cash flow obligations due to the changes in the expected path of interest rates. A related study is the wonderful recent work of Ippolito et al. (2017) who show that firms that have issued more floating rate debts, as proxied by bank loans (which are mostly floating rate obligations), see more reaction of their stock prices to Kuttner surprises (Kuttner, 2005). They refer to this as the floating rate channel of monetary policy. We will use their covariates, in particular their bank debt leverage measure, in our work to make sure that our cash flow exposure measure is not proxying for their bank debt leverage measure.

2.3 Data and Summary Statistics

This section describes our data and provides summary statistics relevant for our analysis. The baseline sample period, which ranges from 2004 to 2008, is identical to that of Ippolito et al. (2017) whose analysis of the floating rate channel of monetary policy is intimately related to our analysis of the cash flow effect of monetary policy. This choice and other decisions related to empirical design make our results consistently comparable to theirs initially. We then turn to a longer sample, between 2004 to 2014, when our data set ends. There were 93 FOMC announcements between January 2004 and September 2014. We employ our preferred measures of cash flow exposure in addition to bank debt leverage, and also use Ippolito et al.'s (2017) conditioning variables in our regression models to make sure that our results are not driven by their bank debt leverage measure.

Whereas individual firms differ in many dimensions, our interest will be on their cash flows. In particular, we will be looking at changes in expected cash outlays of firms on days of monetary policy surprises due to unhedged floating rate obligations on their balance sheets. To do so, we first look at the construction of monetary policy surprise measures and firm balance sheet information, before proceeding to the event study based on these variables.

2.3.1 Monetary Policy Data

Monetary policy effects on stock prices have been of long-standing interest. However, these effects are hard to interpret with aggregate data due to opposing

information and discount rate effects on stock prices. Figure 2.1 shows daily aggregate stock price changes (S&P500 returns) in response to intraday monetary policy surprises (Kuttner surprises) between 2004 and 2008. These surprises are market-based monetary policy innovations, using short-dated federal funds futures contracts, that capture the change in market participants' beliefs about the effective federal funds rate in the remainder of the calendar month at the time of a monetary policy announcement (see Kuttner, 2005). If there is no surprise at the time of the announcement, spot-month federal funds futures quotes will be unchanged. Otherwise, the exact magnitude of the surprise can be read off from the change in these contract prices with appropriate scaling.

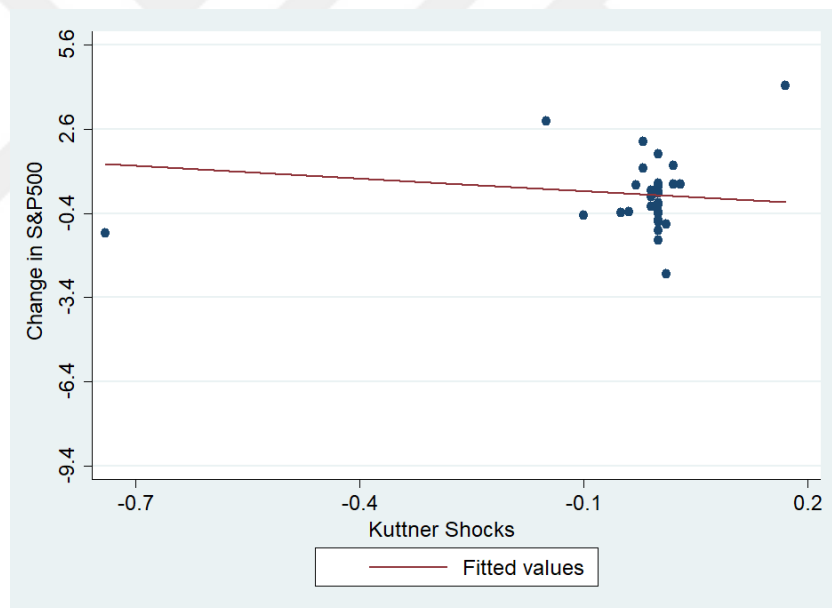


Figure 2.1: Daily Aggregate Stock Price Changes in Response to Kuttner Shocks

First, looking at monetary policy surprise measures, it is rather clear that there had been very few policy surprises in the Kuttner surprise sense between 2004, when the data set on firm balance sheets became available, and 2008, when the Global Financial Crisis hit and monetary policy in the US reached the ZLB, with no surprises in the policy setting for several years afterwards. This is not because

monetary policy had no surprises in this period, but because policy surprises came from the statement, changing expectations about the future course of policy rates, rather than the surprises in the immediate policy setting. In fact, this had been the case before the ZLB as well: the FOMC signaled its policy decision fairly transparently before the meetings took place, hence the surprise in the 21st century always came mainly from what is now called forward guidance.

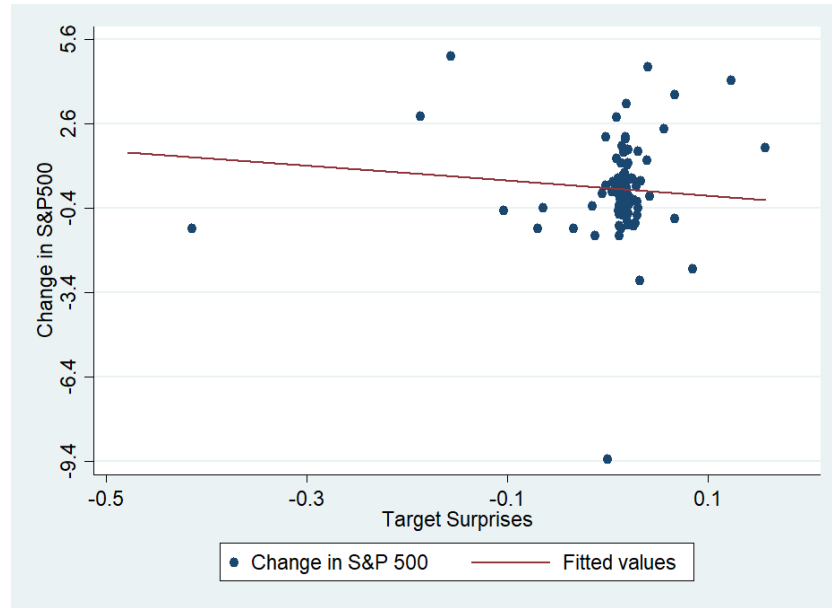
We use Gürkaynak et al.'s (2005) measures of monetary policy shocks (GSS surprises henceforth) in our analysis. The GSS shocks are constructed under the identifying assumption that no economic news other than an FOMC announcement drives changes in asset prices in a thirty-minute window bracketing the announcement. Therefore, the asset price changes during this window of time can be attributed to a genuine monetary policy surprise which could not have been anticipated on the basis of what is known up until the announcement is made. The use of the narrow window makes this identifying assumption credible, which is also the identifying assumption underlying the Kuttner surprises.

The GSS surprises, unlike Kuttner's measure of monetary policy surprises (Kuttner, 2005) employed by Ippolito et al. (2017), are two-dimensional with the first dimension being exclusively related to the change in the current policy target and the second dimension to the change in the market perceptions of future policy rates (e.g., forward guidance). Following Gürkaynak et al. (2005), we refer to them as "target factor" and "path factor" respectively. These are the first two principal components of the yield curve up to one year maturity in a narrow (thirty-minute) window bracketing an FOMC announcement, rotated such that

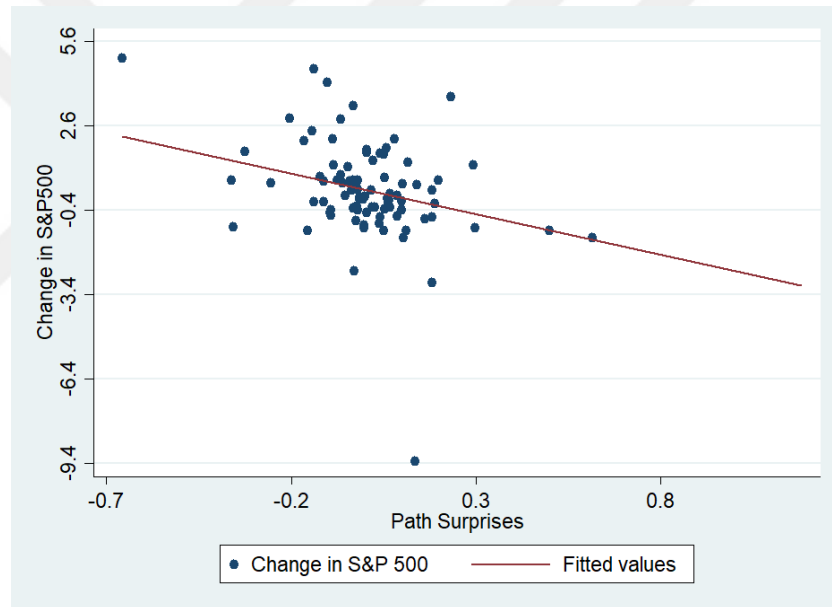
one factor (path) is orthogonal to the Kuttner surprise. Hence, one factor (path) captures only the revisions to interest rates up to a year ahead that are not driven by the surprise in the current policy action (target), and the two rotated factors remain orthogonal to each other by construction. Campbell et al. (2017) and Swanson (2017) both discuss the mechanics of the GSS surprises and bring in other asset prices to help interpret monetary policy actions. The temporal separation afforded by the GSS shocks is particularly useful in light of the fact that floating rate debt maturity, which is mainly concerned with the future monetary policy actions, plays an important role in our analysis.

Figure 2.2 shows the S&P500 response to monetary policy, this time separately to the target and path surprises. The top panel of the figure resembles Figure 2.1, but the bottom panel is different and shows the aggregate stock price response to the path surprises. It is clear that the path surprises function differently from the target surprises, and indeed stock prices have been more responsive to the path surprises, than to the target surprises.

While introducing the path surprises allows capturing much more of the monetary policy surprise variance and the resulting changes in aggregate stock returns, one can make little inference from these aggregate stock price responses that is useful in understanding the transmission of monetary policy. We therefore turn to individual stock prices, where we can use cross-sectional variations in firms' cash flow exposure to study a particular type of financial accelerator.



(a) Target Shocks



(b) Path Shocks

Figure 2.2: Daily Aggregate Stock Price Changes in Response to GSS Shocks

The panel above plots daily changes in S&P500 Index against the target shocks on the FOMC announcement dates between January 2004 and September 2014, and the panel below the same time series against the path shocks. The lines give the OLS fitted values.

2.3.2 Firm-level Data

To analyze how the FOMC announcements affect the financial market's assessments of individual firms' exposures to floating rate debts and stock prices in

turn, we construct a panel data whose cross-sectional dimension corresponds to US firms and event dimension to the FOMC announcement dates (refer to Section 2.3.1). Our firm selection is based on a firm’s macroeconomic importance and financial data availability. For this reason, we choose firms which were part of S&P500 between 1957 and 2014 whose balance sheet data are also available in Capital IQ (CIQ) database. This gives us 728 firms in total. Ehrmann and Fratzscher (2004), Gorodnichenko and Weber (2016), and Eijffinger et al. (2017) are some examples which study relationships between monetary policy and stock returns using S&P500 firms.

The stock return, which is the main dependent variable in our paper, is computed using the log-difference of a stock price the day before and the day after an FOMC announcement (closing quotes). This makes sure that our analysis is comparable to Ippolito et al.’s (2017) which is based on the same two-day window. We obtain similar results when we consider one-day window covering the stock return only on the day of an FOMC announcement instead (not shown here for brevity), even though they are less accurate than those based on the two-day window. The stock price is obtained from the Center for Research in Security Prices (CRSP) database.

The main regressor in our analysis is a measure of a firm’s exposure to floating rate debts which are financial obligations whose interest rates vary with benchmark rates such as the federal funds rate or the London Interbank Offered Rate (LIBOR) over the course of their contract periods. To calculate floating rate exposure, we require detailed information about the firm’s debt structures beyond

face values such as debt categories (e.g., bank loans, bonds, notes, etc.), interest rate types (i.e., fixed vs. floating rate), and maturity per category/type. They are available at annual frequency in 10-K forms of CIQ database¹ which are filed at the end of each firm’s fiscal year. Tables 1 and 2 in Appendix A provide breakdowns of total debts and total floating rate debts issued by firms in our data set respectively, and Table 3 gives descriptive statistics for floating rate debt items. Table 4 in the same appendix presents breakdowns of debts according to debt maturity and interest rate types, and Table 5 provides descriptive statistics for debts at different maturities. Floating rate exposure of each firm in our sample is constructed as follows. First, floating rate debt items which are convertible, issued in currencies other than US Dollars, or non-recourse are dropped from the list because they are not directly related to the cash flow channel of monetary policy we study in this paper. Debt items which have already defaulted are also removed. Second, for each remaining item, its maturity is set to either the final payment date stipulated on the contract or the simple average of the lower and upper bound of the designated payment interval depending on which case is applicable. The maturity of a perpetuity is set to 100 years. Finally, the maturity of each debt item from the previous step is multiplied by the corresponding leverage ratio (i.e., outstanding value of the debt item over total assets of the firm) and summed across the items to give the firm’s exposure to floating rate debts. By construction, it captures both maturity and leverage of a firm’s floating rate obligations, thus intimately related to its future cash flow exposure. For this reason, we use the expressions “floating rate exposure” and “cash flow exposure” interchangeably to refer to this measure.

¹They are also available at quarterly frequency in CIQ database, but only from 2012 onward.

The standard balance sheet items are obtained from Compustat database. Based on these, we compute size, profitability, book leverage, and market-to-book ratio which are used as control variables in our analysis. They are available at quarterly frequency. Bank debt leverage (i.e., bank debts over total assets, where bank debts are the sum of term loans and credit lines), which is the main regressor of Ippolito et al. (2017) and also a measure of floating rate leverage in our model, is calculated using both CIQ and Compustat. We also consider floating rate debt leverage (i.e., total floating rate debts over total assets, where total floating rate debts are all obligations whose interest rates are variable) as an alternative measure of floating rate leverage as Ippolito et al. (2017) do in their paper. Figure 2.3, which plots floating rate debt leverage against bank debt leverage, shows that the two measures are closely related, with bank debts being mostly floating rate obligations. Figure 2.4, however, reveals that our preferred measure of cash flow exposure contains variations that are differentially informative over and above those contained in the leverage measures. Finally, Figure 2.5 provides the simple average of the exposure measure in each decile of bank debt leverage. It confirms the positive relationship between the two as shown in Figure 2.4, but also indicates that the relationship is quantitatively stronger at the right tail. Other variables that are included in our regression models are deflated by CPI and recast in real terms, wherever applicable.

As in Ippolito et al. (2017), we compare the stock returns of the firms which hedge against interest rate risks of floating rate debts to those which do not in the two-day window explained above. To this end, we construct a dummy variable for hedging by following the text search method of Ippolito et al. (2017). It uses

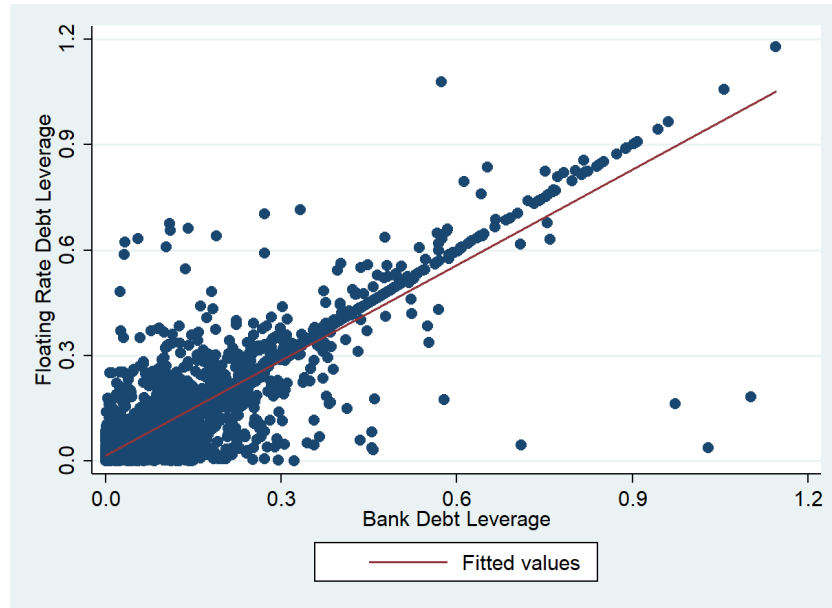


Figure 2.3: Floating Rate Debt Leverage and Bank Debt Leverage

Floating rate debt is all obligations whose interest rates are variable. Bank debt is the sum of term loans and credit lines. They are expressed as fractions of total assets to give “Floating Rate Debt Leverage” and “Bank Debt Leverage” respectively. The line plots OLS fitted values.

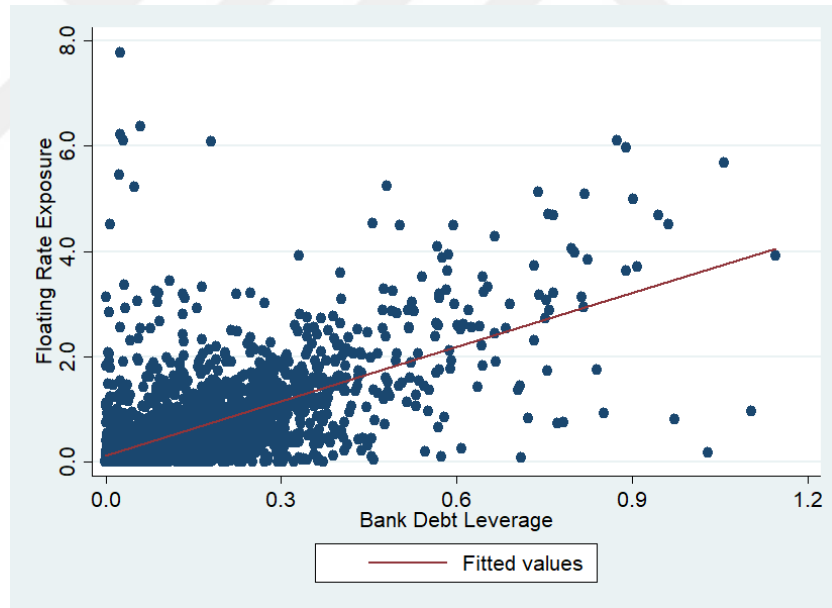


Figure 2.4: Floating Rate Exposure and Bank Debt Leverage

“Bank Debt Leverage” is the ratio of bank debts (term loans + credit lines) to total assets. “Floating rate exposure” is constructed by multiplying each floating rate debt item by its maturity and expressing the resulting sum as a fraction of total assets. The line plots the OLS fitted values.

as inputs 10-K reports from the Securities and Exchange Commission (SEC)

database (which are the original source of 10-K forms in CIQ). The reports,

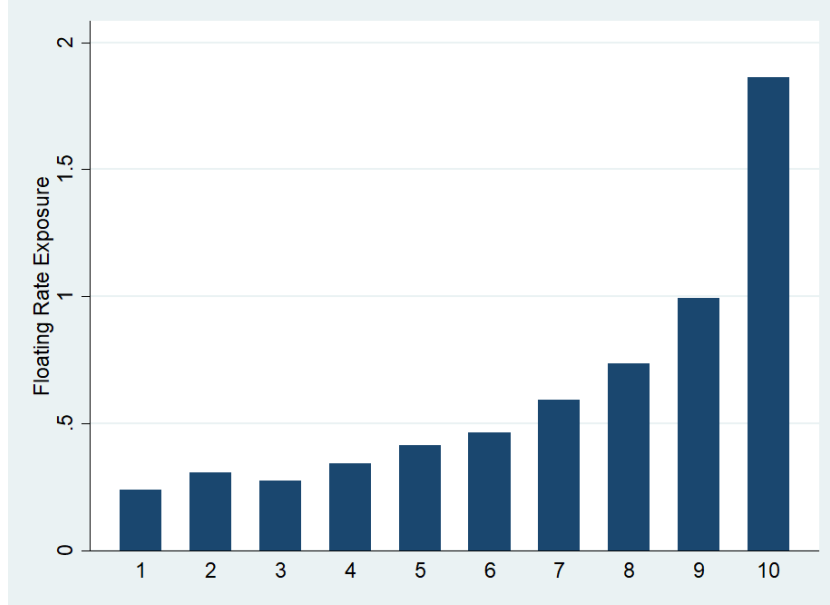


Figure 2.5: Floating Rate Exposure over Deciles of Bank Debt Leverage

The figure provides the simple average of the floating rate exposure in each decile of the bank debt leverage. “1” along the horizontal axis means between the bottom and the 1st decile, “2” means between the 1st and the 2nd decile, and so on.

which every firm regulated by the SEC is required to file at the end of its fiscal year (annual in frequency), provide textual information about the firm’s hedging decisions related to interest rate risks. We set the dummy variable for hedging to one if the following phrases are found on the report: “hedge interest rate,” “hedge against interest rate,” “interest rate swap,” or their variants.²As shall be seen later, the positive interaction effect among the path shock, the floating rate exposure, and the hedging dummy provides key evidence for the cash flow effect of monetary policy.

We merge the two-day window stock returns and the GSS factors with the firm-level variables above, taking into account the fact that the end of fiscal year differs across firms. This allows us to match the latest available balance sheet

²We also check for false positives using the following phrases: “not hedge interest rate,” “not use interest rate swap,” “not use any interest rate swap,” “not currently use interest rate swap,” “not currently use any interest rate swap,” “not use fixed to floating interest rate swap,” “termination of interest rate swap,” “not use derivative financial instruments as a hedge against interest rate,” or their variants.

information in CIQ (available at annual frequency) to the FOMC announcements rather than crudely using calendar year. Because the SEC requires 10-K forms to be released to public within 90 days following the end of a firm's fiscal year, we assume that both Compustat and CIQ variables are observed with one quarter delay. In this regard, we differ from Ippolito et al. (2017) who assume that the balance sheet variables are observed with one year lag. Table 2.1 provides the summary statistics for the firm-level variables used in our regression analysis. It shows that on average the firms which hedge against interest rate risks of their floating rate debts are not so different from those which do not, especially in terms of their floating rate leverage (in terms of bank debts as well as all floating rate debts) and exposure: our sample is well-balanced.

Table 2.1: Summary Statistics for Balance Sheet Variables

	Hedge=0		Hedge=1		Entire Sample	
	Mean	SD	Mean	SD	Mean	SD
Exposure	0.56	0.77	0.58	1.03	0.58	0.95
Bank Debt Leverage	0.12	0.13	0.13	0.14	0.13	0.14
Floating Rate Debt Leverage	0.12	0.13	0.12	0.15	0.12	0.14
Size	4.24	1.34	5.05	1.47	4.74	1.48
Book Leverage	0.34	1.60	0.53	10.65	0.46	8.42
Market-to-book Ratio	1.70	1.35	1.28	0.84	1.44	1.09
Profitability	0.04	0.03	0.03	0.02	0.03	0.03
No. Of Observations	22924					

Notes: The dummy variable Hedge = 1 for firms which engage in hedging activities against interest rate risks of their floating rate obligations. Exposure is the sum of maturity weighted floating rate debts as a fraction of total assets. Bank Debt Leverage is the ratio of total bank debts to total assets. Floating Rate Debt Leverage is the ratio of total floating rate debts to total assets. Size is the logarithm of the book value of total assets, Book Leverage is the ratio of total debts to the sum of total debts and the book value of equity, Market-to-book Ratio is the ratio of the sum of the market value of equity and total debts to total assets, and Profitability is the ratio of operating income before depreciation to total assets.

Finally, we employ the log-difference of capital and inventory investment respectively and profit over total assets as the dependent variables to analyze real effects of monetary policy in connection to floating rate exposure. They are computed

using Compustat database and available at quarterly frequency.

The summary of data construction and additional information are provided in Appendix B.

2.4 Cash Flow Effect of Monetary Policy

This section is concerned with demonstrating the cash flow effect of monetary policy. Based on our event study of the FOMC announcements, we find that (in order of increasing importance) (i) the floating rate channel of monetary policy operates through the path factor of monetary policy, not the target factor, (ii) floating rate exposure, not floating rate leverage, is an important determinant of stock market reactions to monetary policy shocks, and (iii) the negative interaction effect between the path factor and the floating rate exposure measure and the positive interaction effect among the path factor, the exposure measure, and the interest rate risk hedging dummy provide key evidence regarding the floating rate channel of monetary policy, whose essence we interpret to be the cash flow effect. We also find that the monetary policy channel documented above was not changed at the ZLB, which confirms the view that forward guidance was a dominant source of monetary policy surprises, in and out of the ZLB.

2.4.1 Empirical Design

As discussed by Gürkaynak et al. (2005), the event study methodology based on high-frequency data allows researchers to circumvent endogeneity issues related to

omitted variable bias and reverse causality. This is especially useful in the current context because there is evidence that the FOMC announcements are influenced by stock market movements (see D’Amico and Farka, 2011). To avoid this pitfall in a systematic and credible manner, we follow Gürkaynak et al. (2005) and design an event study to understand how monetary policy affects stock returns.

We build our event study of the effects of the FOMC announcements on Ippolito et al. (2017). However, our empirical design differs from theirs in two meaningful ways. First, unlike Ippolito et al. (2017) who use Kuttner’s (2001) one-dimensional measure of monetary policy shocks, we employ Gürkaynak et al. (2005) two-dimensional measures of monetary policy surprises. As explained in Section 2.3.1, this enables us to investigate not only shocks to the current monetary policy target (target factor)³, but also shocks to the future monetary policy actions (path factor). Second, whereas Ippolito et al. (2017) focus on the interaction among the target factor, the floating rate leverage, and the interest rate risk hedging dummy and find evidence in favor of their floating rate channel of monetary policy, we also consider the interaction among the path factor, the floating rate exposure, and the interest rate risk hedging dummy and obtain evidence in favor of the floating rate channel involving only these latter variables. We interpret this as capturing the cash flow effect of monetary policy. Even though our findings are different from those of Ippolito et al. (2017), our conclusions are nonetheless consistent with theirs: the floating rate channel of monetary policy exists and matters.

³As Gürkaynak et al. (2005) show, the target factor is highly correlated with the Kuttner shocks by construction (their correlation is above 95 percent). Therefore, they can be used interchangeably.

We first study 47 FOMC announcements from January 2004 to December 2008. Because we use the same sample period as Ippolito et al. (2017), our results are comparable to theirs on a consistent basis. Our regression model is

$$\begin{aligned}
\Delta p_{it} = & \beta_0 + \beta_1 target_t + \beta_2 path_t + \beta_3 hedge_{it-1} + \beta_4 leverage_{it-1} + \beta_5 exposure_{it-1} \\
& + \beta_6 target_t * hedge_{it-1} * leverage_{it-1} + \beta_7 path_t * hedge_{it-1} * leverage_{it-1} \\
& + \beta_8 target_t * hedge_{it-1} * exposure_{it-1} + \beta_9 path_t * hedge_{it-1} * exposure_{it-1} \\
& + \lambda_1 target_t * controls_{it-1} + \lambda_2 path_t * controls_{it-1} \\
& + \text{uninteracted terms and first order interaction terms} + \epsilon_{it}
\end{aligned} \tag{2.1}$$

where i is the firm subscript, t is the FOMC announcement subscript, Δp_{it} is the two-day stock return bracketing an FOMC announcement, $target_t$ is the monetary policy target surprise, $path_t$ is the monetary policy path surprise, $hedge_{it}$ is the hedging dummy whose value is equal to one if firm i hedges against interest rate risks, $leverage_{it}$ is the floating rate leverage measure (i.e., bank debt leverage), and $exposure_{it}$ is the floating rate exposure measure. $controls_{it}$ includes size, profitability, book leverage ratio, and market-to-book ratio. Section 2.3 and Appendix B provide the details of data construction. All regressors other than the monetary surprises are lagged by a quarter to avoid a potential endogeneity problem. This is why the time subscript on these variables is $t-1$. The regression is run with firm-level fixed effects, and standard errors are clustered at the event-level as in Gorodnichenko and Weber (2016). We also control for the possibility

that interest rate derivatives are purchased for speculative purposes rather than hedging motives by discarding from the sample the firms which invest in interest rate derivatives even though their floating rate leverage ratios (i.e., total floating rate debts over total assets) are below 1 percent. This decreases the number of firms to 652 in the baseline sample (from January 2004 to December 2008) and 667 in the extended sample (from January 2004 to September 2014). This is similar to Ippolito et al.'s (2017) procedure for separating out potentially speculative derivative investments from those motivated by hedging. When we also drop financial firms (because financial firms are very different from other types of firms in many characteristics), the sample sizes further drop to 550 and 562 respectively. We conduct our empirical analysis based on these samples.

2.4.2 Results

Now, we turn to our empirical results. Recall that the dependent variable in our event study is the two-day stock returns bracketing the FOMC announcements. We first analyze the pre-ZLB periods in the US (January 2004 to December 2008), then extend our analysis to include the ZLB periods (January 2004 to September 2014). We uncover the floating rate channel of monetary policy, explain its connection to the underlying cash flow effect, and demonstrate the invariance of this policy channel in and out of the ZLB.

Pre-ZLB Results

In their paper, Ippolito et al. (2017) take the positive triple interaction effect among the target factor, the floating rate leverage, and the hedging dummy as the key evidence for the floating rate channel of monetary policy: it demonstrates that the stock prices of the firms which hedge against interest rate risks of their floating rate debts fare better in response to contractionary monetary policy target surprises. The coefficient of the interaction effect is 17.78 and statistically significant at 10 percent level.⁴ Table 6 in Appendix A replicates Ippolito et al.'s (2017) study using our data, and shows that although there are some minor definitional and coverage differences, we find what they find: firms that have more floating rate debts as a fraction of their total assets are more affected by monetary policy target surprises if they do not hedge against interest rate risks of their floating rate debts. Formally, the triple interaction term under the first column has the estimated coefficient of 23.379, and it is statistically significant at 5 percent level.

We then turn to one of our main contributions. While floating rate leverage measures are a natural starting point to think about liabilities that are policy-rate sensitive, notice that this lumps together floating rate debts of different maturities together. A floating rate liability with one quarter maturity will have a much different cash flow implication than one with a five year maturity. Hence, we construct a size-weighted floating rate exposure measure by multiplying each

⁴Ippolito et al. (2017) use both floating rate debts and bank debts (as a proxy for floating rate debts) in their analyses. The results related to floating rate debts are listed under columns (5) and (6) of Table V in their paper. We consider regression specifications with floating rate debts in place of bank debts in Section 2.6 as part of robustness checks.

floating rate obligation by its maturity and expressing the resulting sum as a fraction of total assets. It is clear from Figure 2.3 that while the floating rate exposure measure, or better, future expected cash flow obligations, are positively related to bank debt leverage, these two are not the same -bank debt leverage is an imperfect proxy for future cash outflows. We therefore use our cash flow measure, but continue to control for bank debt leverage.

Table 2.2 shows the main findings of our paper. The results under column (2) can be summarized as follows: the floating rate channel of monetary policy operates through the path factor and the cash flow exposure measure. Specifically, we show that whereas a contractionary path surprise hurts the stock returns of the firms that are more exposed to floating rate debts more, hedging against interest rate risks of their floating rate debts allows them to weather the shock better. This is evidenced by the negative coefficient on the double interaction term involving the path shock and the exposure measure (-3.446, at 1 % level of statistical significance) and the positive coefficient on the triple interaction term involving the path shock, the exposure measure, and the hedging dummy (2.754 at 1 % level). In contrast to these, the double interaction between the target factor and the floating rate leverage measure and the triple interaction among the target factor, the floating rate leverage measure, and the hedging dummy, which serve as the key evidence for Ippolito et al. (2017) version of the floating rate channel of monetary policy, are not statistically significant at conventional levels, once the exposure measure and its interactions with other covariates are controlled for. Column (1) runs the regression model under column (2) without controlling for the leverage measure and its interactions with other covariates. The results

remain similar to those under column (2), adding further support to our findings.

Table 2.2: Pre-ZLB

VARIABLES	(1) Stock Return	(2) Stock Return
target	-27.586*** (6.863)	-29.543*** (8.177)
path	-9.227*** (2.730)	-9.627*** (2.429)
exposure	0.016 (0.221)	0.133 (0.274)
hedge#exposure	0.176 (0.238)	-0.273 (0.468)
target#exposure	0.118 (1.026)	6.089 (3.728)
hedge#target#exposure	-2.507* (1.335)	-10.932*** (3.466)
path#exposure	-2.029*** (0.575)	-3.446*** (0.713)
hedge#path#exposure	1.612** (0.800)	2.754*** (0.794)
leverage		0.117 (1.644)
target#leverage		-25.266 (16.803)
hedge#leverage		2.827 (2.859)
hedge#target#leverage		28.874 (21.888)
path#leverage		7.962* (4.267)
hedge#path#leverage		-6.095 (6.213)
Observations	7,581	5,627
R-squared	0.126	0.131
Firm FE	YES	YES
Firm Controls / Contr*Surp	YES	YES

Notes: The dependent variable is the two-day stock return bracketing an FOMC announcement. The sample covers 47 FOMC announcements between January 2004 and December 2008. The dummy variable hedge = 1 if a firm enters into interest rate swaps to protect against interest rate risks of their floating rate obligations. Firm-level control variables are size, book leverage, market-to-book ratio, and profitability. Regression (1) includes policy surprises (target and path factors), exposure, and their interactions with hedge and firm-level control variables. Regression (2) augments regression (1) with bank debt leverage and its interactions with policy surprises and hedge. The regression coefficients of control variables are not shown here for brevity. The numbers in the parentheses are standard errors. Both regressions are run with firm-level fixed effects, and standard errors are clustered at the event-level. Only the firms whose floating rate debts constitute more than 1 % of total assets are included to control for potentially speculative interest rate derivative investments. We also drop financial firms. 550 firms remain in the sample after these procedures. Market-to-book ratio and exposure are trimmed at the bottom and top 1%. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

We interpret the results above as the demonstration of the cash flow effects of monetary policy. Intuitively, the firms which hedge against interest rate risks of their floating rate debts fare better because the financial market participants, given their perception of tighter future monetary policy actions, (i) understand that these firms will be protected from additional interest rate expenses in the future and (ii) take this into account in evaluating the firms' future cash flows, hence their market values.

In this light, our result also indicates that the financial market participants are sophisticated in their firm value assessments. We pursue this question in Section 2.5.

Did Monetary Policy Work Differently at the ZLB?

To investigate whether the ZLB altered the cash flow effect of monetary policy, we extend our baseline sample to include the recent ZLB periods in the US. The extended sample includes 93 FOMC announcements between January 2004 and September 2014. We incorporate the ZLB periods into the regression model in equation (1) by introducing a dummy variable whose value is equal to one from January 2009 onward.⁵

Table 2.3 demonstrates that the monetary transmission mechanism we studied earlier was not interrupted during the ZLB periods: the triple interaction among the path factor, the cash flow exposure measure, and the ZLB dummy and the quadruple interaction among the three regressors and the hedging dummy are not

⁵The results in this section are robust to employing different starting points for the ZLB periods.

statistically significant at conventional levels even though the associated double (i.e., path and exposure) and triple interaction effects (i.e., path, exposure, and hedge) remain similar (quantitatively and in terms of statistical significance) to those in the previous section (in Table 2.2). Based on these results, we conclude that the cash flow effect of monetary policy was intact at the ZLB: the floating rate channel always operated through the interaction of forward guidance and cash flow exposure, in and out of the ZLB.

Marginal Effects of Monetary Policy Path Surprises

To facilitate interpretation of the cash flow effect of monetary policy, we compare the marginal effects of a 100 basis point path surprise on stock returns of various firms in the sample, which are computed based on the estimates in Table 2.3. First, we test the null hypotheses that the stock returns of firms at different percentiles of cash flow exposure are not different (in terms of differences), considering non-hedgers and hedgers separately in and out of the ZLB. Table 2.4 reports the rejection of these hypotheses in various sub-samples. Among the non-hedgers, the stock returns of highly exposed fare worse than those of lowly exposed both in and out of the ZLB, with the results being stronger both quantitatively and in terms of statistical significance outside the ZLB (at 1 percent level). For instance, the stock return of the firms whose exposure is at the 90th percentile of the exposure is lower by 4.85 percentage points relative to that at the 10th percentile. The results are reversed for the hedgers, but they are statistically significant only at the ZLB (at 10 percent level).

Table 2.3: Including ZLB

VARIABLES	Stock Return	VARIABLES	Stock Return
target	-29.990*** (7.123)	lev.	1.484 (1.274)
path	-6.124* (3.161)	hedge#lev.	1.316 (2.246)
exposure	-0.081 (0.235)	zlb#lev.	1.395 (1.912)
hedge#exposure	-0.082 (0.327)	target#lev.	-23.48 (16.548)
zlb#exposure	0.093 (0.359)	hedge#target#lev.	28.981 (20.795)
target#exposure	6.164* (3.661)	zlb#target#lev.	-17.836 (89.253)
hedge#target#exposure	-10.951*** (3.445)	hedge#zlb#lev.	-4.768 (3.181)
zlb#target#exposure	-7.896 (14.923)	hedge#zlb#target#lev.	86.156 (133.387)
hedge#zlb#exposure	0.021 (0.494)	path#lev.	7.690** (3.819)
hedge#zlb#target#exposure	17.655 (22.349)	hedge#path#lev.	-5.411 (6.024)
path#exposure	-3.416*** (0.708)	zlb#path#lev.	-6.324 (6.361)
hedge#path#exposure	2.795*** (0.773)	hedge#zlb#path#lev.	20.847** (9.008)
zlb#path#exposure	1.525 (1.254)		
hedge#zlb#path#exposure	1.862 (1.418)		
Observations	15,494		
R-squared	0.092		
Firm FE	YES		
Firm Controls /Contr*Surp	YES		

Notes: The dependent variable is the two-day stock return bracketing an FOMC announcement. The sample covers 93 FOMC announcements between January 2004 and September 2014, which includes the zero lower bound periods. These are incorporated into the regression models using a dummy variable (denoted by “zlb” in the table, where zlb = 1 from 2009 onward). All other conventions are identical to those in Table 2.1. We use abbreviation “lev” for leverage. 562 firms remain in the sample after controlling for potentially speculative derivative investments and dropping financial firms. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 2.5 tests different null hypotheses that the stock returns of hedgers and non-hedgers are not different (in terms of differences), considering different percentiles of cash flow exposure in and out of the ZLB. It shows that the positive effect of hedging shows up among highly exposed firms as expected, with the effect being stronger at the ZLB. Outside the ZLB, the stock return of the hedgers at the 99th percentile of the exposure is 7.30 percentage points higher than that of the non-hedgers.

The results above suggest that the cash flow effect of monetary policy is economically meaningful.

Table 2.4: Differences between High and Low Exposure Firms (in Percentage Points)

	Within non-hedgers		Within hedgers	
	ZLB = 0	ZLB = 1	ZLB = 0	ZLB = 1
p.90 vs. p.10	-4.85***	-2.68*	0.55	3.36*
p.66 vs. p.33	-1.41***	-0.78*	0.16	1.00*

Notes: Based on regression in Table 2.3, we test the null hypothesis that the effects of a 100 basis point path surprise on stock returns do not differ across different levels of exposure (equality restriction of the form $A=B$, where A and B are the stock returns of high and low exposure firms respectively) within the group of non-hedgers and hedgers, in and out of the zero lower bound period. In the first row, high and low exposure levels correspond to the 90th percentile and the 10th percentile respectively. The second row tests the difference between the 66th and 33th percentiles of exposure. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

2.5 Sophistication or Rules of Thumb?

An interesting question is whether financial market participants study the balance sheets of the firms and, understanding the effect of monetary policy path surprises on the cash flows, price stocks accordingly, or given how persistent cash flow exposure is, learn rules of thumb such that certain firms fare better or

Table 2.5: Differences between Hedgers and Non-Hedgers (in Percentage Points)

	ZLB = 0	ZLB = 1
p.10	-1.43*	-1.59
p.33	-0.96	-0.8
p.50	-0.47	0
p.66	0.19	1.12
p.90	2.53*	5.02***
p.99	7.30***	12.96***

Notes: Based on regression in Table 2.3, we test the null hypothesis that the effects of a 100 basis point path surprise on stock returns do not differ across hedgers and non-hedgers at the same level of exposure (equality restriction of the form $A=B$, where A and B are the stock returns of hedgers and non-hedgers respectively), in and out of the zero lower bound. First column gives exposure levels in terms of percentiles. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

worse as interest rates begin to decrease or increase. We show that the marginal stock market investor is quite sophisticated in that the repricing of stocks in high frequency is not based on rules of thumb but on knowledge of balance sheet conditions and understanding their interactions with monetary policy.

We conduct two related tests of stock market sophistication, in the context of the pooled sample (from January 2004 to September 2014) in light of the result in Section 2.4.2 that the floating rate channel of monetary policy did not change at the ZLB. First, we investigate whether stock market participants use rules of thumb where the firms experiencing large changes in their cash flow exposure are regarded differently when repricing stocks following monetary policy surprises. To do so, we compute one quarter changes in cash flow exposure measures and create separate dummy variables for large positive and negative changes. The thresholds for large changes are set at top 20 percent of positive changes and top 20 percent of (absolute values of) negative changes in the whole sample respectively. We then interact these dummy variables with the regressors in equation (1). Table 2.6

provides the results. Column (1) shows that all variables interacted with these dummy variables, in particular the triple interaction terms involving the path factor, the cash flow exposure measure, and the large change dummies, are not statistically significant at conventional levels. Column (2), where the large change dummies are based on changes in exposure one quarter earlier (effectively, two quarters before the corresponding FOMC announcement), gives the same results. In both cases, the negative interaction effect between the path factor and the exposure measure is significant both economically and statistically (at 1 percent level).

Second, we check whether stock market participants treat the firms that are new in the stock market differently from the rest when repricing stocks in high frequency. We construct a dummy variable for Initial Public Offering (IPO) whose value is equal to one if a firm is within the first two years of IPO. Then, the IPO dummy is interacted with the aforementioned regressors to test our hypothesis. Column (3) of Table 2.6, which provides the results, suggests that stock market participants do not consider the new firms to be peculiar, as the terms interacted with the IPO dummy are not statistically significant at conventional levels. However, the negative interaction effect between the path factor and the exposure measure is economically and statistically significant (at 1 percent level). These results continue to hold when the firms within the first two years of IPO are more finely categorized (e.g., within the first quarter of IPO, within the second quarter of IPO, so on) (not shown here for brevity).

The two tests of stock market sophistication and their variants indicate that

repricing of stocks in high frequency in response to a monetary policy path surprise is based on reading of the firms' balance sheet conditions and understanding how they interact with monetary policy, and not using rules of thumb based on certain firm characteristics: stock market participants, at least in aggregate, are quite sophisticated.

2.6 Robustness

In this section, we consider an alternative measure of floating rate leverage and additional asset - pricing determinants, both one at a time and jointly, to test the robustness of the cash flow effect of monetary policy. We show that the results in Section 2.4, which demonstrate that the repricing of stocks in high frequency hinges on the interaction between monetary policy path surprises and exposures to future cash flow obligations, are robust to these considerations, in and out of the ZLB.

We examine the following changes to the baseline regression model in equation (1): (i) augmenting the model with the three Fama-French factors (i.e., market risk, small minus big, and high minus low) (Fama and French, 1992 and 1995) and their interactions with path factor, (ii) replacing bank debt leverage (i.e., bank debts over total assets) with floating rate debt leverage (i.e., total floating rate debts over total assets) as an alternative measure of floating rate leverage, and (iii) implementing (i) and (ii) jointly. The results are provided under columns (1) to (3) of Table 2.7 respectively. They show that the key evidence for the cash flow effect of monetary policy in Section 2.4.2, which consists of the negative double

Table 2.6: Stock Market Sophistication

	(1)	(2)	(3)
	(Dummy Large Changes)	(Dummy Large Changes Lagged)	(Dummy for Initial 8 Quarters)
VARIABLES	Stock Return	Stock Return	Stock Return
target	-30.314*** (7.045)	-30.062*** (7.211)	-30.130*** (6.953)
path	-5.879* (3.347)	-5.736 (4.170)	-5.840* (3.374)
path#exposure	-2.938*** (0.714)	-2.840*** (0.735)	-2.838*** (0.693)
hedge#path#exposure	2.979*** (0.660)	3.264*** (0.692)	3.033*** (0.655)
positive dummy	1.715* (0.974)	0.427 (0.783)	
positive dummy#path	2.731 (9.802)	-9.538 (14.232)	
positive dummy#exposure	-0.600 (0.454)	0.211 (0.467)	
positive dummy#path#exposure	1.804 (4.170)	2.791 (6.807)	
negative dummy	0.162 (0.527)	0.532 (0.547)	
negative dummy#path	4.850** (2.312)	-0.793 (4.696)	
negative dummy#exposure	0.281 (0.308)	0.078 (0.339)	
negative dummy#path#exposure	1.760 (1.882)	0.584 (5.054)	
IPO dummy			-1.500* (0.858)
IPO dummy#path			-6.321 (4.320)
IPO dummy#exposure			0.826 (0.818)
IPO dummy#path#exposure			3.840 (3.305)
Observations	15,494	15,387	15,494
R-squared	0.087	0.086	0.086

Notes: The sample period ranges from 2004 to 2014. The zero lower bound dummy is not included here, given the result that the transmission mechanism of monetary policy has not changed in and out of the zero lower bound. The dependent variable is the two-day stock return bracketing an FOMC announcement. “Positive dummy” corresponds to the observations that belong to top 20 percent of positive changes in exposure in the sample. Similarly, “Negative dummy” stands for the observations that belong to top 20 percent of (absolute values of) negative changes in exposure. “IPO dummy” indicates that firms are within the first two years of IPO. Regressions (1) to (3) use these dummy variables respectively, with (2) differing from (1) in the dummies being based on the changes in exposure in $t-2$ (i.e., two quarters before). For (3), similar results follow when firms within the first two years of IPO are more finely categorized (e.g., within the first quarter of IPO, within the second quarter of IPO, so on). Other conventions are identical to those in the tables above.

interaction between the path factor and the cash flow exposure measure and the positive triple interaction among the path factor, the exposure measure, and the interest rate risk hedging dummy, remains intact under the changes above. When we extend the analysis to include the ZLB periods, the same results follow, which also indicate the floating rate channel of monetary policy did not change at the ZLB. These results are given in Table 2.8.

We also conduct a falsification or placebo test to ascertain that the results in Section 2.4 are not due to chance but driven by the genuine existence of the cash flow effect of monetary policy. Again, we use the regression model in equation (2.1) for this. The dependent variable in the placebo test is the two-day stock return one week before an FOMC announcement, which should not react to monetary policy surprises if our results above were indeed capturing the cash flow effect as we understand it. We employ both bank debt leverage and floating rate debt leverage as floating rate leverage measure, and also consider both pre-ZLB and extended sample including the ZLB periods for analysis. Table 2.9 (with each column corresponding to different permutations of alternative floating rate leverage measure and sample) shows that our event study passes the placebo test, as no covariate, especially the double interaction between the path factor and the exposure measure and the triple interaction among the path factor, the exposure measure, and the hedging dummy, is statistically significant at conventionally accepted levels.

Based on the results above, we conclude that the cash flow effect of monetary policy, which we uncovered and analyzed in the preceding sections, is empirically

robust.

Table 2.7: Robustness in Pre-ZLB

	(1) (Bank Debt Leverage + Fama-French Factors) Stock Return	(2) (Floating Rate Debt Leverage) Stock Return	(3) (Floating Rate Debt Lev.+Fama-French) Stock Return
VARIABLES			
target	-29.565*** (10.355)	-26.747*** (6.778)	-26.940*** (9.105)
path	-7.652*** (2.185)	-9.630*** (2.643)	-7.812*** (2.383)
exposure	0.204 (0.261)	0.088 (0.210)	0.149 (0.202)
hedge#exposure	-0.338 (0.460)	-0.084 (0.404)	-0.123 (0.411)
target#exposure	5.123 (4.090)	1.136 (2.773)	0.756 (2.697)
hedge#target#exposure	-9.712** (3.795)	-2.366 (3.155)	-1.928 (3.112)
path#exposure	-2.796*** (0.905)	-3.243*** (0.591)	-3.024*** (0.491)
hedge#path#exposure	2.188** (0.966)	3.691*** (0.787)	3.572*** (0.751)
leverage	-0.345 (1.672)	-0.631 (1.864)	-0.941 (1.782)
hedge#leverage	3.129 (2.901)	1.771 (2.299)	1.848 (2.298)
target#leverage	-26.006 (16.605)	-6.874 (17.319)	-9.009 (17.974)
hedge#target#leverage	27.588 (20.903)	-0.258 (21.944)	1.402 (21.612)
path#leverage	7.693* (4.071)	8.486** (3.824)	10.205*** (3.740)
hedge#path#leverage	-4.219 (5.850)	-13.485** (5.385)	-14.030** (5.250)
Observations	5,627	7,581	7,581
R-squared	0.212	0.127	0.209

Notes: Table 2.7 provides robustness checks for regression (2) in Table 2.2. The dependent variable is the two-day stock return bracketing an FOMC announcement. (1) adds the Fama-French factors and their interaction terms to regression (2) in Table 2.2. (2) here has the same specification as (2) in Table 2.2 except for bank debt leverage being replaced by floating rate debt leverage. (3) adds the Fama-French factors and their interactions to (2). These models are estimated using the baseline sample (January 2004 to December 2008). Other conventions are identical to those in the tables above. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 2.8: Robustness including ZLB

	(1) (Bank Debt Leverage + Fama-French Factors) Stock Return	(2) (Floating Rate Debt Leverage) Stock Return	(3) (Floating Rate Debt Lev.+Fama- French) Stock Return
target	-32.638*** (9.508)	-27.315*** (6.113)	-30.067*** (8.471)
path	-4.442 (2.846)	-6.307** (2.928)	-4.624* (2.687)
exposure	-0.093 (0.226)	0.027 (0.198)	0.005 (0.183)
hedge#exposure	-0.115 (0.336)	-0.304 (0.318)	-0.292 (0.312)
zlb#exposure	0.057 (0.350)	0.189 (0.422)	0.206 (0.397)
target#exposure	5.446 (3.925)	1.070 (2.505)	0.850 (2.379)
hedge#target#exposure	-9.953*** (3.691)	-2.228 (2.910)	-1.853 (2.772)
zlb#target#exposure	-4.517 (14.655)	-10.749 (19.914)	-6.424 (18.437)
hedge#zlb#target#exposure	14.088 (24.060)	14.838 (22.484)	11.320 (24.071)
hedge#path	-1.101 (1.010)	-0.145 (0.723)	-0.210 (0.698)
path#exposure	-2.811*** (0.775)	-3.064*** (0.616)	-2.837*** (0.480)
hedge#path#exposure	2.186** (0.840)	3.712*** (0.760)	3.579*** (0.682)
zlb#path#exposure	0.671 (1.231)	0.277 (1.297)	0.071 (1.158)
hedge#zlb#path#exposure	2.241 (1.467)	-1.228 (1.867)	-0.632 (1.821)
leverage	1.198 (1.240)	0.440 (1.371)	0.283 (1.350)
hedge#leverage	1.604 (2.230)	2.297 (2.108)	2.234 (2.051)
zlb#leverage	1.509 (1.828)	0.545 (2.393)	0.278 (2.320)
target#leverage	-26.012 (15.942)	-3.726 (15.972)	-6.810 (16.297)
hedge#target#leverage	28.824 (19.362)	-2.171 (20.177)	-0.331 (19.826)
zlb#target#leverage	-29.127 (82.616)	20.947 (101.939)	-0.765 (98.329)
hedge#zlb#target#leverage	104.413 (141.564)	43.188 (123.406)	58.464 (131.495)
path#leverage	6.136* (3.607)	7.847** (3.717)	8.480** (3.715)
hedge#path#leverage	-2.809 (5.458)	-12.703** (5.297)	-12.762** (5.197)
zlb#path#leverage	-5.469 (6.098)	-0.486 (6.645)	-1.601 (6.478)
hedge#zlb#path#leverage	15.766* (8.795)	33.010*** (11.324)	27.662** (11.517)
Observations	15,494	18,550	18,550
R-squared	0.195	0.088	0.190

Notes: Table 2.8 provides robustness checks for regression in Table 2.3. The dependent variable is the two-day stock return bracketing an FOMC announcement. These models are estimated based on the extended sample (January 2004 to September 2014) that includes the zero lower bound periods (incorporated into the regression models above with the dummy variable “zlb”). Other conventions are identical to those in Table 2.8. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 2.9: Placebo Tests

	(1) (Contol Bank Debt Leverage)	(2) (Control Floating Rate Debt Leverage)	(3) (Contol Bank Debt Leverage)	(4) (Control Floating Rate Debt Leverage)
VARIABLES	Stock Return	Stock Return	Stock Return	Stock Return
target	0.627 (11.651)	3.255 (10.748)	-3.903 (10.425)	0.195 (9.808)
path	0.799 (5.319)	1.702 (5.745)	4.975 (5.014)	4.452 (5.064)
path#exposure	-0.064 (1.002)	-0.226 (1.031)	-0.319 (1.042)	-0.586 (1.077)
hedge#path#exposure	1.016 (0.984)	1.193 (0.987)	1.632 (1.116)	1.548 (1.047)
zlb#path#exposure			1.513 (1.275)	2.571 (2.972)
hedge#zlb#path#exposure			-1.410 (1.411)	-4.520 (2.828)
Observations	5,628	7,582	15,496	18,552
R-squared	0.095	0.087	0.042	0.045

Notes: The dependent variable is the two-day stock return one week before an FOMC announcement. Regressions (1) and (2) use the regression specification (2) in Table 2.2. Regressions (3) and (4) use the regression specification in Table 2.3 which includes the zero lower bound dummy variable and its interactions with policy surprises, exposure, and leverage.

2.7 Balance Sheet Regressions

Does monetary policy, through its interaction with cash flow exposure, have real effects on firms? After all, we care about the cash flow effect because of its repercussion on real outcomes. This, as explained in the introduction, is also a test of the failure of the Modigliani-Miller theorem where cash in the firm is more valuable than cash outside the firm, with well-known implications on real firm behaviors such as capital investment, as exemplified by the financial accelerator mechanism of Kiyotaki and Moore (1997) and Bernanke et al. (1999). In this section, we show that the firms that have issued more floating rate debts fare worse in real outcomes such as capital and inventory investments and profits in the quarters following monetary policy changes. To make our results comparable

to those of Ippolito et al. (2017), we adopt their regression model specifications for balance sheet regressions as closely as possible.

We start our analysis with capital investment. Capital, which is a stock variable, is defined as the sum of property, plant, and equipment. The dependent variable is the log-difference of capital between $t+x$ and $t-1$, where t is the reference quarter and $x = 1, 2, \dots, 8$. The top half of Table 2.10 shows that the sum of all changes in the federal funds rate during the reference quarter (denoted by “change”), through interaction with cash flow exposure, leads to delayed downward adjustments in capital starting from $t+6$ (6 quarters out from the reference quarter) onward: the coefficients on the double interaction terms are -0.031 (5% level of statistical significance), -0.060 (1% level), and -0.081 (1% level) for $t+6$, $t+7$, and $t+8$ respectively. The bottom half of Table 2.10, on the other hand, suggests that the double interaction terms involving the cumulative interest rate changes and bank debt leverage are not statistically significant at conventional levels, at all horizons. This explains why Ippolito et al. (2017) did not find significant results for the sub-sample of firms (financially “unconstrained” in their language) whose characteristics match our sample (which consists of S&P500 firms): it is floating rate exposure, not floating rate leverage, through which the floating rate channel of monetary policy affects capital investment. The economic significance of the results above are as follows: one standard deviation increase in the exposure measure (0.83) in $t-1$, given one percentage point increase in the policy rate change in the reference quarter t , decreases capital investment by 2.57%, 4.98%, and 6.72% relative to t in $t+6$, $t+7$, and $t+8$ respectively.

Table 2.11 indicates similar results for inventory investment, which is also defined as the log-difference relative to the reference quarter, with three notable differences: (i) the statistically significant reduction comes about sooner, from $t+2$ onward to be precise, with larger effects (in terms of percents) at all horizons and (ii) the peak effect occurs in $t+5$, with the inventory investment decreasing by 11.95 % relative to the reference quarter in response to one standard deviation increase in the exposure measure and one percentage point increase in the policy rate, and (iii) hedging against interest rate risks works well, with its effect being large and statistically significant at all horizons considered. Again, the bottom half of the table affirms that it is floating rate exposure, not floating rate leverage, that matters for the floating rate channel analyzed here. The behaviors of capital and inventory investments documented above, for instance the delayed adjustment of the former but the immediate reaction of the latter, accord well with our understanding of the financial accelerators and business cycles. Tables 7 and 8 in Appendix A provide the balance sheet regressions for cash holding and coverage ratio in the interest of completeness.

Finally, we examine the cash flow effect of monetary policy on the profit, which is measured by sales minus cost of goods sold and interest rate expenses and expressed as a fraction of total assets. Table 2.12 shows that the effect is immediate, starting from $t+1$, and remains statistically significant at conventional levels until $t+6$. This, like the two balance sheet regressions above, verifies the floating rate channel of monetary policy, where a change in the policy rate in the reference quarter leads to changes in the firm's future cash flows because the former induces changes in interest rate expenses associated with the firm's floating rate

obligations. These are consequently reflected in the profit sequence, as shown in the table. The economic significance of the cash flow effect, based on the same scenario as above, is as follows: the profits relative to total assets decline by 0.91 %, 0.81 %, 0.80 %, 0.93 %, 0.84 %, and 0.50 % from $t+1$ to $t+6$ respectively in response to one standard deviation increase in the exposure measure and one percentage point increase in the interest rate. Moreover, hedging against interest rate risks of floating rate obligations is effective, which largely offsets the baseline effect as shown in the table.

Our balance sheet regressions, as explained above, are tests of the Modigliani-Miller theorem. We find economically and statistically significant evidence pointing to its rejection, which first show up the profits and the inventory investments, and eventually in the capital investments. This clearly demonstrates the real effects of the cash flow channel of monetary policy. The results in Section 2.5 suggest that stock market participants understand this, and take it into account in repricing stocks in high frequency in reaction to monetary policy path surprises based on their knowledge of firm-level balance sheet conditions.

Table 2.10: Balance Sheet Regressions: Capital Investment

Exposure	(t+1) Capital Inv.	(t+2) Capital Inv.	(t+3) Capital Inv.	(t+4) Capital Inv.	(t+5) Capital Inv.	(t+6) Capital Inv.	(t+7) Capital Inv.	(t+8) Capital Inv.
exposure	-0.007 (0.005)	-0.017** (0.008)	-0.029*** (0.010)	-0.046*** (0.012)	-0.068*** (0.016)	-0.088*** (0.017)	-0.113*** (0.018)	-0.133*** (0.021)
change#exposure	0.007 (0.007)	0.002 (0.010)	-0.003 (0.012)	-0.008 (0.014)	-0.014 (0.015)	-0.031** (0.015)	-0.060*** (0.019)	-0.081*** (0.022)
hedge#exposure	0.005 (0.005)	0.014* (0.007)	0.027*** (0.010)	0.048*** (0.012)	0.067*** (0.016)	0.084*** (0.017)	0.105*** (0.017)	0.117*** (0.021)
hedge#change#exposure	-0.003 (0.008)	-0.002 (0.010)	0.000 (0.013)	-0.024 (0.019)	-0.019 (0.020)	-0.006 (0.020)	0.021 (0.022)	0.050* (0.026)
zlb#change#exposure	0.107 (0.166)	0.088 (0.195)	-0.040 (0.201)	-0.007 (0.197)	0.001 (0.203)	-0.013 (0.209)	-0.041 (0.220)	-0.004 (0.228)
hedge#zlb#change#exposure	-0.064 (0.178)	-0.061 (0.209)	-0.006 (0.224)	-0.042 (0.220)	-0.043 (0.232)	0.038 (0.239)	0.095 (0.254)	0.071 (0.261)
R-squared	0.336	0.397	0.438	0.477	0.515	0.542	0.564	0.594
Leverage								
leverage	0.027 (0.027)	-0.001 (0.035)	-0.016 (0.046)	-0.074 (0.056)	-0.152** (0.073)	-0.230*** (0.082)	-0.341*** (0.091)	-0.414*** (0.108)
change#leverage	0.053 (0.032)	0.055 (0.042)	0.090 (0.060)	0.114 (0.069)	0.125 (0.079)	0.077 (0.087)	0.007 (0.103)	-0.043 (0.117)
hedge#leverage	-0.024 (0.027)	0.009 (0.036)	0.046 (0.046)	0.087 (0.055)	0.141** (0.068)	0.202*** (0.078)	0.297*** (0.080)	0.345*** (0.096)
hedge#change#leverage	-0.040 (0.038)	-0.066 (0.047)	-0.108* (0.065)	-0.160** (0.075)	-0.187** (0.083)	-0.170* (0.094)	-0.098 (0.107)	-0.029 (0.120)
zlb#change#leverage	0.022 (0.626)	0.552 (0.767)	-0.747 (0.904)	0.219 (0.932)	0.438 (1.084)	0.367 (1.056)	-0.125 (1.063)	0.237 (1.100)
hedge#zlb#change#leverage	0.055 (0.613)	-0.509 (0.839)	0.384 (1.030)	-0.800 (1.115)	-1.029 (1.214)	-0.924 (1.273)	-0.104 (1.298)	-0.297 (1.422)
Observations	5,902	5,881	5,690	5,505	5,327	5,128	4,942	4,753
R-squared	0.336	0.397	0.437	0.474	0.511	0.538	0.559	0.588

Table 2.11: Balance Sheet Regressions: Inventory Investment

VARIABLES	(t+1) Inventory	(t+2) Inventory	(t+3) Inventory	(t+4) Inventory	(t+5) Inventory	(t+6) Inventory	(t+7) Inventory	(t+8) Inventory
exposure	-0.023 (0.020)	-0.057** (0.027)	-0.035 (0.027)	-0.026 (0.036)	-0.049 (0.034)	-0.040 (0.032)	-0.034 (0.038)	-0.018 (0.038)
change#exposure	-0.043 (0.029)	-0.069** (0.029)	-0.098*** (0.030)	-0.110*** (0.035)	-0.144*** (0.036)	-0.107** (0.042)	-0.127*** (0.046)	-0.109** (0.045)
hedge#exposure	0.017 (0.021)	0.047 (0.029)	0.019 (0.028)	0.017 (0.037)	0.043 (0.035)	0.047 (0.034)	0.046 (0.039)	0.026 (0.039)
hedge#change#exposure	0.055* (0.031)	0.081** (0.035)	0.109*** (0.036)	0.112** (0.044)	0.151*** (0.046)	0.103** (0.051)	0.113** (0.053)	0.104** (0.051)
zlb#change#exposure	0.250 (0.291)	-0.045 (0.368)	-0.101 (0.507)	0.011 (0.503)	-0.244 (0.611)	-0.363 (0.537)	-0.173 (0.566)	-0.234 (0.574)
hedge#zlb#change#exposure	-0.541 (0.391)	0.456 (0.386)	0.490 (0.504)	0.129 (0.569)	0.556 (0.677)	1.367** (0.627)	1.149 (0.822)	1.181 (0.786)
R-squared	0.295	0.445	0.382	0.410	0.426	0.524	0.525	0.532
Leverage								
leverage	-0.075 (0.080)	-0.143 (0.109)	-0.140 (0.120)	-0.161 (0.130)	-0.188 (0.131)	-0.184 (0.123)	-0.198 (0.136)	-0.194 (0.140)
change#leverage	-0.218* (0.117)	-0.173 (0.136)	-0.223 (0.181)	-0.191 (0.194)	-0.199 (0.220)	-0.004 (0.219)	-0.086 (0.179)	-0.140 (0.169)
hedge#leverage	0.106 (0.085)	0.161 (0.120)	0.134 (0.132)	0.186 (0.146)	0.219 (0.145)	0.231 (0.143)	0.225 (0.149)	0.211 (0.156)
hedge#change#leverage	0.172 (0.127)	0.088 (0.157)	0.091 (0.196)	0.043 (0.219)	0.067 (0.248)	-0.127 (0.248)	-0.095 (0.213)	-0.026 (0.206)
zlb#change#leverage	1.743 (1.773)	0.034 (2.668)	1.566 (2.500)	1.039 (2.654)	0.961 (2.137)	1.408 (1.514)	1.069 (1.700)	-0.555 (2.312)
hedge#zlb#change#leverage	-2.543 (2.375)	3.333 (3.081)	0.393 (3.140)	-1.480 (3.579)	-4.805 (3.446)	-1.234 (2.820)	0.458 (3.073)	2.167 (3.605)
Observations	2,772	2,775	2,688	2,589	2,492	2,422	2,314	2,215
R-squared	0.295	0.445	0.381	0.410	0.426	0.524	0.524	0.533

Table 2.12: Balance Sheet Regressions: Profits over Total Assets

VARIABLES	(t+1) Profit	(t+2) Profit	(t+3) Profit	(t+4) Profit	(t+5) Profit	(t+6) Profit	(t+7) Profit	(t+8) Profit
exposure	-0.794** (0.392)	-0.689* (0.374)	-0.478 (0.359)	-0.596* (0.357)	-0.417 (0.343)	-0.298 (0.338)	-0.237 (0.279)	-0.323 (0.238)
change#exposure	-1.091*** (0.412)	-0.975** (0.421)	-0.969** (0.407)	-1.116*** (0.399)	-1.018*** (0.371)	-0.603* (0.331)	-0.392 (0.286)	-0.282 (0.226)
hedge#exposure	0.753** (0.382)	0.633* (0.364)	0.409 (0.348)	0.482 (0.346)	0.298 (0.333)	0.189 (0.330)	0.121 (0.271)	0.220 (0.235)
hedge#change#exposure	1.101*** (0.424)	0.969** (0.432)	0.960** (0.421)	1.152*** (0.411)	1.027*** (0.380)	0.705** (0.337)	0.500* (0.297)	0.447* (0.240)
zlb#change#exposure	0.001 (2.028)	3.048 (1.928)	4.983** (2.500)	-0.351 (1.899)	-0.731 (1.870)	0.110 (1.948)	0.481 (1.750)	-2.838 (1.798)
hedge#zlb#change#exposure	0.622 (2.292)	-4.923** (2.192)	-6.170** (2.873)	-1.219 (2.141)	0.803 (2.070)	-0.202 (2.222)	-0.003 (2.289)	1.644 (2.142)
Observations	6,355	6,312	6,113	5,901	5,693	5,482	5,279	5,061
R-squared	0.892	0.891	0.895	0.891	0.892	0.892	0.892	0.892

Notes: Tables 2.10 and 2.11 examine how monetary policy affects capital and inventory investment respectively through interaction with exposure (top halves of the tables) and bank debt leverage (bottom halves of the tables) for the sample period between January 2004 and September 2014. The zero lower bound periods are incorporated into the regression models using the dummy variable “zlb” as above. “change” is the sum of all changes in the federal funds rate during the reference quarter as in Ippolito et al. (2017). The dependent variables are the change in capital investment (in Table 2.10) and the change in inventory investment (in Table 2.11). “t+x” corresponds to $\ln(y_{t+x}) - \ln(y_{t-1})$ where y is either capital investment or inventory investment, t is the reference quarter, and x = 1, 2, ..., 8. Capital investment is measured by log of total fixed capital (property, plant, and equipment). The dependent variables are trimmed at the bottom and top 1 % to control for outliers. The results without trimming are similar. For the capital investment regressions, we control for book leverage, size, market-to-book ratio, profitability, short-term debt, cash flow, and lagged investment, which are also interacted with change. For the inventory investment regressions, we control for book leverage, size, market-to-book ratio, profitability, and short-term debt. In both regressions, we also include firm and year-quarter fixed effects, and cluster standard errors at the industry-quarter level. Other conventions are identical to those in the tables above. The economic significance of the results above are as follows. One standard deviation increase in exposure (0.83) in t-1, given one percentage point increase in the federal funds rate in t, decreases capital investment by 2.57 %, 4.98 %, and 6.72 % in t+6, t+7, and t+8 respectively. For inventory investment, the effect comes sooner and larger with 5.73 %, 8.13 %, and 9.13 % reductions in t+2, t+3, and t+4 respectively followed by 11.95 % reduction in t+5 at the peak. This is followed by 8.88 %, 10.54 %, and 9.05 % reductions in t+6, t+7, and t+8 respectively.

Table 2.12 analyzes how monetary policy affects profits through interaction with exposure. The dependent variable is the ratio of profits to total assets, which is computed by dividing sales minus cost of goods sold and interest rate expenses by total assets. It is multiplied by 100 to facilitate interpretation. We also control for book leverage, size, market-to-book ratio, profitability, and cash flow. Other conventions are identical to those for the investment regressions in Tables 2.10 and 2.11. Some calculations on the economic significance: one standard deviation increase in exposure (0.83) in t-1, given one percentage point increase in the federal funds rate in t, decreases profit relative to total assets by 0.91 %, 0.81 %, 0.80 %, 0.93 %, 0.84 %, and 0.50 % from t+1 to t+6 respectively.

The numbers in the parentheses are standard errors. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

2.8 Conclusion

Cash flow matters. Stock market participants are convinced that firms that have higher unhedged floating rate obligations will fare worse in an increasing interest rate environment, and better in a decreasing one. And they are right, both because of the mechanical effect of higher interest rates redistributing firm income from dividends to interest payments, and because as future cash flow obligations increase, firm investment also decreases. That is, higher interest payments lead to higher cash outflows, and firms cannot costlessly substitute external financing for internal funds. This is a clear financial accelerator channel that is intimately linked to monetary policy as firms' new debt payments depend on interest rates, as well as the payments of their previously issued floating debts.

We find that looking at the maturity structure of floating rate debt obligations is important in understanding the interaction between monetary policy decisions and the cash flow channel. Bank debt and floating rate debt leverage do not sufficiently capture the cash flow obligations and how these change in response to monetary policy surprises as these measures are based on the principal value, rather than the commitments for future payments, which depend on maturity as well as the principal value. This distinction becomes especially important when studying the zero lower bound period as leverage and future cash flow obligations behaved differently in this period.

We also show that the choice of monetary policy surprise measure matters. The path, or forward guidance, component of monetary policy is the surprise about future path of interest rates. It is natural that this is the component that has a

sizable bearing on future cash flow obligations due to floating rate debts, and is therefore the component that stock market participants pay attention to when updating their beliefs about firms' cash flows and reassessing stock prices according to new information. This distinction is important for aggregate stock index changes in response to monetary policy, as well as for individual firms' stock price changes, both before and after the zero lower bound.

The main test in this paper, showing that in high frequency stock prices respond to monetary policy surprises in an understandable way that depends on firms' balance sheets, is the joint test of the existence of such an effect and market participants' ability to price it in shortly after a policy announcement. Finding the effect naturally leads to the question of whether market participants actually pay attention to firm balance sheets and understand how they interact with monetary policy, or follow rules of thumb as floating rate exposure is quite persistent. We show that even for firms that have just joined the stock market or firms that have had sizable changes in cash flow exposure in the previous quarter, their stocks are not priced differently, leading us to conclude that market participants indeed pay attention to balance sheets and differentiate firms by their liabilities when repricing stocks due to monetary policy surprises.

Lastly, we show that cash flow exposure has real effects. More exposed firms - those that have more unhedged long maturity floating rate debts- see their investment, inventory, and profits change more in quarters following monetary policy changes. This is very strong evidence in favor of a financial friction where cash in the firm is more valuable than cash outside it. There is indeed an external

finance premium, and unhedged floating rate exposure triggers it.

Our event study, which uncovers the cash flow channel of monetary policy, provides a small glimpse of what lies behind Bernanke and Gertler's (1995) "black box". It suggests that monetary policy should take the ensuing cash flow effect seriously to achieve economic and financial stability, at least over the business cycle frequencies where it *really* matters.



CHAPTER 3

ROBUSTNESS CHECKS TO THE CASH FLOW EFFECT

3.1 Introduction

In this chapter, I present additional analyses and robustness checks related to the findings in the previous chapter. The robustness checks are concerned with the stock market reaction to monetary policy at the level of individual firms' equity prices, which extends the analysis in Section 2.3.2.

The first robustness check is about the firm sample. I extend our sample to include medium-sized firms as well. Next, I present our main specifications with one-day window stock returns, instead of two-day window employed in Chapter 2. Then, I explore different statistical treatments to refine the data in our main sample, such as winsorizing or dropping utilities sector. Fourth, I show evidence on the floating rate channel using alternative controls such as floating rate to fixed rate debt ratio, floating rate debt to total debt ratio, and long term floating rate to total debt ratio instead of bank debt leverage and floating rate debt leverage

used in the second chapter. Fifth, I run similar regressions with time fixed effects. Finally, I show further evidence on the effectiveness of the floating rate channel in the zero lower bound (ZLB) period.

3.2 Different Sample Selections

In addition to Standard & Poor's (S&P) 500 Index, which measures the performance of large companies, in this section I extend the analysis to medium-sized and small firms. Specifically, S&P Mid-Cap 400 and S&P Small-Cap 600 provide investors with a benchmark for medium-sized and small companies respectively.

The analysis based on the extended sample with medium-sized firms is presented in Table 3.1. Here, the regression period is 2004-2014, without employing ZLB dummies.¹ In line with the main results, a contractionary path surprise hurts the stock returns of the firms that are more exposed to floating rate debts more, and hedging against interest rate risk mitigates the adverse effect of the shock. On the other hand, the magnitude of the coefficients for the main regressors, are smaller and weaker in terms of statistical significance. Specifically, the double interaction term involving the path shock and the exposure measure is -1.103 and significant at 5 % level, and the triple interaction term involving the path shock, the exposure measure, and the hedging dummy is 1.758 and significant at 5 % level.

It is also possible to further extend the sample with small-cap firms. However, we

¹The results are similar when I use ZLB dummies.

Table 3.1: Sample of Large-cap and Mid-cap Firms

VARIABLES	(1) Stock Return
target	-22.241*** (6.944)
path	-6.745** (3.166)
target#exposure	0.631 (0.949)
hedge#target#exposure	-4.816*** (1.164)
path#exposure	-1.103** (0.507)
hedge#path#exposure	1.758** (0.688)
target#leverage	-8.723 (6.204)
hedge#target#leverage	16.997** (6.828)
path#leverage	1.924 (3.573)
hedge#path#leverage	-2.228 (3.618)
Observations	31,266
R-squared	0.08

Notes: The dependent variable is the two-day stock return bracketing an FOMC announcement. The sample covers 93 FOMC announcements between January 2004 and September 2014. The dummy variable hedge = 1 if a firm enters into interest rate swaps to protect against interest rate risks of their floating rate obligations. Firm-level control variables are size, book leverage, market-to-book ratio, and profitability. The regression is run with firm-level fixed effects, and standard errors are clustered at the event-level. Only the firms whose floating rate debts constitute more than 1 % of total assets are included to control for potentially speculative interest rate derivative investments. We also drop financial firms. Market-to-book ratio and exposure are trimmed at the bottom and top 1%. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

no longer obtain the evidence for the floating rate channel in this case. Ippolito et al. (2017) use all available firms in Capital IQ, but refine their sample by excluding firms whose total assets are lower than 10 million dollars, or whose stock price is lower than 5 dollars per share to reduce potential noise created by small firms. The issue with small firms is that their stock prices can be very volatile due to the phase in firm life cycle. Because small firms find it difficult to obtain bank debt, having more floating rate debt might even signal future possibility to grow. In that sense, it is not very clear how future cash flows, floating rate debt, and monetary policy surprises relate to one another. These two arguments potentially explain why the evidence is not there when I extend the sample to include small-cap firms.

In the extended sample regressions, I adopt the regression specification used for large firms in *S&P500*. When small firms are included in the sample, it may be useful to check additional specifications, for instance controlling for firm level properties such as cash flow volatility, interest rate sensitivity, or future growth prospects. Because of data constraints, I can not implement such additional specifications for now. Moreover, using the overall sample may require additional trimming of balance sheet variables or stock prices. I leave these tasks to future research. Another interesting question is to test stock market participant's sophistication for small, medium or large firms separately. The attention allocated to different classes of firms might be asymmetric and warrants serious analysis.

3.3 Stock Returns in One Day Window

In Chapter 2, stock returns are computed with a two-day window, to make the results there comparable to thereof Ippolito et al. (2017). Here, I present the same regressions with a one-day window. The first two regressions in Table 3.2 are for pre-ZLB period, the last two regressions are for the whole sample period which includes ZLB dummy. The main evidence for the floating rate channel, interaction of path surprise and exposure, is negative and statistically significant in the one-day window as well. However, the significance of the triple interaction of path surprise, hedge and exposure is not as conspicuous as the one for the two day window.

Finding evidence with one-day returns is important to ascertain the validity of our results. Once investors realize floating rate debt matters and behave accordingly, they would not wait until the second day to adjust their portfolios. On the other hand, since there are a lot of speculative movements in stock prices in the first day, which create noise, we measure the net effect more accurately with a two-day window return.

3.4 Different Data Treatments

In the main regressions in Chapter 2, financial firms (SIC codes: 6000-6999) are not included to the analysis because their nature and financial structure are very different from the firms in other sectors. Since Fama and French (1992) argued that the same level of leverage might have different meanings across financial

Table 3.2: Regressions with one day window

VARIABLES	(1) Two-Day	(2) One-Day	(3) Two-Day	(4) One-Day
target	-29.5426*** (8.1767)	-11.1870 (7.0245)	-29.9904*** (7.1232)	-11.1787* (6.2485)
path	-9.6272*** (2.4291)	-7.6531*** (2.8354)	-6.1241* (3.1613)	-5.6967** (2.6338)
path#exposure	-3.4460*** (0.7134)	-1.8130** (0.8169)	-3.4161*** (0.7083)	-1.7191** (0.7910)
hedge#path#exposure	2.7538*** (0.7940)	0.9771 (0.6812)	2.7952*** (0.7729)	1.0020 (0.6811)
zlb#path#exposure			1.5245 (1.2538)	1.9847** (0.9800)
hedge#zlb#path#exposure			1.8620 (1.4175)	1.0164 (0.9183)
Observations	5,627	5,628	15,494	15,496
R-squared	0.1308	0.1102	0.0922	0.0787

Notes: The regressions (1) and (2) are for the period 2004-2008. The regressions (3) and (4) are for the period 2004-2014 including the ZLB dummy. The dependent variables are two-day stock return bracketing an FOMC announcement in (1) and (3), and one day return in (2) and (4). The other conventions are similar to Table 2.2 and Table 2.3. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

and non-financial firms, it has become a standard practice to treat financial firms differently in quantitative macro finance studies. In this section, I show that if I include all sectors, or also drop firms belonging utilities sector (SIC codes: 4900-4949), our results continue to hold.

Additionally, I check results with winsorizing market to book ratio and exposure at 1 percent rather than trimming them. Extreme values in data contaminate the results and can mislead the researcher, and for this reason, require special treatment. There are mainly two ways to manage extreme values: one can either trim them from the sample, or winsorize them (meaning replacing extreme values with a specified percentile of the data). The first method was chosen in the second Chapter. Here, I show that the results remain similar even if I winsorize the data at 1 percent.

In Table 3.3 and Table 3.4, I present regression results for the pre-ZLB period and the whole period. The coefficients of our main interest remain significant with proper signs. The magnitudes increase when I drop utilities sector in addition to financials. The double interaction term involving the path shock and the exposure measure changes to -4.983 from -3.446 and the triple interaction term involving the path shock, the exposure measure, and the hedging dummy rises to 4.194 from 2.754 when compared to the results in Chapter 2, Table 2.2 for the pre-ZLB period. Remarkably, the magnitude of the triple interaction increases to a point of almost canceling out the effect of the double interaction. This can be interpreted as hedging mattering even more for the firms in non-financial or non-utility sectors. In other words, market participants pay even more attention to hedging activities of these firms.

3.5 Different Control Measures

In the main analysis in Chapter 2, we presented results based on controlling for bank debt leverage or floating rate debt leverage. In this section, I provide additional results in which I replace leverage with other compositional measures such as floating rate to fixed rate debt ratio, floating rate debt to total debt ratio and long term floating rate to total debt ratio. I replace leverage with these measures rather than augmenting them to the original regression. The reason is that using these control variables and book leverage would make the data highly collinear with floating debt leverage or bank debt leverage. Even though these measures do not substitute for leverage, it is worth knowing what happens if we

Table 3.3: Pre-ZLB: different statistical treatments

	(All firms)	(Exclude both fin. nd util.)	(Winsorize)
VARIABLES	(1) Stock Return	(2) Stock Return	(3) Stock Return
target	-19.700*** (6.094)	-30.057*** (8.091)	-25.931*** (7.226)
path	-9.517*** (2.593)	-9.499*** (2.585)	-8.292*** (2.455)
target#exposure	6.206 (3.975)	4.360 (4.518)	4.854 (4.230)
hedge#target#exposure	-10.633** (4.159)	-9.574** (4.271)	-9.932** (3.780)
path#exposure	-3.680*** (0.700)	-4.983*** (1.030)	-2.413*** (0.837)
hedge#path#exposure	3.605*** (0.823)	4.194*** (1.167)	2.469*** (0.874)
target#leverage	-31.834* (17.434)	-15.695 (19.805)	-21.838 (16.680)
hedge#target#leverage	35.570* (21.000)	21.660 (23.639)	26.342 (22.019)
path#leverage	6.487 (4.446)	14.983*** (4.798)	4.616 (3.828)
hedge#path#leverage	-7.730 (5.990)	-11.684** (5.361)	-3.681 (5.624)
Observations	6,103	5,043	5,856
R-squared	0.135	0.135	0.132

Notes: The regressions check robustness of the regression (2) in Table 2.2. The regression (1) uses all S&P 500 firms from all sectors. Regression (2) excludes both financial firms and utilities sector. Regression (3) winsorizes market-to-book ratio and exposure at the bottom and top 1%. Other conventions are similar to Table 2.2. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 3.4: Including ZLB: different statistical treatments

	(All firms)	(Exclude both fin. and util.)	(Winsorize)
VARIABLES	(1) Stock Return	(2) Stock Return	(3) Stock Return
target	-20.934*** (5.799)	-30.335*** (7.160)	-26.698*** (5.991)
path	-4.698 (3.529)	-6.275* (3.221)	-4.409 (3.239)
target#exposure	6.345 (3.895)	4.690 (4.383)	5.039 (4.077)
hedge#target#exposure	-10.847** (4.132)	-9.833** (4.161)	-9.944*** (3.609)
zlb#target#exposure	-15.559 (11.488)	-1.889 (16.765)	0.669 (15.565)
hedge#zlb#target#exposure	23.433 (21.894)	9.757 (26.850)	12.618 (23.054)
path#exposure	-3.633*** (0.678)	-4.890*** (1.009)	-2.604*** (0.775)
hedge#path#exposure	3.686*** (0.821)	4.179*** (1.123)	2.739*** (0.875)
zlb#path#exposure	3.182* (1.714)	2.757* (1.543)	3.564** (1.725)
hedge#zlb#path#exposure	-1.573 (2.061)	1.418 (1.746)	-2.569 (1.704)
target#leverage	-29.566* (17.186)	-15.299 (19.230)	-20.333 (16.429)
hedge#target#leverage	35.894* (20.373)	23.123 (22.175)	26.018 (20.891)
zlb#target#leverage	5.243 (78.576)	-35.381 (107.490)	-41.498 (92.230)
hedge#zlb#target#leverage	72.198 (127.645)	124.539 (157.395)	105.080 (132.992)
path#leverage	6.143 (3.940)	14.615*** (4.217)	4.636 (3.622)
hedge#path#leverage	-7.550 (5.915)	-10.476** (5.094)	-3.550 (5.601)
zlb#path#leverage	-3.603 (7.825)	-13.217* (7.169)	-5.347 (6.904)
hedge#zlb#path#leverage	25.876** (10.712)	23.531*** (8.905)	18.471* (10.830)
Observations	16,818	13,995	16,044
R-squared	0.089	0.094	0.089

Notes: The regressions check robustness of the regression in Table 2.3. The regression (1) uses all S&P 500 firms from all sectors. Regression (2) excludes both financial firms and utilities sector. Regression (3) winsorizes market-to-book ratio and exposure at the bottom and top 1%. Other conventions are similar to Table 2.3. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

control for the compositional choices. The answer is, our results remain intact.

My first control measure is floating rate debt to fixed rate debt ratio which delivers information about firm's choice between two interest rate types. The results are presented in Table 3.5 and Table 3.6. As I stated in the second chapter, fixed rate liabilities are, in a net present value sense, lowered by higher interest rates, but floating rate liabilities do not change much. Because of this, one might anticipate this ratio to be more responsive to target shocks due to changes in the net present value of fixed rate debt. This is indeed the case. The double interaction of target and floating to fixed ratio is negative, meaning firms with more floating rate debt compared to their fixed rate debt would get affected more from target surprises. Moreover, we still see the evidence for protective role of hedging. This channel warrants further analyses, especially a structural one.

Furthermore, the evidence for exposure channel still exists. The coefficients of the double interaction of path and exposure and the triple interaction of path, exposure and hedge are statistically significant at 1 % level and the magnitudes are close to the ones in Table 2.2. So, the cash flow channel still operates via exposure and path factor of monetary policy.

Using the other two control measures, which define floating rate debt as a ratio of total debt, or floating rate debt whose maturity is more than one year as a ratio to total debt, the main message continues to hold for both pre-ZLB period and the whole sample period.

Table 3.5: Pre-ZLB: Different control measures

VARIABLES	(Floating debt over fixed debt) (1) Stock Return	(Floating debt over total debt) (2) Stock Return	(Long term floating debt over total debt) (3) Stock Return
target	-28.324*** (6.272)	-23.853*** (7.730)	-24.623*** (6.966)
path factor	-8.674*** (3.091)	-9.150*** (2.792)	-7.820** (2.924)
target#exposure	-0.369 (1.084)	1.207 (1.290)	2.571** (1.132)
hedge#target#exposure	-1.222 (1.496)	-2.732** (1.281)	-4.196*** (1.101)
path#exposure	-3.012*** (0.757)	-2.325*** (0.524)	-2.357*** (0.594)
hedge#path#exposure	2.446** (1.034)	2.449*** (0.671)	2.401*** (0.732)
target#floating over fixed	-0.012*** (0.004)		
hedge#target#floating over fixed	0.013*** (0.005)		
path#floating over fixed	-0.002 (0.002)		
hedge#path#floating over fixed	0.002 (0.002)		
target#floating debt over total debt		-5.250 (3.455)	
hedge#target#floating debt over total debt		1.395 (5.232)	
path#floating debt over total debt		1.189 (0.998)	
hedge#path#floating debt over total debt		-3.533 (2.141)	
target#long floating debt over total debt			-8.432** (3.306)
hedge#target#long floating debt over total debt			2.064 (5.117)
path#long floating debt over total debt			-0.097 (1.114)
hedge#path#long floating debt over total debt			-1.748 (2.530)
Observations	6,630	7,581	6,920
R-squared	0.130	0.126	0.134

Notes: The regressions check robustness of the regression (2) in Table 2.2. The regression (1), (2) and (3) replaces leverage with floating debt to fixed debt ratio, floating debt over total debt ratio and long term floating debt over total debt ratio respectively. Other conventions are similar to Table 2.2. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 3.6: Including ZLB: Different control measures

VARIABLES	(Floating debt over fixed debt) (1) Stock Return	(Floating debt over total debt) (2) Stock Return	(Long term floating debt over total debt) (3) Stock Return
target#exposure	-0.172 (1.001)	1.362 (1.143)	2.627** (1.119)
hedge#target#exposure	-1.031 (1.389)	-2.770** (1.112)	-4.101*** (1.055)
zlb#target#exposure	-3.829 (14.183)	-4.567 (16.141)	-8.433 (17.371)
hedge#zlb#exposure	-0.405 (0.353)	-0.291 (0.421)	-0.336 (0.442)
hedge#zlb#target#exposure	12.019 (14.108)	12.274 (19.941)	12.988 (20.830)
path#exposure	-2.940*** (0.745)	-2.318*** (0.552)	-2.358*** (0.639)
hedge#path#exposure	2.431** (0.974)	2.665*** (0.659)	2.621*** (0.733)
zlb#path#exposure	1.223 (1.612)	-0.046 (1.339)	-0.008 (1.524)
hedge#zlb#path#exposure	3.146* (1.665)	3.062** (1.541)	3.036* (1.669)
target#floating over fixed	-0.011*** (0.004)		
hedge#target#floating over fixed	0.012*** (0.004)		
zlb#target#floating over fixed	0.013*** (0.004)		
hedge#zlb#target#floating over fixed	0.524** (0.207)		
path#floating over fixed	-0.001 (0.001)		
hedge#path#floating over fixed	0.001 (0.001)		
zlb#path#floating over fixed	0.001 (0.001)		
hedge#zlb#path#floating over fixed	0.023** (0.010)		
target#floating debt over total debt		-4.207 (3.328)	
hedge#target#floating debt over total debt		1.177 (5.115)	
zlb#target#floating debt over total debt		-16.286 (26.306)	
hedge#zlb#target#floating debt over total debt		44.446 (42.875)	
path#floating debt over total debt		1.533 (1.086)	
hedge#path#floating debt over total debt		-4.100* (2.127)	
zlb#path#floating debt over total debt		1.268 (2.114)	
hedge#zlb#path#floating debt over total debt		6.688 (4.066)	
target#long floating debt over total debt			-6.688** (2.973)
hedge#target#long floating debt over total debt			1.342 (4.987)
zlb#target#long floating debt over total debt			-22.620 (26.082)
hedge#zlb#target#long floating debt over total debt			65.346 (39.843)
path#long floating debt over total debt			0.415 (1.103)
hedge#path#long floating debt over total debt			-2.234 (2.320)
zlb#path#long floating debt over total debt			0.706 (2.185)
hedge#zlb#path#long floating debt over total debt			7.762** (3.762)
Observations	16,663	18,550	17,453
R-squared	0.091	0.087	0.090

Notes: The regressions check robustness of the regression in Table 2.3. The regression (1), (2) and (3) replaces leverage with floating debt to fixed debt ratio, floating debt over total debt ratio and long term floating debt over total debt ratio respectively. Other conventions are similar to Table 2.3. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

3.6 Time Fixed Effects

I did not employ time fixed effects throughout the analysis in Chapter 2, since the empirical design is event study which focuses only on FOMC dates. It is a very small probability that any other event takes place during this interval, which would also affect stock prices significantly. Moreover, since the policy shock variables, target and path, are time-variant, including time fixed effects would eliminate the individual effects of these shocks. It would be equivalent to treating FOMC days as they are completely different special days, proxied by dummies, without considering their sign and magnitude. In other words, time fixed effects would imply a different intercept for each event day.

Here, I run regressions which do not treat target and path factor as individual regressors, as they are absorbed with time dummies. Even though I do not favor this specification, it is worth checking this, and it indeed passes the check: the results remain similar to main findings in Chapter 2, which are presented in Table 3.7 and 3.8 for the pre-ZLB period and the whole period respectively. The double interaction term involving the path shock and the exposure measure and the triple interaction term involving the path shock, the exposure measure, and the hedging dummy continues to be significant with the expected signs. However, for the specification with bank debt leverage, the significance level for the coefficient of the triple interaction drops.

Table 3.7: Pre-ZLB: Time fixed effects

VARIABLES	(Bank Debt Leverage) Stock Return	(Floating Rate Debt Leverage) Stock Return
target#exposure	5.636 (4.093)	1.312 (2.693)
hedge#target#exposure	-10.062** (3.774)	-2.364 (3.087)
path#exposure	-2.411** (1.032)	-2.653*** (0.562)
hedge#path#exposure	1.929* (1.014)	3.196*** (0.779)
target#leverage	-26.649 (16.142)	-9.280 (17.438)
hedge#target#leverage	28.835 (21.148)	2.552 (21.021)
path#leverage	7.585* (4.261)	10.156*** (3.765)
hedge#path#leverage	-4.986 (5.953)	-13.659*** (5.040)
Observations	5,627	7,581
R-squared	0.313	0.315

Notes: The regressions check robustness of the regression (2) in Table 2.2. The regression (1) and (2) uses bank debt and floating rate debt leverage respectively. The target and path factors preserved in interactions but solo effects are replaced with time dummies. Other conventions are similar to Table 2.2. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 3.8: Including ZLB and time dummies

	(Bank Debt Leverage)	(Floating Rate Debt Leverage)
VARIABLES	(1) Stock Return	(2) Stock Return
target#exposure	5.656 (4.068)	1.218 (2.398)
hedge#target#exposure	-10.059*** (3.799)	-2.138 (2.795)
zlb#target#exposure	-14.937 (15.082)	-9.693 (16.873)
hedge#zlb#target#exposure	20.846 (24.544)	16.881 (22.532)
path#exposure	-2.243** (0.955)	-2.389*** (0.541)
hedge#path#exposure	1.606* (0.927)	2.992*** (0.744)
zlb#path#exposure	-0.060 (1.375)	-0.085 (1.134)
hedge#zlb#path#exposure	2.449 (1.535)	-0.022 (1.788)
target#leverage	-26.379* (15.660)	-7.544 (15.787)
hedge#target#leverage	29.263 (19.656)	0.838 (19.218)
zlb#target#leverage	-43.572 (87.418)	-43.109 (100.992)
hedge#zlb#target#leverage	25.015 (139.882)	15.430 (114.649)
path#leverage	5.581 (3.905)	8.478** (3.687)
hedge#path#leverage	-2.846 (5.607)	-12.096** (4.859)
zlb#path#leverage	-9.799 (5.930)	-6.023 (6.067)
hedge#zlb#path#leverage	14.517* (8.729)	23.952** (10.814)
Observations	15,494	18,550
R-squared	0.338	0.339

Notes: The regressions check robustness of the regression in Table 2.3. The regression (1) and (2) uses bank debt and floating rate debt leverage respectively. The target and path factors preserved in interactions but solo effects are replaced with time dummies. Other conventions are similar to Table 2.3. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

3.7 More Evidence on the Cash Flow Effect during the ZLB Period

Finally I present regressions for the period after 2009 until 2014. Ippolito et al. (2017) investigate the floating rate channel by looking at the period from November 2008 to September 2011 based on Wright's (2012) policy surprise measures which use the high frequency price changes in longer maturity Treasury futures on a very tight event window (15 minutes before each of these announcements to 1 hour and 45 minutes afterwards) around FOMC announcements during this unconventional monetary policy period. So, these surprises mostly capture what our path surprises capture by construction.

Here, I replicate those ZLB period regressions using only path surprises for the period 2009-2014. In Table 3.9, the regression (1) uses only leverage, (2) adds exposure, and (3) employs floating rate debt leverage instead of bank debt leverage.

Similar to Ippolito et al. (2017), there is no evidence for the floating rate channel as presented in regression (1) in Table 3.9. However, once exposure comes into the scene, I again find evidence in favor of the floating rate channel. Specifically, the double interaction term involving the path shock and the exposure measure is -1.826 and significant at 10 % level, and the triple interaction term involving the path shock, the exposure measure, and the hedging dummy is 3.812 and significant at 1 % level, in regression (2). Notably, in this sub-sample regression, the absolute value of the triple interaction exceeds the absolute value of the double

interaction which implies that hedging compensates for the negative effect of path shock very strongly. I conjecture that the market participants paid even more attention to hedging activities during the ZLB period. This result is in accordance with the findings of marginal effects analysis in Table 2.4 and Table 2.5. There, I also show that hedging brings more gain especially during the ZLB period.

Table 3.9: Regressions for the period 2009-2014

	(Only leverage)	(Bank debt leverage and exposure)	(Floating rate debt leverage and exposure)
VARIABLES	(1) Stock Return	(2) Stock Return	(3) Stock Return
path	0.935 (10.570)	4.209 (10.970)	4.668 (10.716)
exposure		-0.132 (0.210)	-0.248 (0.240)
path#exposure		-1.826* (0.939)	-2.921*** (1.068)
hedge#exposure		0.143 (0.202)	0.143 (0.269)
hedge#path#exposure		3.812*** (1.230)	1.907 (1.852)
path#leverage	1.363 (5.330)	0.638 (6.534)	6.599 (6.511)
hedge#path#leverage	11.233 (7.084)	14.973* (8.885)	20.616* (10.476)
Observations	13,771	9,867	10,969
R-squared	0.052	0.060	0.059

Notes: The sample covers the period The sample covers 46 FOMC announcements between January 2009 and September 2014, which correspond to the zero lower bound episodes in the US. Here, we include only the path factor as a measure of monetary policy surprise following the specification of Ippolito et al. (2017). Regression (1) emulates Ippolito et al. (2017) by including only bank debt leverage and path surprise. Regressions (2) adds exposure and its interactions to (1). In (3), we replace bank debt leverage with floating rate debt leverage. The dummy variable hedge = 1 if a firm enters into interest rate swaps to protect against interest rate risks of their floating rate obligations. Firm-level control variables are size, book leverage, market-to-book ratio, and profitability. The regression is run with firm-level fixed effects, and standard errors are clustered at the event-level. Only the firms whose floating rate debts constitute more than 1 % of total assets are included to control for potentially speculative interest rate derivative investments. We also drop financial firms. Market-to-book ratio and exposure are trimmed at the bottom and top 1%. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

3.8 Conclusion

In this chapter, I presented additional robustness checks to the main findings in the second chapter. I showed that the results regarding the floating rate channel of monetary policy and market participants' ability to price it shortly after a policy announcement remain intact under various data and model specifications.

I showed that extending the sample to include S&P 400 Mid-Cap firms continues to provide the evidence for the floating rate channel. Due to data limitations, I could not include all available firms in Capital IQ for the analysis. I defer this to a future project in order to enhance understanding of how the floating rate channel works.

I also discussed alternative statistical specifications, for instance, one involving selection of firms (using all sectors or dropping utilities sector), and presented that our results are robust. In our main regressions, we controlled for bank debt or floating rate debt leverage. Alternatively, I controlled for debt composition (more specifically, the ratio of floating rate debt to total debt or its ratio to fixed rate debt). These measures do not perfectly substitute for leverage, but the evidence for the floating rate channel continues to hold. I also analyzed the ZLB period by considering only after 2009 period as Ippolito et al. (2017) do. I verified that during ZLB period, the floating rate channel functioned similarly.

In short, the results presented here demonstrate that what we find in the second chapter are robust and meaningful.

CHAPTER 4

MODELING DEBT MATURITY IN GENERAL EQUILIBRIUM

4.1 Introduction

The global financial crisis in 2008, has triggered substantial research on the balance sheet channel of monetary policy transmission. Various mechanisms have been pursued to understand Bernanke and Gertler’s (1995) “black box”, using the crisis as a natural experiment. Almeida et al. (2012) analyze the crisis period and find that firms whose long-term debt was mostly maturing right after the third quarter of 2007 cut down investment by significantly more than otherwise similar firms whose debt was scheduled to mature after 2008. Foley-Fisher et al. (2016) focus on the Fed’s maturity extension program (MEP)¹, and show stock prices rose much more for firms with longer maturity debt. Moreover, according to their findings, the firms which increased the level of their long-term debts during the MEP also expanded their employment and investment. These papers

¹It was announced on Sept. 21, 2011, with the intention of lowering long-term rates.

together with our results in Chapter 2 present evidence on the importance of debt maturity over business cycles.

This chapter studies the role of debt maturity of constrained entrepreneurs in a general equilibrium framework, where endogenous borrowing constraints serve as an amplification mechanism. To motivate the co-existence of financial instruments at different maturities, I assume a liability-asset matched maturity environment as in Myers (1977) which is supported by the empirical findings of Stohs and Mauer (1996).

The difficulty in modeling and analyzing maturity choice of a single agent when different types of financial instruments are available, in a general equilibrium setting is well-known. As an alternative to completely micro-founded maturity decision, I build a stylized model in which maturity choices are decided by capital types possessed. I enforce producers to borrow long-term debt if they produce with a capital which is long lived (depreciate very slowly). The opposite is true for short-term debt. An entrepreneur is able to borrow short-term if his capital is short lived (depreciates very fast). This structure is a short cut to a search-based process in which savers who volunteer to lend in a longer horizon search for firms that have returns in the long run (because of their capital), to guarantee at least some part of repayment.

This very simple model embeds loan to investment ratios and average maturity as potential macro prudential policy variables. It treats the two sectors to be completely separated. So, the transmission or substitution effects across the sectors in response to shocks are very limited. Nevertheless, this model provides

a useful starting point to extend and add more sophisticated properties.

Next, I extend the model to embrace price stickiness and monetary policy. This turns the basic model into a standard New Keynesian dynamic stochastic general equilibrium model. Now with nominal debts and distortionary effects of inflation, the interactions between the two sectors become pronounced.

The models presented here provide a set of results with macro-prudential and monetary policy implications. I show that the share of long-term debt financed sector influences the aggregate real effects of monetary policy. The economy-wide effect of macro-prudential policy which targets one sector depends on the relative size of that sector.

Moreover, a shock to the borrowing constraint affects borrowers and lenders in opposite directions. On the one hand, borrowers are forced to invest and produce less; on the other hand this causes lenders to have more resources to consume (instead of lending). Justiniano et al. (2015) point out that borrowing shocks are far from being the main drivers of business or credit cycles for the very same reason. In this simple set up, I do not consider the possibility of policy coordination. The lack of coordination implies that inflation targeting policy rules and macro-prudential policies might work in opposite directions. The tightening effect of a macro-prudential policy might be weakened by loose monetary policy.

In reality, the repayment structure matters as much as the maturity. If long-term debt is issued at the floating rate basis, aggregate shocks change the outstanding amount to repay, which results to cash inflow or outflow, and makes the effect of the shock even stronger. Calza et al. (2013) estimate vector autoregressive re-

gressions (VARs) for a set of countries and find that the economies which finance long-term mortgage debts with floating rate debt are more sensitive to monetary policy shocks. I experiment with fixed rate and floating rate debt on long-term debt, which is used to finance firm level investment. The impulse response analyses show that floating rate debt is more disruptive in terms of consumer welfare in response to tightening monetary policy shocks when compared to fixed rate debt. I also show that extending the maturity of the floating rate debt harms the sector whose financing depends on long-term debt by more. In other words, longer floating rate maturity would leave firms in a more vulnerable situation in response to contractionary policy surprises. This is in accordance with the empirical findings in Chapter 2 which point out the important role of debt maturity.

These findings demonstrate that the balance sheet channel of monetary policy is not limited to net worth effect. One of the channels I emphasize is the maturity and repayment structure of corporate debt which are directly linked to future cash flow prospects.

The models built in this chapter serve as a benchmark to study the transmission of various policies to economy, and can be extended in many directions such as equity finance and a combined portfolio choice under micro-foundations.

The chapter is structured as follows: Section 4.2 reviews the related literature. Section 4.3 builds a simple model and discusses its properties. Sections 4.4 and 4.5 present impulse responses; Section 4.6 extends the simple model to include nominal rigidities in the form of price stickiness and monetary policy. Section 4.7 provides discussions about long-term floating rate debt. Section 4.8 concludes.

4.2 Literature Review

Modigliani and Miller (1958) theorem on capital structure is a milestone in corporate finance. The basic theory shows that under perfect capital markets without any friction, the choice of capital structure and financial instruments are inconsequential to the value of the firm. Stiglitz (1974) extends this theorem and shows that the maturity structure of debt is inconsequential as well. Since then, researchers in corporate finance literature have studied a number of frictions such as tax, agency costs, asymmetric information to point out under what conditions the maturity of debt is relevant, and whether long-term debt is optimal or not.

This chapter is related to various strands of the literature which rejects the irrelevance of debt and maturity structure, with a special focus on aggregate economic implications.

The early literature concentrates on four types of hypotheses about the determinants of corporate debt maturity structure: agency cost hypotheses as in Diamond (1991), signaling and liquidity risk hypotheses as in Flannery (1986), maturity matching hypothesis as in Myers (1977), and tax hypotheses as in Kane, Marcus, and McDonald (1985) which are reviewed in Stohs and Mauer (1996).

There is an extensive empirical literature on the determinants of corporate debt maturity which aim to test these hypotheses. Guedes and Opler (1996) show that large firms with investment grade credit ratings borrow both long and short maturity debt; on the other hand, firms with speculative grade credit ratings typically borrow at medium maturities. Stohs and Mauer (1996) find that larger,

less risky firms with longer-term asset maturities use longer-term debt. Servaes et al. (2009) present a wide-ranging set of survey results. They show that when deciding on maturity structure, one of the main issues that firms take into account is the structure of their assets. I motivate the theoretical model in this chapter with these findings, and build a link between asset maturity and liability maturity. I assume two sectors with different capital structures which have to finance their investment with long-term or short-term debt.

The relevance of debt maturity in a general equilibrium setting has been analyzed by the literature that focuses on three different questions. The first strand is government debt and international borrowings that have been popular since the international financial crises of the 1990s, which put many emerging markets into a vulnerable position of debt roll-over crises. Most of these papers lack the endogenous choice between long-term and short-term debt, but instead compare the two extreme cases. Alfaro and Kanczuk (2009) compare short-term and long-term government debt in a general equilibrium model with uncertainty. Solving an optimal maturity problem for the calibrated Brazilian economy, they conclude that short-term debt implies higher welfare levels because of the higher premium required for the long-term debt due to default risk.²

The other two issues have been put on the spotlight by both the policy makers and academics, especially after the recent financial crisis. The second branch is financial institutions' maturity mismatch in their assets and liabilities as in the canonical model of Diamond and Dybvig (1983). The maturity mismatch argu-

²Some other examples that deal with government debt include Hatchondo and Martinez (2009), Jeanne (2009), Preston and Eusepi (2011) and Arellano and Ramanarayanan (2008), and Bhattarai et al. (2015)

ment, which suggests that highly levered financial institutions holding too much short-term liabilities to fund their long-term assets, can trigger the crisis (Brunermeier, 2009). The consequences and relevant policy actions have been studied extensively.³ The third branch is concerned with housing finance and mortgage credits, which is not completely independent from the second branch. The researchers in this field pay special attention to the structure of debt repayments. They investigate the implications of fixed rate and floating rate multi period debt comprehensively.

Benes and Lees (2010) investigate business and housing cycle dynamics in response to finance shocks. They find that multi-period fixed rate contracts can help smoothing out adverse effects of particular shocks. Calza et al. (2013) study housing finance and the transmission of monetary policy shocks. In accordance with my findings, they show that consumption is affected more from monetary policy if mortgage debts are prevalent in the floating-rate type. Similarly, Brzoza-Brzezina et al. (2014) study monetary and macro prudential policy transmission with multi-period loans to housing. They have similar results when they compare fixed rate and floating rate debt multi period loans. Sustek et al. (2015) study transmission channels additionally and show that monetary policy effects the economy through the cost of new borrowings and the value of outstanding debt with long-term nominal debt.⁴

The results presented in this chapter are in line with the findings of these papers.

In my model the endogenous borrowing constraints on corporate debt amplify

³See for example Farhi and Tirole (2012), Stein (2012), and Segura and Suarez (2016).

⁴Other studies on mortgage debts and its implications include Kydland et al. (2014), Gelain et al. (2015).

the fundamental shocks. The comparisons across floating rate and fixed rate verify that monetary policy is less effective when debt contracts are written with floating rate repayment structure in terms of inflation. However, they are more disruptive for consumption. In addition to this, the analysis of maturity for the floating rate debt shows that extending its maturity cause firms to be more vulnerable to adverse shocks.

While the literature is rich in terms of pointing out the significance of maturity structure of government debt, financial institutions' maturity mismatch or mortgage debts and the relevant policy implications, it has not sufficiently explored the implications of corporate debt maturity in standard dynamic general equilibrium models in response to macroeconomic shocks. Among the recent studies, Bengui (2011) analyzes private debt maturity choices in a Kiyotaki and Moore (1997) type environment, with endogenous collateral constraints. In his model, long-term debt provides insurance against negative shocks, but at the expense of an extra cost over short-term debt. Borrowers choose their debt maturity by trading off the insurance benefits of long-term debt with its costs. He concludes that macro prudential policy in the form of a tax on short-term debt can lead to Pareto improvements. Converse (2017) focuses on emerging markets and investigates the relationship between international capital flows and maturity mismatch of investment projects. He shows that shocks to capital flow volatility are more destructive when maturity mismatch is prevalent. Shen (2016) studies the role of debt maturity in the context of financial amplification effect and sudden stop crises from emerging countries perspective. She finds that increasing the debt maturity can be beneficial in terms of welfare. Unlike Bengui (2011) I consider

two production sectors which finance themselves with completely different instruments, and this makes steady state or debt types determinate. In his model, long-term bond is modelled as a long-term perpetuity which is a resalable asset. In my model, the debt is modelled as a repayment commitment which cannot be resold. This allows me to compare fixed rate and floating rate long-term loans. Unlike Shen (2016) and Converse (2017), the motivation of this chapter is not debt finance in emerging markets and capital flow crisis. Instead, my focus is transmission of monetary policy and macro prudential policies in a model economy.

Finally, this chapter is related to the literature on financial frictions. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997) illustrate that in the presence of financial frictions, endogenous variations in borrowers' net worth can lead to amplification of fundamental shocks. When modeling borrowing constraints, I use the structure proposed by Kiyotaki and Moore (1997). In particular, I follow Iacoviello (2005), Monacelli (2009) and Bengui (2011) who embed the mechanism into New Keynesian dynamic stochastic general equilibrium models. To augment the model with price stickiness and monetary policy, I borrow Bernanke et al.'s (1999) model structure and impose price stickiness to retailers.

4.3 Model

I construct a very simple two sector RBC model with two distinct goods, which is inspired by Kiyotaki and Moore (1997). The model has three agents. There are households who are savers, and two kinds of entrepreneurs. Two entrepreneurs

produce completely different goods that the households consume. I assume a single representative household.

In standard models without any frictions, going back to Modigliani and Miller (1958) and Stiglitz (1974), the maturity choice is irrelevant. In equilibrium, the returns will be equalized and agents will be indifferent to holding different assets. However, empirical studies show that there are many reasons for and consequences of holding long-term or short-term debt. One of the reasons as highlighted by Servaes et al. (2009) is that firms borrow taking their cash flow structure into account. If they expect cash inflows in the future, they tend to borrow long-term debt. I call this maturity matching hypothesis. Converse (2017) and Fan et al. (2010) demonstrate that maturity mismatch is not an issue for the firms in advance economies. Instead, the firms with long-term projects can easily find long term finance. So the model in this chapter reflects an advance economy. This motive enables us to create an environment in which agents are forced to borrow depending on their production structure, so that they are prevented from rolling over short-term debt which can substitute for long-term debt.

I name the two different sectors as short-lived-capital good sector and long-lived-capital good sector. These sectors differ in their longevity of capital and debt finance structure. short-lived-capital good sector (can be thought as services or software sector) is financed with short term debt and its capital depreciates very fast. The depreciation rate for this sector is calibrated to 0.9. Long-lived-capital good sector (can be thought as manufacturing sector), on the other hand, financed with long term debt and its capital depreciates slowly. The depreciation rate is

calibrated to 0.025. I refrain using durable/non-durable goods or perishable/non-perishable goods, because the model built here, is not completely in line with the literature on those goods. I also do not refer to services or manufacturing sectors directly, since my assumptions and calibration do not exactly match those sectors.

The first type of entrepreneur produces and get utility from the short-lived-capital good which depreciates at a higher rate. To invest and produce this good, entrepreneur should take short-term debt from household. Since the model is entirely in real terms, the debt will be a promise to repay in terms of goods. With this borrowing, the entrepreneur will have short-lived-capital investment. He will produce, consume, invest and repay his debt to household.

The second type of entrepreneur produces the long-lived-capital good that depreciates much slower. To finance his investment good, he needs to take long-term debt, whose repayment structure is an infinite maturity perpetuity. For both types of producers, I assume investment becomes productive with one period lag.

The representative household likes to consume a consumption basket in which both goods enter with a CES⁵ structure. The household behaves like a banker; he receives returns from financial instruments and lends to entrepreneurs each period. Both producers are limited in terms of borrowing: they are subject to collateral constraints á la Kiyotaki and Moore (1997).

I assume that entrepreneurs' utility function is the natural logarithm of their consumption. As explained in Iacoviello (2005), there are two ways to model constrained producers. One way is modeling them as risk neutral agents, who

⁵Aggregation function combines two kinds of goods with a constant elasticity of substitution.

respond heavily to shocks. The other is imposing a constant death probability, which gives more passive responses. Logarithmic utility lies somewhere in the middle, which I follow.

To keep things simple, I avoid incorporating an investment goods production sector and labor into the model, but these can be added very easily. In this way, the relationship between debt and investment can be interpreted as a mechanism which converts financial claims to outputs in terms of goods produced.

4.3.1 Long-term and Short-term Debt Structure

To examine the effects of long-term debts, I choose to model them as perpetuities whose repayments decrease geometrically. This enables us to investigate the role of maturity in a tractable manner. As explained in Benes and Lees (2010), it is easy to specify the “average” time until maturity of such a geometric loan by Macaulay’s duration, that is, the weighted term to maturity of the cash flows from a loan.⁶

The structure of this instrument is explained as follows. Assume that an agent borrows b_t^L amount for long-term debt. Repayment is done with a rate which declines at ϕ , with a fixed rate r_t^L .

⁶Benes and Lees (2010) discusses that Macaulay’s duration of an asset, or a stream of payments in general, can be computed as $d = \frac{\sum_{k=1}^{\infty} kPV_{t+k}}{\sum_{k=1}^{\infty} PV_{t+k}}$, where PV is the present value of a payment receivable at time t. Then, the duration at steady state is given by:

$$d = \frac{\sum_{k=1}^{\infty} k \frac{\phi^{k-1}}{R^k}}{\sum_{k=1}^{\infty} \frac{\phi^k}{R^k}} = \frac{\frac{R}{(R-\phi)^2}}{\frac{1}{R-\phi}} = \frac{R}{R-\phi} \quad (4.1)$$

which is a function of short-term interest rate R , and the parameter ϕ .

- repayment due at $t+1$ $r_t^L b_t^L$
- at $t+2$ $\phi r_t^L b_t^L$
-
- at $t+k$ $\phi^k r_t^L b_t^L$

Call j_t^L sum of outstanding payments due in time t . Then, I can use it as a state variable, whose law of evolution is,

$$j_t = \phi j_{t-1} + r_{t-1}^L b_{t-1}^L \quad (4.2)$$

From modeling perspective, introducing long-term debt with this structure costs adding only one more state variable, and for this reason the average maturity can be calibrated with a single parameter. If I choose to use a finite long-term maturity, that would cause many complications such as the curse of dimensionality.

Short-term debt is a standard non-state-contingent instrument which bears an interest rate of r_t^S .

4.3.2 Households

Households are the bankers in the economy: they are more patient than the entrepreneurs. In this model, I do not model labor choice since it is not central to my study. Instead, I assume, starting from the steady state, the household lives of his financial returns, consuming two kinds of goods, long-lived-capital

good and short-lived-capital good, and lend to producers. In this sense they resemble savers in Monacelli (2009).

The infinitely-lived representative household maximizes his lifetime discounted utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t \{\log X_t\} \quad (4.3)$$

where E_0 is the expectations operator, β is the discount factor, and X_t is the consumption bundle that household consumes. The bundle is defined as a CES function of long-lived-capital and short-lived-capital goods which are denoted by C_t^L and C_t^S respectively:

$$X_t = \left[(1 - \kappa)^{\frac{1}{\eta}} (C_t^S)^{\frac{\eta-1}{\eta}} + \kappa^{\frac{1}{\eta}} (C_t^L)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \quad (4.4)$$

Household can lend using both short-term and long-term debts to entrepreneurs. These real debts are used by two distinct producers. The household maximizes his life time utility subject to the flow budget constraint.

$$P_t^C C_t^S + P_t^L C_t^L + b_t^S + P_t^L b_t^L = r_{t-1}^S b_{t-1}^S + P_t^L j_t + T_t \quad (4.5)$$

and the evolution of long-term debt repayments is given by

$$j_t = \phi j_{t-1} + r_{t-1}^L b_{t-1}^L. \quad (4.6)$$

Since this is an entirely real model, I make use of the assumption that short-term debt repayments are made in short-lived-capital good and long-term debt

repayments are made in long-lived-capital good units. That's why, I multiply the repayments with the prices of goods accordingly. I normalize the price of short-lived-capital good, P_t^C to 1. Relative price of long-lived-capital good, P_t^L , is determined from consumption maximization as follows:

$$P_t^L = \left(\frac{\kappa}{1 - \kappa} \frac{C_t^S}{C_t^L} \right)^{\frac{1}{\eta}}. \quad (4.7)$$

Household's behaviour will be characterized by the first order conditions from utility maximization subject to the constraints. The Euler equations provide a link between consumption and debt returns:

$$X_t^{(\frac{1}{\eta}-1)} (C_t^S)^{-\frac{1}{\eta}} (1 - \kappa)^{\frac{1}{\eta}} = \lambda_{1,t} \quad (4.8)$$

$$\beta r_t^S \lambda_{1,t+1} = \lambda_{1,t} \quad (4.9)$$

$$\beta r_t^L \lambda_{2,t+1} = \lambda_{1,t} P_t^L \quad (4.10)$$

$$\lambda_{2,t} - \beta \phi \lambda_{2,t+1} = \lambda_{1,t} P_t^L \quad (4.11)$$

Here, $\lambda_{1,t}$ is the Lagrange multiplier associated with the budget constraint, and $\lambda_{2,t}$ is the Lagrange multiplier associated with the evolution of long-term repayments. Notice that at the steady state, short-term rate will be equal to the inverse of the discount factor of the household: $r_t^S = 1/\beta$ and the long-term rate will be $r_t^L = \frac{1-\beta\phi}{\beta}$. So, the long-term interest rate per period equals to the short-term interest rate, corrected by its average maturity.

I do not model labor or any other income sources for the household. As in

Monacelli (2009), I assume that the economy starts from the steady state. The solution involves taking a linear approximation of the equilibrium conditions in the neighborhood of deterministic steady state. The household will continue to have returns from previous lending and finance new investment.

4.3.3 Short-lived-capital Good Entrepreneurs

Short-lived-capital producers will consume only their own good. They possess the technology for producing the short-lived-capital good from the short-term investment good. They are less patient than the household and they need to borrow to finance their investment, they accumulate capital as well. However, it is assumed that in this sector, the depreciation rate is extremely high, and so it is called short-lived-capital sector. Since their capital is short-lived, I assume that they can only take short-term debt for which they should repay one period later. They turn their total capital into production with a decreasing returns to scale function: $Y_t^S = A_t^S (K_{t-1}^S)^\alpha$ where A_t^S is the total factor productivity that follows a autoregressive process.

Since these entrepreneurs produce in a market that is perfectly competitive, a single representative agent suffices. His problem is as follows:

Maximize the discounted life time utility,

$$E_0 \sum_{t=0}^{\infty} \gamma^t \{ \log C_t^{S,e} \} \quad (4.12)$$

subject to the budget constraint

$$C_t^{S,e} + r_{t-1}^S b_{t-1}^S + I_t^S = b_t^S + A_t^S (K_{t-1}^S)^\alpha \quad (4.13)$$

where $C_t^{S,e}$ is entrepreneur's own consumption, I_t^S is short-term (short-lived-capital) investment. Their investment is limited by a borrowing constraint. As stated above, the entrepreneur needs to borrow to increase his capital stock and so that he can produce more. I assume that his borrowing is constrained by a fraction of his investment:⁷

$$b_t^S \leq \chi_t^S I_t^S. \quad (4.14)$$

The stock of short-term capital is denoted by K_t^S . Then the accumulation of short-investment good can be written as

$$K_t^S = (1 - \delta^S) K_{t-1}^S + I_t^S. \quad (4.15)$$

The optimality conditions of the entrepreneur's problem are as follows:

$$\frac{1}{C_t^{S,e}} - \gamma r_t^S \frac{1}{C_{t+1}^{S,e}} = \mu_{2,t}; \quad (4.16)$$

$$\frac{1}{C_t^{S,e}} = \mu_{2,t} \chi_t^S + \mu_{3,t}; \quad (4.17)$$

$$\frac{1}{C_{t+1}^{S,e}} \gamma A_{t+1}^S \alpha (K_t^S)^{\alpha-1} = \mu_{3,t} - \gamma (1 - \delta^S) \mu_{3,t+1}. \quad (4.18)$$

Here $\mu_{2,t}$ is the Lagrange multiplier associated with the borrowing constraint in

⁷The rationale for this constraint and a discussion about its properties is presented in Appendix C.

(4.14). Notice that as long as entrepreneurs are less patient than the household, this multiplier will be positive at the steady state, so producers will borrow up to their limit. $\mu_{3,t}$ is the Lagrange multiplier associated with the capital accumulation law. The second optimality condition in equation (4.17) arises from the first order condition with respect to investment. It compares the marginal utility from one unit of consumption good to turning it into investment. The return from debt-financed investment is scaled by a factor χ_t^S . The third optimality condition in equation (4.18) states that the marginal gain from additional capital is equal to the marginal product of production function.

I assume that the total factor productivity and the tightness for the borrowing constraint follow stochastic processes:

$$\log(A_t^S) = \bar{A}^S + \rho^{A^S} \log(A_{t-1}^S) + \epsilon_t^{A^S} \quad (4.19)$$

$$\chi_t^S = \bar{\chi}^S + \epsilon_t^{\chi^S}. \quad (4.20)$$

We can interpret χ_t^S as a bounded random variable. Here $\bar{\chi}^S$ represents steady state value of χ_t^S . I calibrate this to be lower than 1 so that in equilibrium the entrepreneurs can only borrow a fraction of their investment, when the constraint is binding at equilibrium. Since entrepreneurs are less patient than the household, the constraint will bind at the steady state equilibrium. Moreover, I assume that it will continue to bind around the steady state equilibrium as in Iacoviello (2005) and Monacelli (2009).

4.3.4 Long-lived-capital Good Entrepreneurs

Similar to short-lived-capital producers, long-lived-capital good producers only consume their own good. They have the technology to produce from long-term investment good. They are less patient than the household, and they need to borrow to finance their investments. They have the same patience level with short-lived-capital good producers. They can accumulate their investment, and the depreciation rate is much lower compared to that of short-lived-capital sector. Since their capital is long-lived, I assume that they can only use long-term debt, as discussed above. They turn their total capital into production with a decreasing returns to scale function: $Y_t^L = A_t^L (K_{t-1}^L)^\alpha$ where A_t^L is the total factor productivity that follows a autoregressive process.

Their maximization problem is similar to that of short-lived-capital good producers, except for the fact that long-lived-capital good producers finance their investment with long-term debt.

Maximize utility:

$$E_0 \sum_{t=0}^{\infty} \gamma^t \{ \log C_t^{L,e} \} \quad (4.21)$$

subject to the budget constraint,

$$P_t^L (C_t^{L,e} + j_t + I_t^L) = P_t^L q_t^L b_t^L + P_t^L A_t^L (K_{t-1}^L)^\nu \quad (4.22)$$

and the borrowing constraint,

$$b_t^L \leq \chi_t^L I_t^L \quad (4.23)$$

the accumulation of long-investment good,

$$K_t^L = (1 - \delta^L)K_{t-1}^L + I_t^L \quad (4.24)$$

and the evolution of long repayments,

$$j_t = \phi j_{t-1} + r_{t-1}^L b_{t-1}^L. \quad (4.25)$$

where $C_t^{L,e}$ is entrepreneur's own consumption, I_t^L is long-term investment and K_t^L is capital stock related to this good.

The optimality conditions are as follows:

$$\frac{1}{C_t^{L,e}} = \gamma \phi \mu_{6,t+1} - \mu_{6,t} \quad (4.26)$$

$$\frac{1}{C_t^{L,e}} = \mu_{5,t} \chi_t^L + \mu_{7,t} \quad (4.27)$$

$$\frac{1}{C_t^{L,e}} = \mu_{5,t} - \gamma \mu_{6,t+1} \quad (4.28)$$

$$\frac{1}{C_{t+1}^{L,e}} \gamma A_{t+1}^L \nu (K_t^L)^{\nu-1} = \mu_{7,t} - \gamma (1 - \delta^L) \mu_{7,t+1} \quad (4.29)$$

Now $\mu_{5,t}$, $\mu_{6,t}$, and $\mu_{7,t}$ are the Lagrange multipliers associated with the borrowing constraint, the evolution of outstanding repayments and the capital accumulation law respectively. The first optimality condition in equation (4.26) emerges from the first order condition with respect to new state variable j_t . It compares the marginal (dis)utility from an additional increase in repayment stock with marginal utility from consumption. Notice that at the steady state, $\mu_{6,t}$ is ex-

pected to be negative since both γ and ϕ less than 1. This makes sense because $\mu_{6,t}$ measures the utility from additional debt repayment which reduces consumption. The second optimality condition in equation (4.27) is similar to above, is about investment decision, taking into account the limit imposed by constraint.

The third condition in equation (4.28) compares the utility from investment financed by additional long-term debt with the cost occurred by its future repayments. Finally the last equation in (4.29) states that the marginal gain from additional capital is equal to the marginal product of production function, similar to above.

As above, I assume that productivity and the tightness parameters follow stochastic processes:

$$\log(A_t^L) = \bar{A}^L + \rho^{A^L} \log(A_{t-1}^L) + \epsilon_t^{A^L} \quad (4.30)$$

$$\chi_t^L = \bar{\chi}^L + \epsilon_t^{\chi^L} \quad (4.31)$$

As above, χ_t^L is interpreted as a bounded random variable. I can also treat the parameter ϕ (which is interpreted as the average maturity of debt) in a similar manner:

$$\phi_t = \bar{\phi} + \epsilon_t^{\phi} \quad (4.32)$$

So, a positive shock to ϕ means longer debt maturity. I prefer not to impose an autoregressive process to macro-prudential variables: χ_t^L , χ_t^S and ϕ_t^L , to make sure they stay between 0 and 1. In Section 4.4 and 4.5, I will present the impulse responses to one-time temporary shocks and simulate the model under permanent MIT shocks respectively.

4.3.5 Market Clearing Conditions

The equilibrium in goods market requires that total consumption and investment are equal to total production.

$$C_t^S + C_t^{S,e} + I_t^S = A_t^S (K_{t-1}^S)^\alpha \quad (4.33)$$

$$C_t^L + C_t^{L,e} + I_t^L = A_t^L (K_{t-1}^L)^\nu \quad (4.34)$$

4.3.6 Calibration

For calibration, I extensively borrow from the literature about U.S. economy. The saver's (household's) discount rate, β , is calibrated to 0.99 to match the annual real rate of return of 4 percent, and borrower's (entrepreneur's) discount rate, γ is calibrated to 0.97 as in Iacoviello (2005) and Monacelli (2009). To calibrate the share of long-lived-capital good consumption in the consumption bundle and the elasticity of substitution between long-lived-capital and short-lived-capital consumption, I follow Engel and Wang (2011) and set κ to 0.23 and η to 1.1. Here, I implicitly assume long-lived-capital goods are proxied by durable goods and short-lived-capital goods are proxied by non-durable goods. For both sectors, we normalize steady state exogenous productivity factors, $\bar{A}^S$ and $\bar{A}^L$ to 1. To calibrate $\bar{\chi}^S$ and $\bar{\chi}^L$, I choose 0.7. Iacoviello (2005) calibrates loan to value ratio to 0.9 and Monacelli (2009) to 0.75. In this regard my parameter choices are not too different.

It might be more preferable to differentiate the tightness of borrowing across two sectors, if one aims to explain business and financial cycles at sectoral level and their contribution to aggregate economy. But this is not the main purpose of this chapter. The results are similar when I consider alternative calibrations.

I calibrate δ^L to 0.025 following the standard value in the literature (Monacelli, 2009). To reflect the much higher depreciation for the short-lived-capital good, I calibrate δ^S to 0.9. I calibrate the capital share in the production function α to 0.3, and ν to 0.4 to highlight higher productivity of long-lived-capital goods. ρ^{A^S} and ρ^{A^L} are calibrated to 0.9, which correspond to highly persistent paths for productivity factors. Finally, the value, $\bar{\phi}$ which reflects the average maturity of repayment of the long-term debt at steady state, is calibrated to 0.5, which means in each period agents pay half of their remaining debt. So, the duration of the long-term debt is twice that of the short-term debt. With this calibration, the model has a stable steady state.

4.4 Impulse Responses of Macroeconomic Variables to Temporary Shocks

In this section, I examine responses of macroeconomic variables to various shocks: productivity shocks to different sectors, shocks to borrowing limits which worsen financial conditions, and a shock to average maturity which increases the repayment period for long term debt. For quantity variables, I present impulse responses as percentage deviations from steady state. These are consumption of

final good (consumption basket), (X_t) ; production of long-lived-capital and short-lived-capital goods, $(Y_t^L$ and $Y_t^S)$; consumptions of household and entrepreneurs, $(C_t^L, C_t^S, C_t^{L,e}, C_t^{S,e})$; capital stocks and investments, $(K_t^S, K_t^L, I_t^S, I_t^L)$; debts and long-term repayments, (b_t^L, b_t^S, j_t) . For prices and debt rates, I present these in levels. Here, the responses to the shocks of our main interest are presented, and those with secondary importance are presented in Appendix D. In impulse response graphs, I used the words “long” and “short” to refer to long-lived-capital good and short-lived-capital sectors respectively. Moreover, for household’s consumption, the abbreviation *H.C.* is used and for entrepreneurs’ consumption *E.C.s*, are used.⁸

A Positive Shock to A_t^L :

The impulse responses to a 10 percent productivity increase in the long-lived-capital good sector are presented in Figure 4.1 and 4.2. The total productivity increase is reflected in the output of the long-lived-capital good producing sector. long-lived-capital good producer’s consumption and household’s final good consumption increases. Since entrepreneurs produce with the accumulated capital from the previous period, the household will benefit from the increased production of the long-lived-capital sector with a one period lag. Both investment and long-term debt will increase by more than 10 percent. Due to the rise in productivity, the relative price of the long-lived-capital good will fall, contributing to the increase in the household consumption of this good.

⁸The impulse response graphs to the same shock are labeled with (1), and (2). The graph set labeled with (1) present impulse responses of consumption basket, productions, household and entrepreneurial consumptions, accumulated repayments of long-term debt and long capital. The graph set labeled with (2) present short capital, investments of both sectors, debts, short and long interest rates, relative price of long-lived-capital good and short-term to long-term debt ratio.

However, the transmission to short-lived-capital sector is very limited. Obviously the reason for this is the assumption on financing: Entrepreneurs finance their investment with completely two different instruments which are not substitutes. Overall, the final good consumption (the basket) will increase up to 5 percent at its highest point.

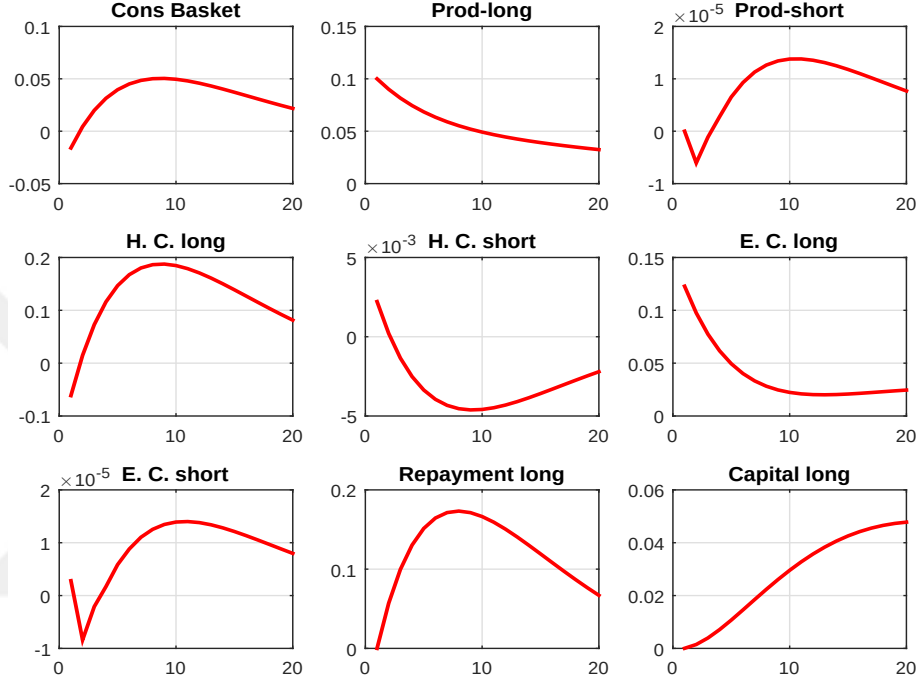


Figure 4.1: Baseline Model IRFs: A Positive Shock to A_t^L (1)

A Negative Shock to χ_t^L :

The impulse responses to a fall in the loan to investment ratio from 0.8 to 0.3, are presented in Figure 4.3 and 4.4. Here we give a negative shock to the loan to investment ratio which implies a tightening in financial conditions for the long-lived-capital good sector. Note that χ_t^L does not follow an autoregressive process, and with a small enough shock the value of the ratio stays between 0 and 1. The effect of a one-time temporary decrease (the next period it returns to the initial value) in this constraint is only visible for the long-lived-capital good sector, and

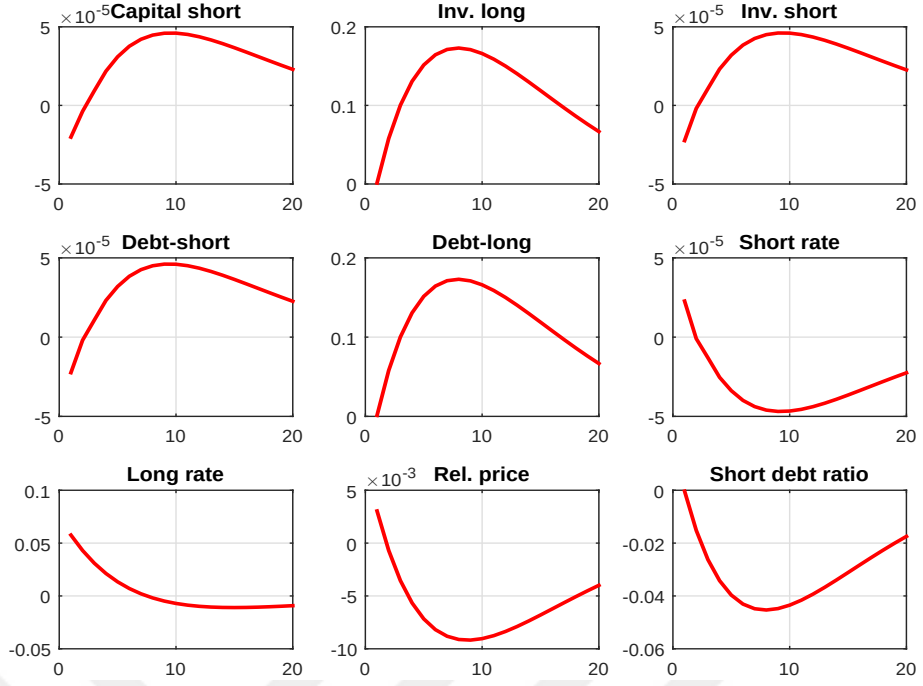


Figure 4.2: Baseline Model IRFs: A Positive Shock to A_t^L (2)

the effects for short-lived-capital sector are negligible as was the case for the productivity shock.

The long-lived-capital good entrepreneur has a chance to increase its investment in the first period by decreasing his own consumption. Since his capital depreciates very slowly, this provides a higher production for a long time (even if the magnitude is very small). However, after the realization of the shock, financing investment becomes much harder, which increases relative price of long-lived-capital good. In turn, household's consumption of long-lived-capital good never increases. This tightening shock causes capital good producers to accumulate more capital. But this does not reflect to consumption. Consumption of the final good falls significantly.

A Positive Shock to ϕ_t :

It is also possible to treat ϕ_t as a policy parameter, say financial authority's

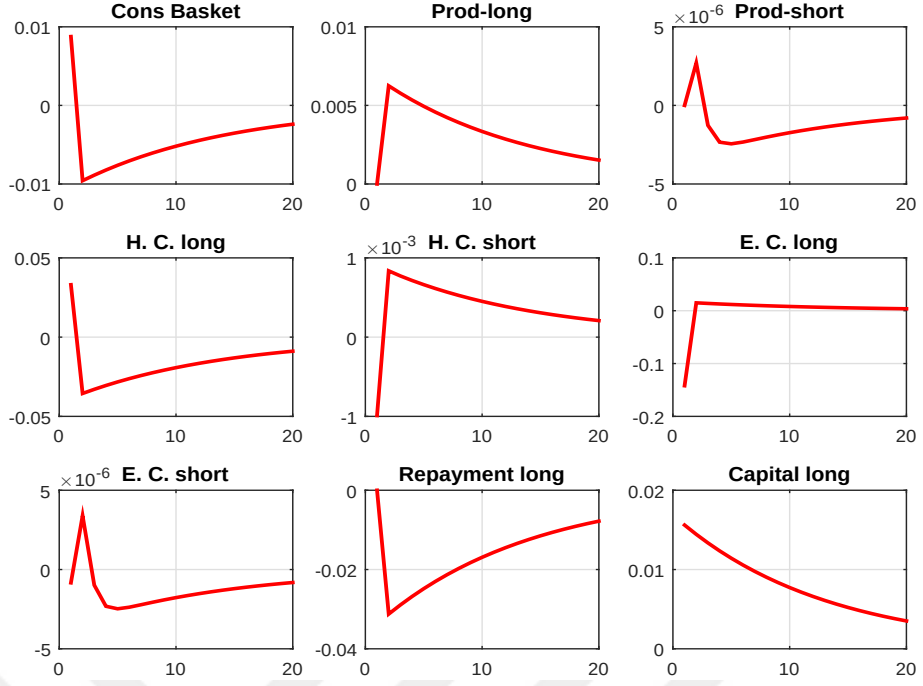


Figure 4.3: Baseline Model IRFs: A Negative Shock to χ_t^L (1)

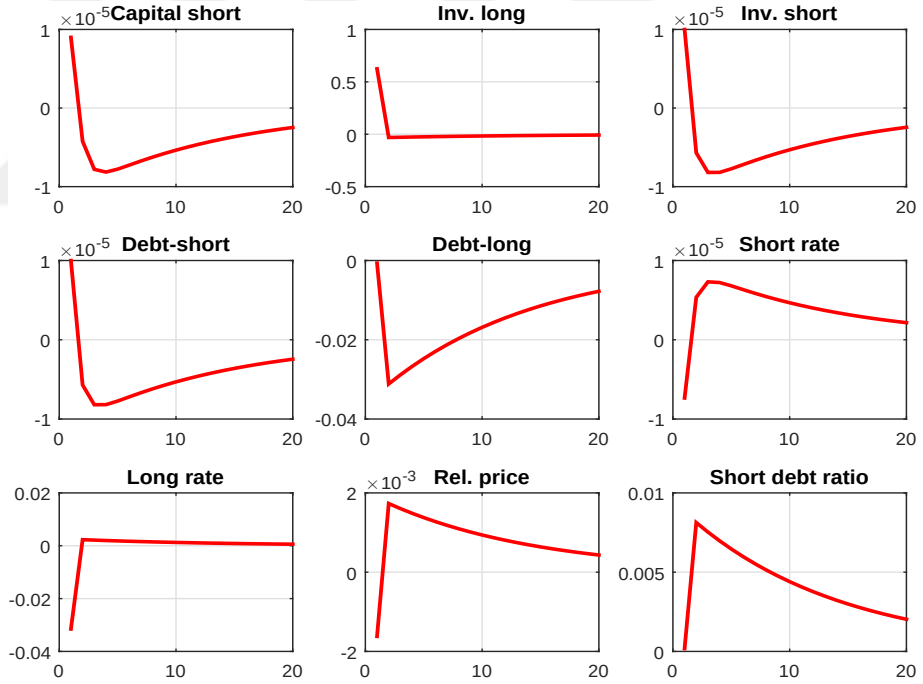


Figure 4.4: Baseline Model IRFs: A Negative Shock to χ_t^L (2)

choice of average maturity. The impulse responses to an increase in the average maturity parameter from 0.5 to 0.7 (which means duration increases from 2 to 3.5 periods), are presented in Figure 4.5 and Figure 4.6. This shock increases the amount of investment and loan demand for the long-term debt financed sector.

The long-lived-capital good producing sector benefits from it, and similar to the positive productivity shock, it lowers the relative price. In the end, household's consumption of the final good increases up to 5 percent. Moreover, short-term over long-term debt ratio falls.

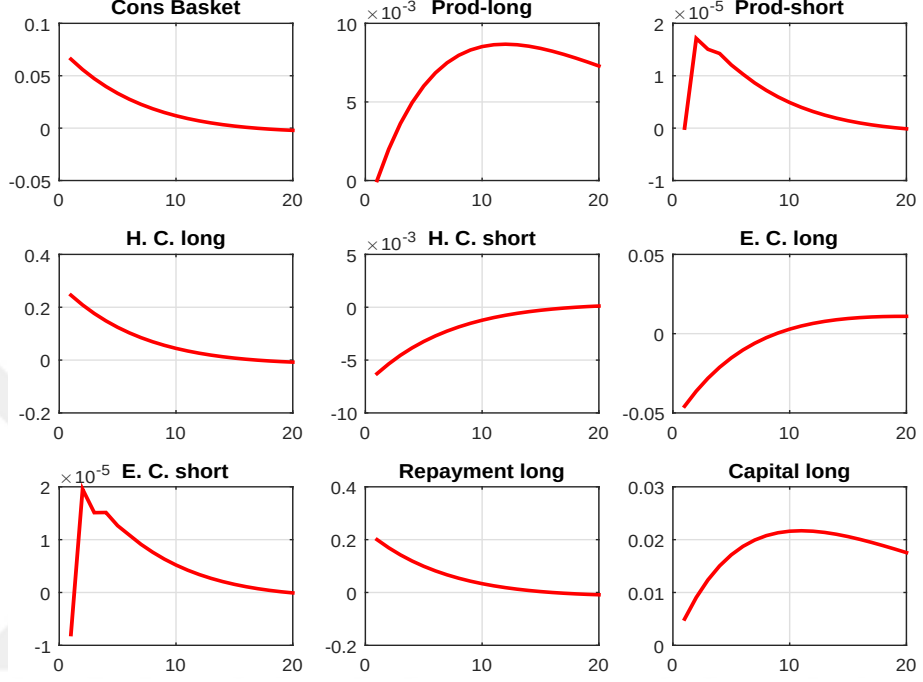


Figure 4.5: Baseline Model IRFs: A Positive Shock to $\phi_t (1)$

4.5 Simulated Paths under Permanent Shocks

In addition to temporary shocks and impulse response functions, in this section, I analyze simulated path under permanent shocks, which are usually called MIT shocks. Specifically, I check the transition paths in response to permanent macro-pudential shocks, such as tightening borrowing constraint for long-term debt financed sector and increasing the average maturity of long-term debt. **A**

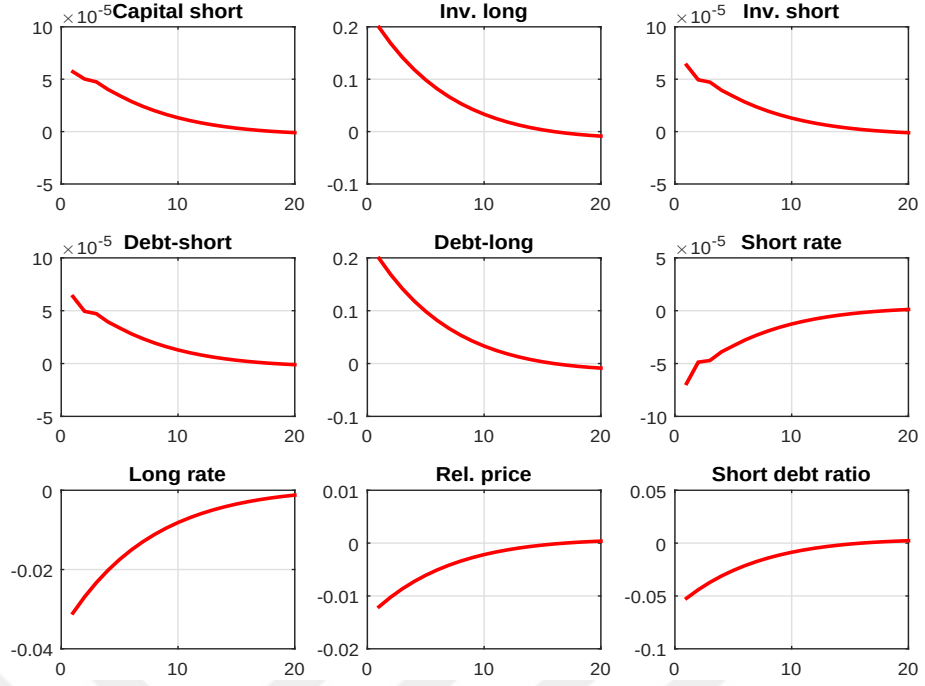


Figure 4.6: Baseline Model IRFs: A Positive Shock to ϕ_t (2)

Negative Shock to χ_t^L :

If the financial conditions become tighter for the long-term debt, we see similar results to those under temporary shocks. The capital stock in the long-term debt financed sector falls. The relevant consumption and production falls as well. Now long-lived-capital good sector suffers from this increased tightness but the effects on the other sector are negligible. The paths are presented in Figure 4.7 and Figure 4.8.

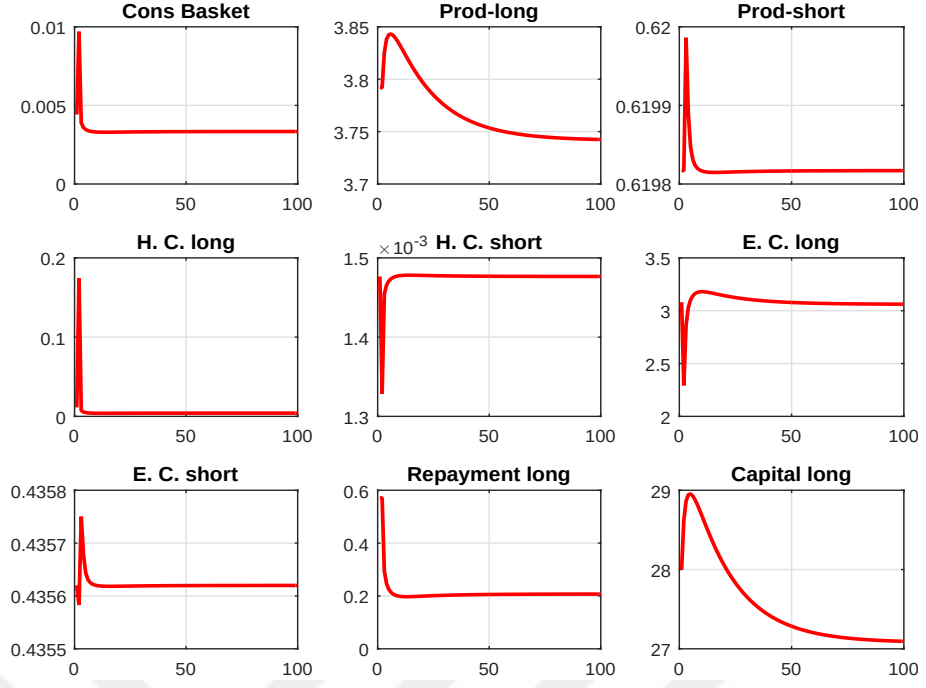


Figure 4.7: Baseline Model MIT Shocks: A Negative Shock to χ_t^L (1)

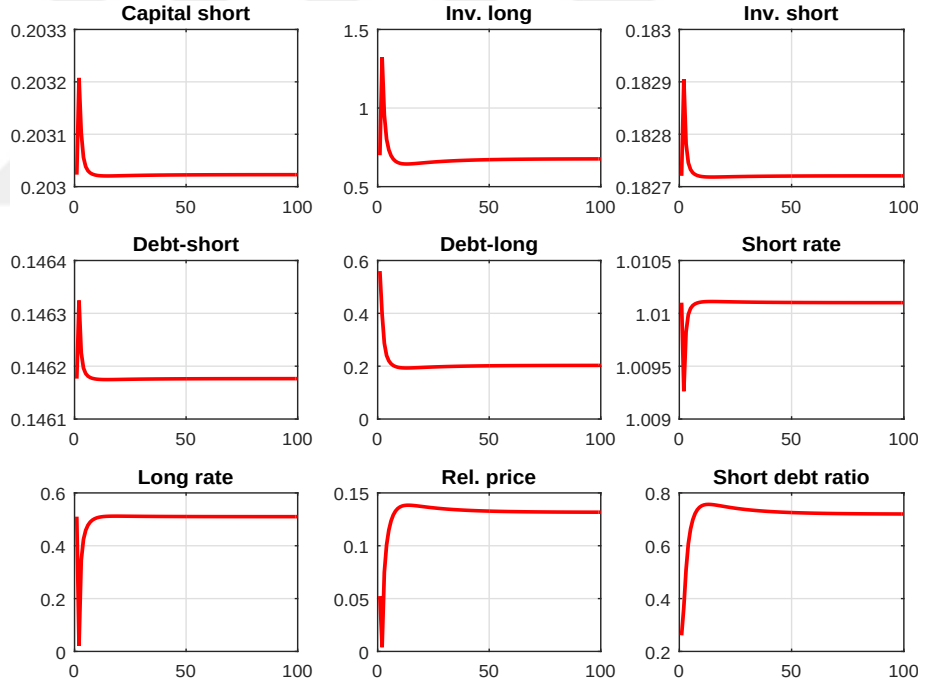


Figure 4.8: Baseline Model MIT Shocks: A Negative Shock to χ_t^L (2)

A Positive Shock to ϕ_t :

Finally, I investigate the transition to a longer maturity economy as presented in Figure 4.9 and Figure 4.10. Imposing a longer repayment structure causes

an expansion in the long-lived-capital good sector. Following the shock, they increase their production. Household's consumption of long-lived-capital goods and final good consumption increase as well. Along the path, production of short-lived-capital good increases as well, starting from the next period.

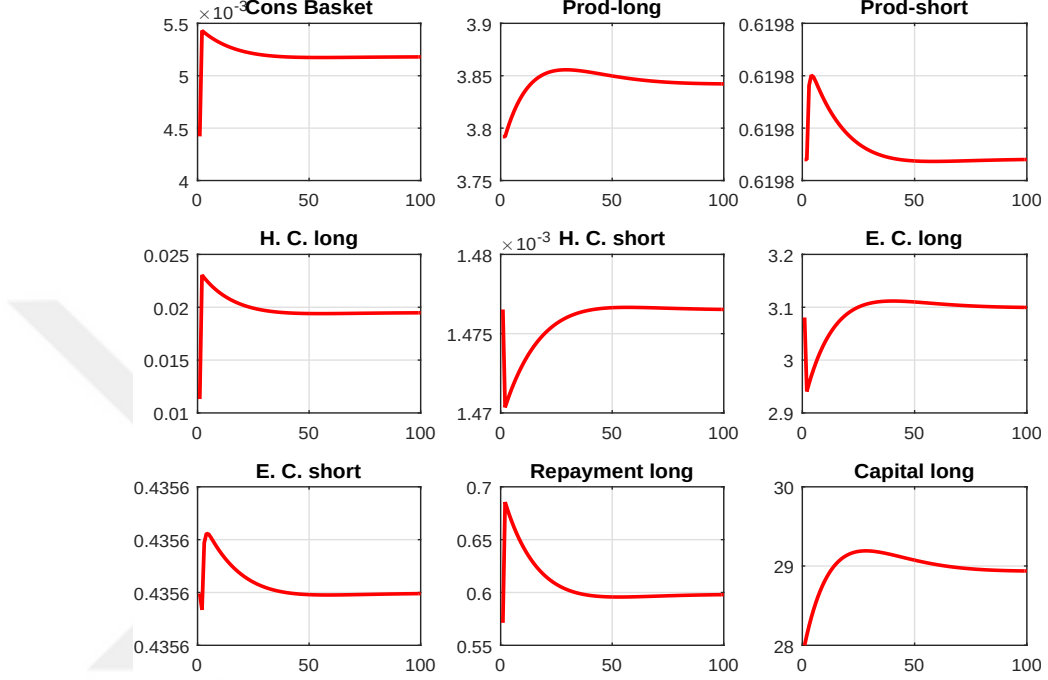


Figure 4.9: Baseline Model MIT Shocks: A Positive Shock to ϕ_t (1)

4.6 Extended Model Under Nominal Rigidities with Monetary Policy

Here, I add more realistic features to the simple model in the earlier sections to investigate the consequences of nominal rigidities, and the effect of monetary policy. Through two new agents, retailers, I introduce price stickiness. Moreover, I extend the model to study the role of floating rate long-term debt. This structure allows to analyze sectoral interactions and provides an environment with

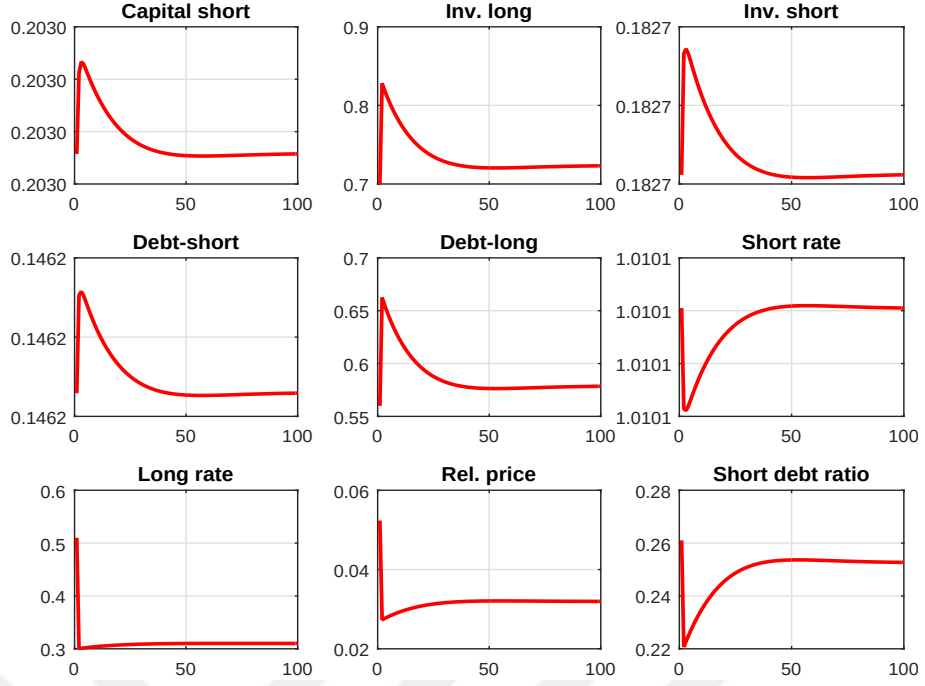


Figure 4.10: Baseline Model MIT Shocks: A Positive Shock to ϕ_t (2)

New Keynesian properties in which I can discuss monetary and macro-prudential policies.

4.6.1 Model

The model is a simple two sector New Keynesian dynamic stochastic general equilibrium (NK-DSGE) model which builds on the simple model described in Section 4.3. I introduce two new agents: long-lived-capital and short-lived-capital retailers to the economy. I assume that they are monopolistically competitive and subject to Calvo price stickiness. The entrepreneurs borrow from the household to invest in their capital, produce their output which they sell to retailers. Each retailer will differentiate the output, turn it into a consumption good and sell back to consumers. Introducing price stickiness and inflation will make a few changes in the model. Now, we switch real debts to nominal debts. So, future

payments will be affected by inflation. I normalize variables by the price of short-lived-capital good. I will denote the relevant gross inflation rate with π_t^S .

Calling j_t sum of real payments due in time t , the evolution of outstanding repayment is

$$j_t = \frac{1}{\pi_t^S}(\phi j_{t-1} + r_{t-1}^L b_{t-1}^L). \quad (4.35)$$

The short-term debt will be repaid in $\frac{1}{\pi_t^S} r_{t-1}^S$ unit of short-lived-capital consumption good in the next period.

4.6.2 Households

Household's problem will remain similar. However, I now, write every thing in nominal terms, and obtain real budget constraint by dividing with the price of short-lived-capital good.

So, the nominal budget constraint is

$$P_t^C C_t^S + P_t^L C_t^L + B_t^S + B_t^L = r_{t-1}^S B_{t-1}^S + J_t + T_t \quad (4.36)$$

which in real terms is

$$C_t^S + q_t^R C_t^L + b_t^S + b_t^L = \frac{1}{\pi_t^S} r_{t-1}^S b_{t-1}^S + j_t + t_t. \quad (4.37)$$

Here, I denote the consumption of long-lived-capital good with C_t^L and consump-

tion of short-lived-capital good with C_t^S . b_t^S , b_t^L and j_t show holdings in terms of real amounts. t_t is some exogenous net transfers. Relative price of long-lived-capital good, q_t^R will be determined from consumption maximization as follows:

$$q_t^R = \left(\frac{\kappa}{1 - \kappa} \frac{C_t^S}{C_t^L} \right)^{\frac{1}{\eta}} \quad (4.38)$$

The first order conditions and relevant Euler equations provide a link between consumption paths and debt returns, as before:

$$X_t^{(\frac{1}{\eta}-1)} (C_t^S)^{\frac{-1}{\eta}} (1 - \kappa)^{\frac{1}{\eta}} = \lambda_{1,t} \quad (4.39)$$

$$\beta \lambda_{1,t+1} r_t^S \frac{1}{\pi_{t+1}^S} = \lambda_{1,t} \quad (4.40)$$

$$\beta \lambda_{2,t+1} r_t^L \frac{1}{\pi_{t+1}^S} = \lambda_{1,t} \quad (4.41)$$

$$\lambda_{2,t} - \beta \phi \lambda_{2,t+1} \frac{1}{\pi_{t+1}^S} = \lambda_{1,t} \quad (4.42)$$

Here, $\lambda_{1,t}$ is the Lagrange multiplier related to the budget constraint, and $\lambda_{2,t}$ is the Lagrange multiplier related to the evolution of long-term repayments. With a non-stochastic steady state inflation of 1 (which follows from the monetary policy rule), the steady state debt interest rates are equal to those in basic model.

4.6.3 Entrepreneurs

In the extended model, there are two retailers in the economy who pack the outputs of entrepreneurs á la Bernanke et al. (1999). The entrepreneurs sell

their output at nominal prices W_t^S for the short-lived-capital goods and W_t^L for the long-lived-capital goods. Then, I can rewrite their budget constraints, again normalized with the price of short-lived-capital good, as follows:

Real budget constraint for the short-lived-capital good entrepreneur:

$$C_t^{S,e} + r_{t-1}^S b_{t-1}^S \frac{1}{\pi_t^S} + I_t^S = b_t^S + w_t^S A_t^S (K_{t-1}^S)^\alpha \quad (4.43)$$

Real budget constraint for the long-lived-capital good entrepreneur:

$$q_t^R C_t^{L,e} + q_t^R I_t^L + j_t = b_t^L + w_t^L A_t^L (K_{t-1}^L)^\nu \quad (4.44)$$

Now w_t^S and w_t^L are relative selling prices, more specifically; $w_t^S = \frac{W_t^S}{P_t^S}$ and $w_t^L = \frac{W_t^L}{P_t^S}$.

The outputs of the two sectors are

$$Y_t^S = A_t^S (K_{t-1}^S)^\alpha \quad (4.45)$$

$$Y_t^L = A_t^L (K_{t-1}^L)^\nu. \quad (4.46)$$

The borrowing constraints remain similar:

$$b_t^S \leq \chi_t^S I_t^S \quad (4.47)$$

$$b_t^L \leq \chi_t^L q_t^R I_t^L. \quad (4.48)$$

Similar to baseline model, the optimality conditions for short-lived-capital good producers are

$$\frac{1}{C_t^{S,e}} - \gamma r_t^S \frac{1}{C_{t+1}^{S,e}} \frac{1}{\pi_{t+1}} = \mu_{2,t} \quad (4.49)$$

$$\frac{1}{C_t^{S,e}} = \mu_{2,t} \chi_t^S + \mu_{3,t} \quad (4.50)$$

$$\frac{1}{C_{t+1}^{S,e}} \gamma w_{t+1}^S A_{t+1}^S \alpha (K_t^S)^{\alpha-1} = \mu_{3,t} - \gamma (1 - \delta^S) \mu_{3,t+1}. \quad (4.51)$$

For long-lived-capital good producers,

$$\frac{1}{C_t^{L,e}} \frac{1}{q_t^R} = \gamma \phi \mu_{6,t+1} \frac{1}{\pi_{t+1}} - \mu_{6,t} \quad (4.52)$$

$$\frac{1}{C_t^{L,e}} = \mu_{5,t} \chi_t^L q_t^R + \mu_{7,t} \quad (4.53)$$

$$\frac{1}{C_t^{L,e}} \frac{1}{q_t^R} = \mu_{5,t} - \gamma \mu_{6,t+1} \frac{1}{\pi_{t+1}} r_t^L \quad (4.54)$$

$$\frac{1}{C_{t+1}^{L,e}} w_{t+1} \gamma A_{t+1}^L \nu (K_t^L)^{\nu-1} = \mu_{7,t} - \gamma (1 - \delta^L) \mu_{7,t+1}. \quad (4.55)$$

The interpretations are similar to the ones in the baseline model but now we have relative price of long-lived-capital good and prices of intermediary goods in optimality conditions.

Note that even with the model that includes all relative prices and convertibility across units of goods, I do not write borrowing constraints in terms of prices or interest rates.

The standard models write this constraint in terms of values, like the total value of repayment can not exceed the value of capital.⁹ I refrain from this for two reasons.

⁹See for example Kiyotaki and Moore (1997), Iacoviello (2005), Monacelli (2009).

First, the long-term debt structure used in this chapter has infinite maturity, It is not trivial how to restrict the repayments for a particular long-term debt. Second, in this set-up, I neither have fixed-supply capital nor capital adjustment costs which would make the price of investment good variable. Instead, I model investment goods which have the same price as the output, as if they are produced by some other perfectly competitive agents. Extensions of the model to include variable price of capital will make the amplification mechanism closer to net worth channel described by the standard models as in Kiyotaki and Moore (1997), and Bernanke et al. (1999).

The accumulation of investment goods and stochastic processes remain the same.

4.6.4 Retailers and Price Stickiness

I assume two distinct monopolistically competitive retailers that buy intermediate goods from entrepreneurs, differentiate them, and turn these into a consumption good á la Bernanke et al. (1999) and Iacoviello (2005). This structure enables us to impose price stickiness easily and allows the pricing decision to be separate from borrowing decision.

There are continuum of retailers, indexed by z for each sector. They buy intermediate goods Y_t^j paying W_t^j and sell at $P_t^j(z)$ to the household, where $j = S$ for short-lived-capital good and $j = L$ for long-lived-capital good.

The final goods ready to consume are,

$$Y_t^j = \left(\int_0^1 (Y_{z,t}^j)^{\frac{\epsilon-1}{\epsilon}} dz \right)^{\frac{\epsilon}{\epsilon-1}}. \quad (4.56)$$

With this aggregate output index, the price index is,

$$P_t^j = \left(\int_0^1 (P_{z,t}^j)^{1-\epsilon} dz \right)^{\frac{1}{1-\epsilon}}. \quad (4.57)$$

Then, the demand for each retail good variety in each sector is,

$$Y_{z,t}^j = \left(\frac{P_{z,t}^j}{P_t^j} \right)^{-\epsilon} Y_t^j. \quad (4.58)$$

Firms in the retail sector are able to change their prices with $1 - \psi^j$ probability.

Then, firm's profit maximization problem takes the form:

$$\max E_t \sum_{k=0}^{\infty} (\psi^j \beta)^k \Lambda_{t,t+k} \left\{ \frac{P_{z,t}^{j*}}{P_{t+k}^j} \left(\frac{P_{z,t}^{j*}}{P_{t+k}^j} \right)^{-\epsilon} Y_{t+k}^j - w_{t+k}^j \left(\frac{P_{z,t}^*}{P_{t+k}^j} \right)^{-\epsilon} Y_{t+k}^j \right\} \quad (4.59)$$

Here, $\Lambda_{t,t+k}$ is the stochastic discount factor of the household. Notably, the demand equation for each variety is also substituted in (4.59). From this point on, I omit the superscript, j, keeping in mind two-different retailers have exactly the same structure. The first order condition is

$$E_t \sum_{k=0}^{\infty} (\psi \beta)^k \Lambda_{t,t+k} \left\{ (1 - \epsilon) \frac{(P_{z,t}^*)^{-\epsilon}}{P_{t+k}^{1-\epsilon}} Y_{t+k} + \epsilon w_{t+k} \frac{(P_{z,t}^*)^{-\epsilon-1}}{P_{t+k}^{-\epsilon}} Y_{t+k} \right\} = 0. \quad (4.60)$$

Simplifying and rearranging, one can rewrite it as:

$$P_{z,t}^* = \frac{\epsilon}{\epsilon - 1} \frac{E_t \sum_{k=0}^{\infty} (\psi\beta)^k \Lambda_{t,t+k} w_{t+k} P_{t+k}^{\epsilon} Y_{t+k}}{E_t \sum_{k=0}^{\infty} (\psi\beta)^k \Lambda_{t,t+k} P_{t+k}^{\epsilon-1} Y_{t+k}}. \quad (4.61)$$

Now, define A_t and B_t as:

$$A_t = E_t \sum_{k=0}^{\infty} (\psi\beta)^k \frac{1}{C'_{t+k}} W_{t+k} P_{t+k}^{\epsilon} Y_{t+k} \quad (4.62)$$

$$B_t = E_t \sum_{k=0}^{\infty} (\psi\beta)^k \frac{1}{C'_{t+k}} P_{t+k}^{\epsilon-1} Y_{t+k} \quad (4.63)$$

Then,

$$A_t = \lambda_{1,t} w_t P_t^{\epsilon} Y_t + \psi\beta E_t A_{t+1} \quad (4.64)$$

$$B_t = \lambda_{1,t} P_t^{\epsilon-1} Y_t + \psi\beta E_t B_{t+1}. \quad (4.65)$$

The price index is

$$P_t = \left(\int_0^1 (P_{z,t})^{1-\epsilon} dz \right)^{\frac{1}{1-\epsilon}}. \quad (4.66)$$

Using Calvo pricing, one can rewrite it as

$$P_t = \left(\int_0^{1-\psi} (P_t^{\#})^{1-\epsilon} dz + \int_{1-\psi}^1 (P_{t-1}(z))^{1-\epsilon} dz \right)^{\frac{1}{1-\epsilon}} \quad (4.67)$$

$$P_t = ((1 - \psi)(P_t^{\#})^{1-\epsilon} + \psi(P_{t-1})^{1-\epsilon})^{\frac{1}{1-\epsilon}}. \quad (4.68)$$

Here, $P^{\#}$ denotes new optimal price which is the same for every firm. Now divide

both sides with P_{t-1} and denote gross inflation with $\pi_t = P_t/P_{t-1}$. Then,

$$\pi_t = ((1 - \psi)(\frac{P_t^\sharp}{P_{t-1}})^{1-\epsilon} + \psi)^{\frac{1}{1-\epsilon}} \quad (4.69)$$

$$P_t^\sharp = \frac{\epsilon}{\epsilon - 1} \frac{A_t}{B_t} \quad (4.70)$$

$$\frac{1}{P_{t-1}} P_t^\sharp = \frac{1}{P_{t-1}} \frac{\epsilon}{\epsilon - 1} \frac{A_t}{B_t} \quad (4.71)$$

Define a_t and b_t as follows:

$$a_t = \frac{A_t}{P_t^\epsilon} \quad (4.72)$$

$$b_t = \frac{B_t}{P_t^{\epsilon-1}} \quad (4.73)$$

$$\frac{p_t^\sharp}{p_t} = \frac{\epsilon}{\epsilon - 1} \frac{a_t}{b_t}. \quad (4.74)$$

In terms of inflation:

$$\pi_t^\sharp = \frac{\epsilon}{\epsilon - 1} \pi_t \frac{a_t}{b_t}. \quad (4.75)$$

Finally the set of equations that describe price formation for each sector is

$$a_t^j = \lambda_{1,t} w_t^j Y_t^j + \psi^j \beta (\pi_t^j)_{t+1}^\epsilon E_t a_{t+1}^j \quad (4.76)$$

$$b_t^j = \lambda_{1,t} Y_t^j + \psi^j \beta (\pi_t^j)_{t+1}^{\epsilon-1} E_t b_{t+1}^j \quad (4.77)$$

$$\pi_t^{j,\sharp} = \frac{\epsilon}{\epsilon - 1} \pi_t^j \frac{a_t^j}{b_t^j} \quad (4.78)$$

$$\pi_t^j = ((1 - \psi^j)(\pi_t^{j,\sharp})^{1-\epsilon} + \psi^j)^{\frac{1}{1-\epsilon}}. \quad (4.79)$$

Since our main interest is not about price stickiness in two different sectors, I assume that ϵ and ψ are the same for both sectors. The role of price stickiness in different sectors is discussed extensively in Monacelli (2009).

If I integrate $Y_{z,t}^j = (\frac{P_{z,t}^j}{P_t^j})^{-\epsilon} Y_t^j$, the aggregate output ready for consumption will be net of price dispersion costs. So, if I define price dispersion as,

$$v_t^{j,p} = \int_0^1 (\frac{P_{z,t}^j}{P_t^j})^{-\epsilon} dz \quad (4.80)$$

$$Y_t^{j,f} = Y_t^j / v_t^{j,p}. \quad (4.81)$$

Because of the price dispersion costs, not all output will reach the final consumption stage.

Last but not least, I define a welfare-based CPI index as in Monacelli (2009):

$$P_t = \left[(1 - \kappa)(P_t^S)^{1-\eta} + \kappa(P_t^L)^{1-\eta} \right]^{\frac{1}{1-\eta}}. \quad (4.82)$$

Using this, it is possible to characterize relative price indexes as follows:

$$\frac{P_t}{P_t^S} = \left[(1 - \kappa) + \kappa(q_t^R)^{1-\eta} \right]^{\frac{1}{1-\eta}} = g_t^S \quad (4.83)$$

$$\frac{P_t}{P_t^L} = \left[\kappa + (1 - \kappa)(q_t^R)^{-(1-\eta)} \right]^{\frac{1}{1-\eta}} = g_t^L \quad (4.84)$$

Then, it is possible to relate CPI to sectoral inflations as

$$\pi_t = \pi_t^j \frac{g_t^j}{g_{t-1}^j} \quad (4.85)$$

4.6.5 Monetary Policy and Market Clearing

The monetary authority chooses short-term interest rate, r_t^S . As in Iacoviello (2005), it follows a Taylor Rule, which takes the form

$$R_t^S = (R_{t-1}^S)^{r_R} \left[\Pi_{t-1}^{1+r_\pi} \left(\frac{Y_{t-1}}{Y_{SS}} \right)^{r_y \bar{r}\bar{r}} \right]^{1-r_R} e_{R,t}. \quad (4.86)$$

Here, $\bar{r}\bar{r}$ and Y_{SS} show steady state levels for real interest rate and output. The natural logarithm of $e_{R,t}$ follows a white noise shock process with a mean 0 and variance, $\sigma_{e_R}^2$.

Equilibrium in goods market entail total consumption and investment should equal to total available output.

$$C_t^S + C_t^{S,e} + I_t^S = Y_t^{S,f} \quad (4.87)$$

$$C_t^L + C_t^{L,e} + I_t^L = Y_t^{L,f}. \quad (4.88)$$

4.6.6 Calibration

For calibration, I use the same parameter values as the baseline model. For price stickiness, I set ψ to 0.75, which is the standard value in the literature as in Iacoviello (2005). For the Taylor rule, I borrow the parameter values from Iacoviello (2005) and calibrate r_R to 0.73, r_π to 0.73 and r_y to 0.

4.6.7 Impulse Responses of Macroeconomic Variables to Temporary Shocks

Here, I present selected impulse responses to temporary shocks. In the basic model, this part was not that interesting, because the interaction across the sectors were minimal. However, with nominal rigidities and monetary policy, the transmission mechanisms are more interesting and worth exploring. Similar to the results in Section 4.4, for quantities, impulse responses are presented in percentage deviations from steady state. For relative prices, inflation and policy rate, they are presented in levels.¹⁰

A Positive Shock to A_t^L :

The impulse responses to a positive productivity shock in long-lived-capital sector are provided in Figures 4.11, 4.12, and 4.13. Contrary to the baseline model, now the interactions across sectors are significant.

After the positive productivity shock, the output and investment in the long-lived-capital good sector increase. The demand for long-term debt rises to finance new

¹⁰Now the figures labeled with (3) present intermediate prices and inflations.

investment. Even though the capital stock for the long-lived-capital good sector increases up to 5 percent, the stock of short-lived-capital good drops by 1 percent. The demand for short-term debt drops as well.

Following the productivity shock, the relative price of the long-lived-capital good falls, which leads to a fall in intermediate good price as well. The disinflation in this sector causes overall CPI to fall. Short-term interest rate experiences a decline. The fall in the interest rates incentives long-lived-capital good entrepreneurs to invest even more. Plus, fall in CPI rises real returns for the household who now increases consumption of both goods. Household increases his consumption by 4-6 percent for both types of goods. To provide the demand for the short-lived-capital good, the entrepreneurs in this sector sacrifice from their own consumption and investment. So the household's consumption of short-lived-capital good increases whereas entrepreneur's consumption and investment falls.

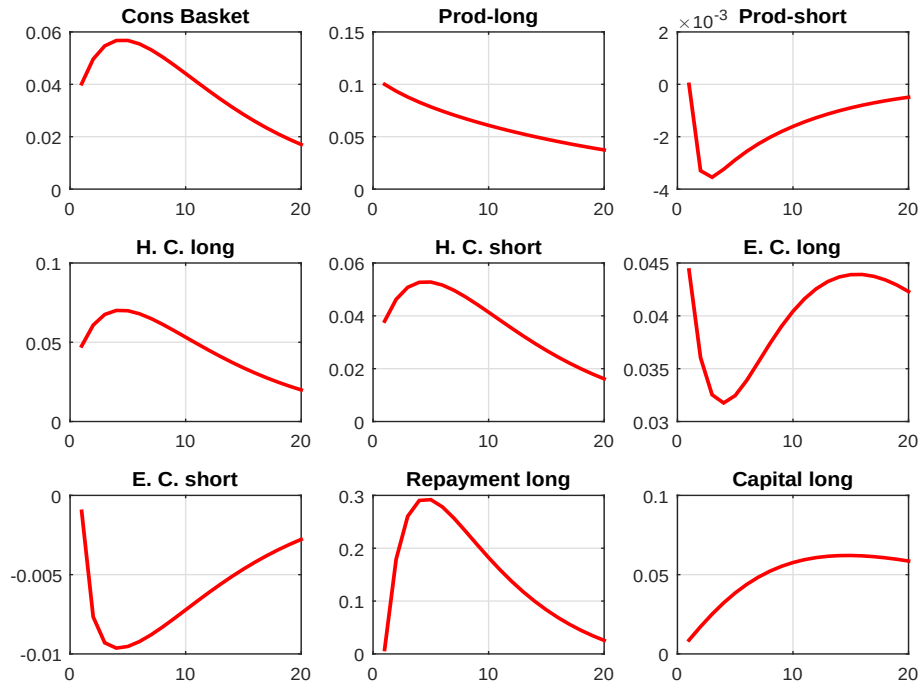


Figure 4.11: Extended Model IRFs: A Positive Shock to $A_t^L (1)$

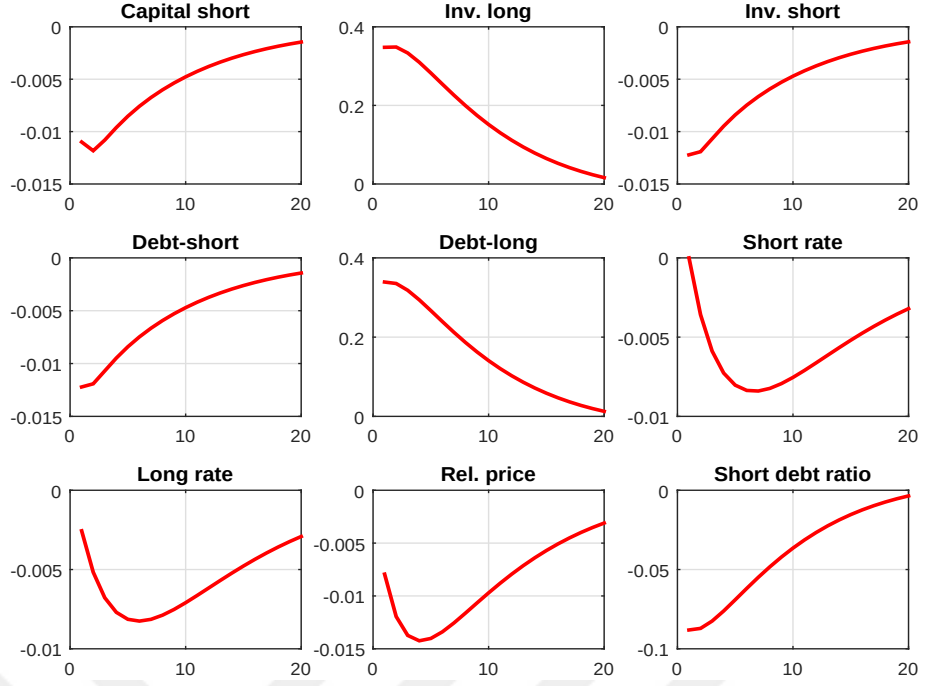


Figure 4.12: Extended Model IRFs: A Positive Shock to A_t^L (2)



Figure 4.13: Extended Model IRFs: A Positive Shock to A_t^L (3)

A Negative Shock to χ_t^L :

Now, I discuss a tightening shock on the constraint on the long-term investment.

The impulse responses are presented in Figures 4.14, 4.15, and 4.16. After the

financial conditions worsen, the capital investment falls. The demand for long-term debt also falls, resulting to long-term interest rate falling as well.

Because entrepreneurs borrow less, the household has more resources to spend on consumption. So, a negative macro-prudential shock works in opposite directions for borrowers and lenders. This result is not specific to the model in this chapter. Justiniano et al. (2015) discuss this and argue that for this reason the shocks to borrowing constraints can not be the main reason for credit cycles.

In addition to this, lower price levels and so disinflation contributes to the increase in household's consumption in both sectors, by increasing real returns. In other words, the effect of a tightening macro prudential policy is only tightening for entrepreneurs. With an inflation-targeting policy rule, monetary authority follows an expansionary policy.

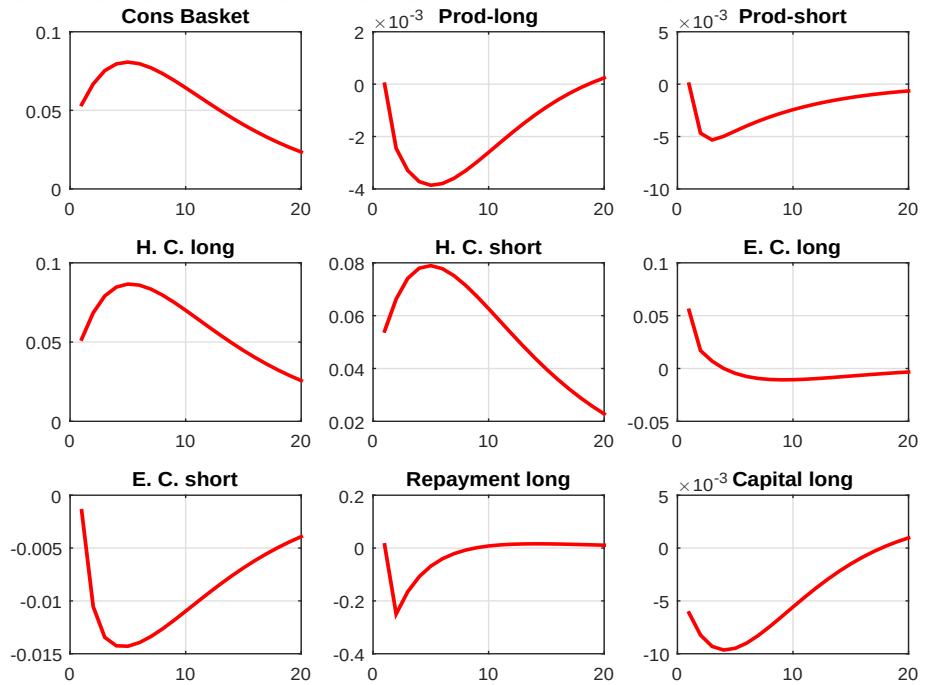


Figure 4.14: Extended Model IRFs: A Negative Shock to χ_t^L (1)

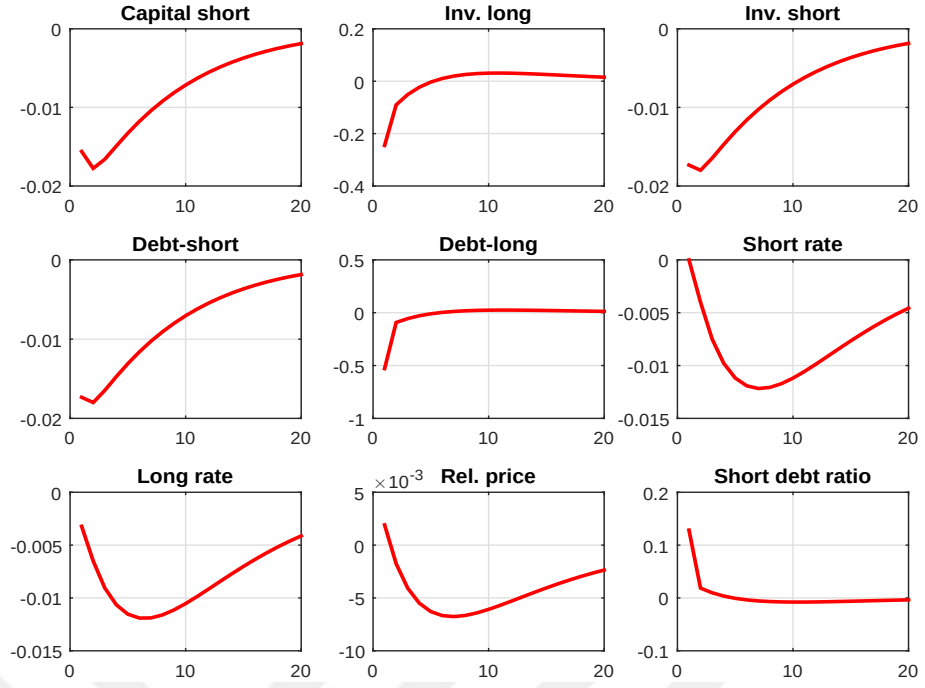


Figure 4.15: Extended Model IRFs: A Negative Shock to χ_t^L (2)

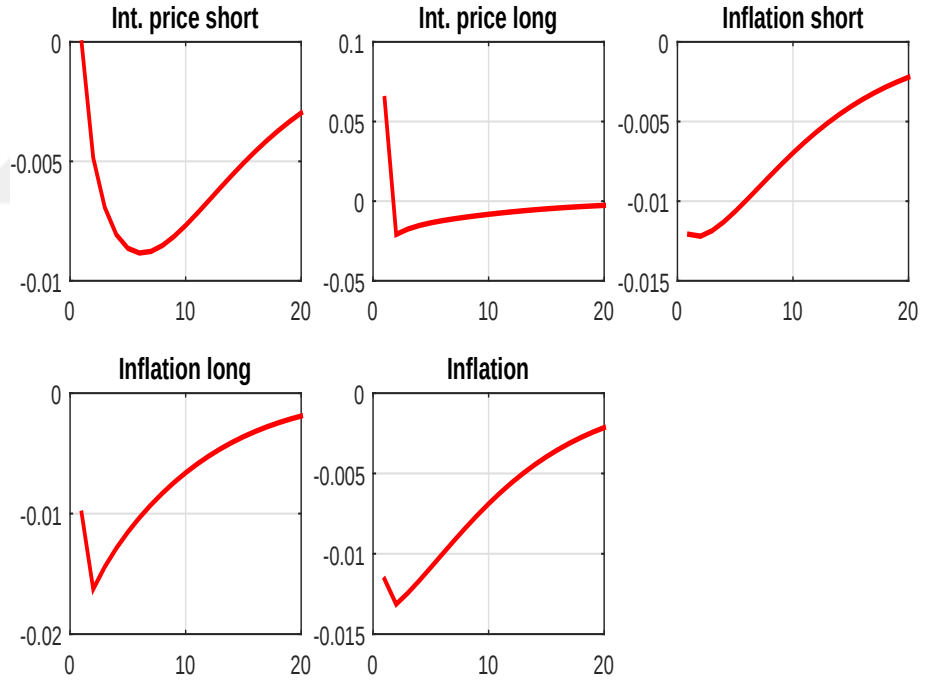


Figure 4.16: Extended Model IRFs: A Negative Shock to χ_t^L (3)

A Positive Shock to ϕ_t :

A positive shock means increasing the maturity of debt contract. The impulse responses are presented in Figures 4.17, 4.18 and 4.19. Now the responses are

different when compared to the baseline model. First, an increase in the maturity raises loan demand and consequently investment and capital stock. The increase in the loan demand, results to interest rates increasing as well. With the same reasoning as above, household devote more of their resources to lend instead of consuming. That explains the fall in household consumption. Because their consumption of long-lived-capital good falls, the relative price of this good increases. That ends up with rise in the inflation and consequently in interest rates. This part is completely different from baseline model.

Even though the financial conditions become more favorable for the long-lived-capital good producing sector, the cost, in terms of interest rate raises as well. As a result of this, their retail price increases. Due to the increase in their prices, inflation goes up. Eventually, the hike in inflation drops the real returns from debts and this also contributes to the fall in household's consumption.

My model shows that, macro prudential policies might not always work as intended: they might have different distributional effects on borrowers and lenders. For example, a policy that targets financial improvement might hurt the consumption of the household (lender) and be beneficial for the entrepreneurs, and vice versa for financial distress.

A Positive Monetary Policy Shock:

Finally, I present the impulse responses to a positive monetary policy surprise. The size of the shock is 1 percent. The impulse responses are presented in Figures 4.20, 4.21, and 4.22. As expected, the rise in the short-term rate causes an increase in the long-term rate as well. Consequently, inflation falls in all sectors. Both

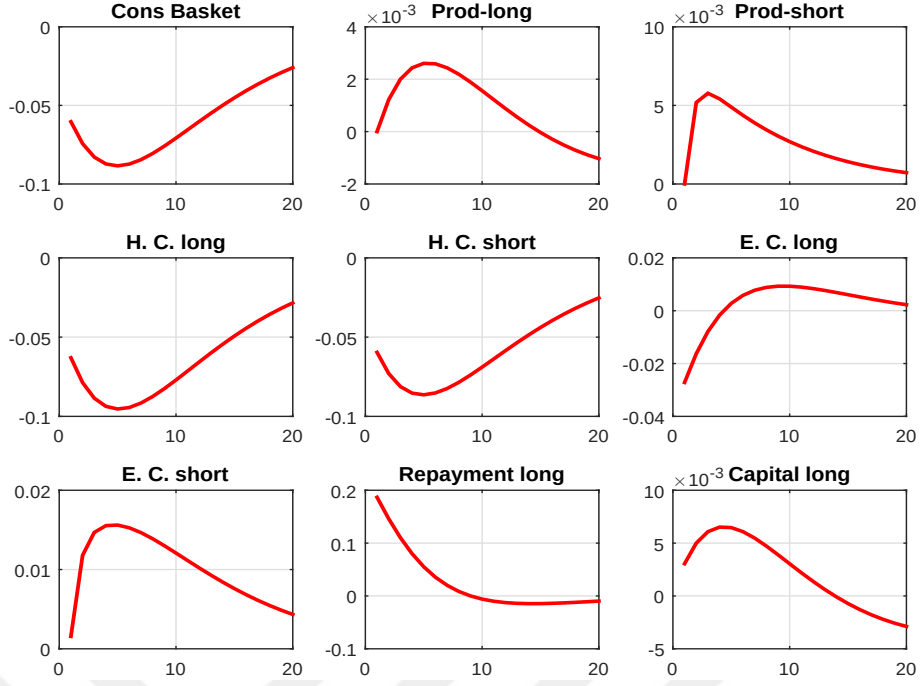


Figure 4.17: Extended Model IRFs: A Positive Shock to ϕ_t (1)

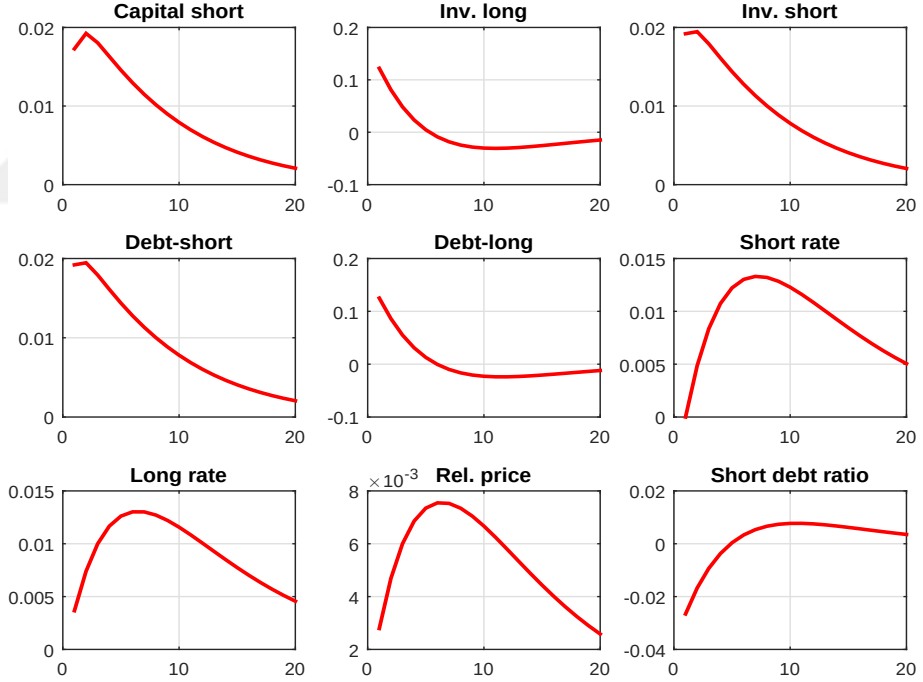


Figure 4.18: Extended Model IRFs: A Positive Shock to ϕ_t (2)

short-term and long-term loans experience a decline together with investment levels and accumulated capital. Eventually, both producers have to cut down their productions. The decline is more pronounced for the long-lived-capital good sector which implies that the short-term debt to long-term debt ratio increases.

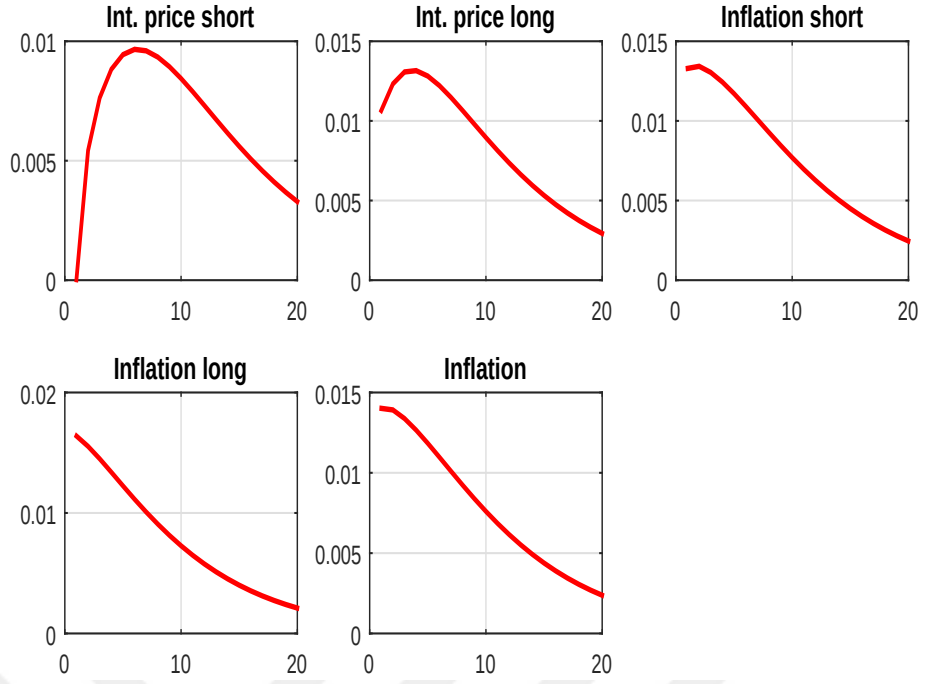


Figure 4.19: Extended Model IRFs: A Positive Shock to ϕ_t (3)

The decrease in household consumption is only restricted to initial periods. The reason for this is twofold. First, due to the fact that entrepreneurs demand less debt, the household can spend more on consumption. Second is the fall in prices and inflation. Because the fall in inflation level increases real returns from financial instruments, this income effect mitigates the adverse effects of tightening policy shock on consumers.

4.7 Floating Rate Long-term Debt

In reality, firms borrow long-term debt, most of which are on the floating rate basis, documented in the second chapter and also in Ippolito et al. (2017). In this section, I will modify the long-term perpetuity debt to have the property of floating rate repayment structure.

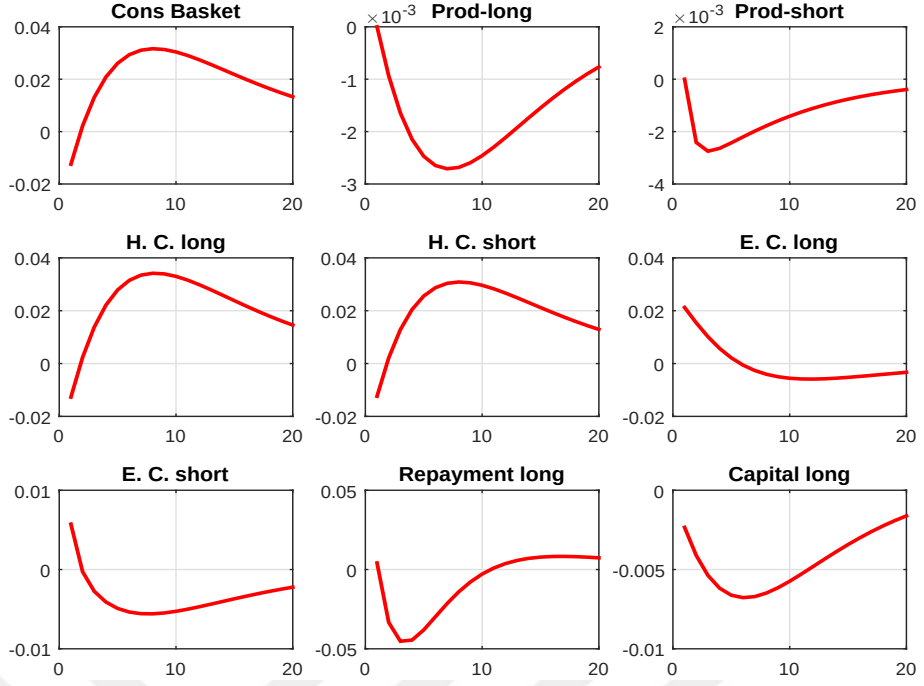


Figure 4.20: Extended Model IRFs: A Positive Shock to Policy Rate (1)

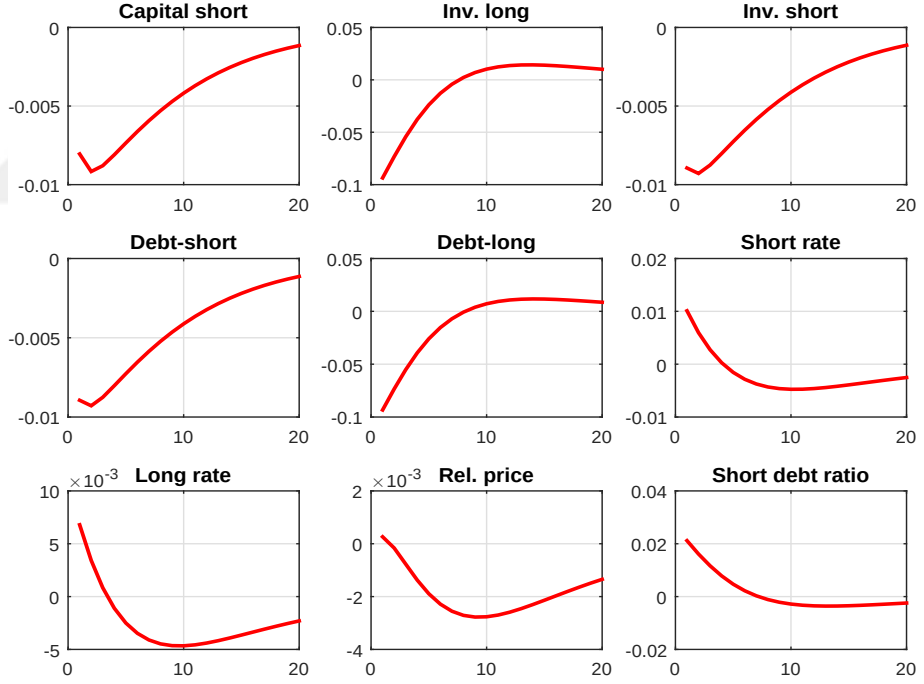


Figure 4.21: Extended Model IRFs: A Positive Shock to Policy Rate (2)

For example, consider that an agent borrows b_t^L amounts of long-term debt. Repayment is done at a decaying rate of ϕ with a floating rate r_t^L , determined one period in advance.

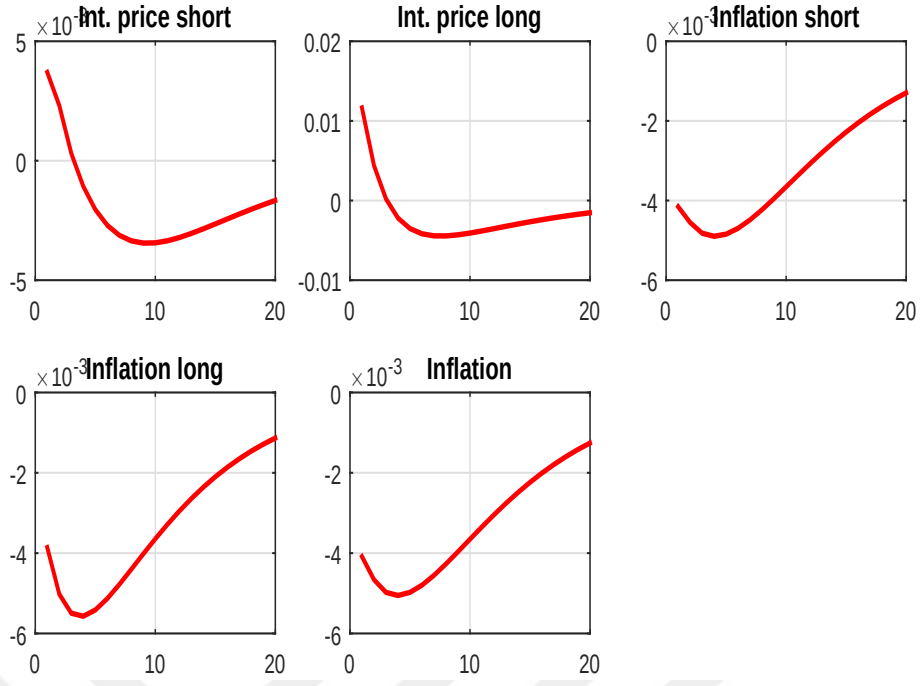


Figure 4.22: Extended Model IRFs: A Positive Shock to Policy Rate (3)

- repayment due at $t+1$ $r_t^L b_t^L$
- at $t+2$ $\phi r_{t+1}^L b_t^L$
-
- at $t+k$ $\phi^k r_{t+k-1}^L b_t^L$

Call j_t^L sum of payments due in time t . Then, I can rewrite it as a state variable, whose law of evolution with floating rate debt is

$$j_t = \phi j_{t-1} \frac{r_{t-1}^L}{r_{t-2}^L} + r_{t-1}^L b_{t-1}^L. \quad (4.89)$$

Now, in each period, outstanding amount of repayment is restructured with the realized change in interest rate.

The floating rate long-term debt will not alter the steady state of the model since

the ratio $\frac{r_{t-1}^L}{r_{t-2}^L}$ is equal to 1 in the steady state. The change in the long-term interest rate will appear in the optimality conditions. Specifically, first order conditions with respect to the state variable, j_t will alter for the household and for the long-lived-capital good producer as follows:

$$\lambda_{2,t} - \beta\phi\lambda_{2,t+1}\frac{1}{\pi_{t+1}}\frac{r_t^L}{r_{t-1}^L} = \lambda_{1,t} \quad (4.90)$$

$$\frac{1}{C_t^{L,e}}\frac{1}{q_t^R} = \gamma\phi\mu_{6,t+1}\frac{1}{\pi_{t+1}}\frac{r_t^L}{r_{t-1}^L} - \mu_{6,t} \quad (4.91)$$

Here, the definitions of the Lagrange multiplier are similar to the original optimality conditions in Section 4.6.2 and 4.6.3.

4.7.1 Compare Maturity for Floating Rate Debt: Responses to Monetary Policy Shock

First, I investigate the effect of floating rate debt maturity by comparing the two models' in responses to monetary policy shocks, which are presented in Figures 4.23-4.27. The average maturity, ϕ , is now treated as a parameter and calibrated to 0.45 and 0.55 respectively for the short maturity and long maturity models. All other parameters are the same.

First, the higher the maturity of floating rate debt, the more persistent inflation is. With a higher maturity floating rate debt, inflation in response to positive monetary policy falls less compared to the model with the lower maturity. The short-term and long-term interest rates remain at higher levels. Capital stock and investment in long-lived-capital good producing sector falls more for the

higher maturity calibration. Due to scale issues the difference in investment is not apparent however the investment in the long maturity economy is lower by around 0.2 %. The differences in impulse responses in high maturity economy and low maturity economy is presented in 4.28.

On the other hand, the decline is modest for the short-lived-capital good sector. This is reflected on both production and consumption. Furthermore, the final good consumption is lower for the higher maturity floating rate debt model. The final good consumption is lower even though the share of the long-lived-capital good sector is calibrated to 0.23, which is a relatively small share. This highlights that depending on this calibration the aggregate macro effects of long term finance might change.

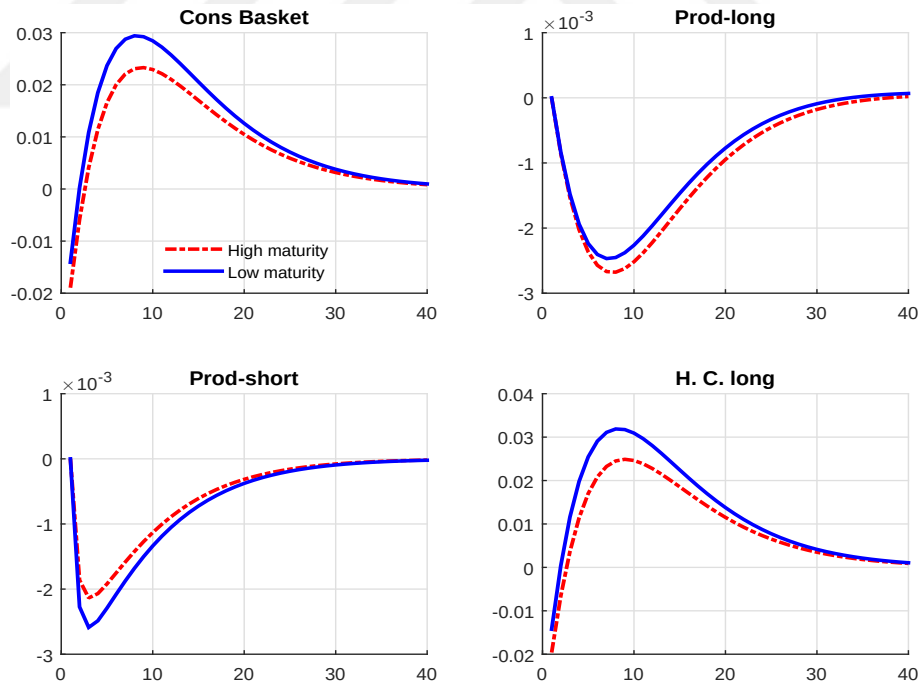


Figure 4.23: Comparison of Long vs. Short Maturity: Responses to positive monetary policy surprise (1)

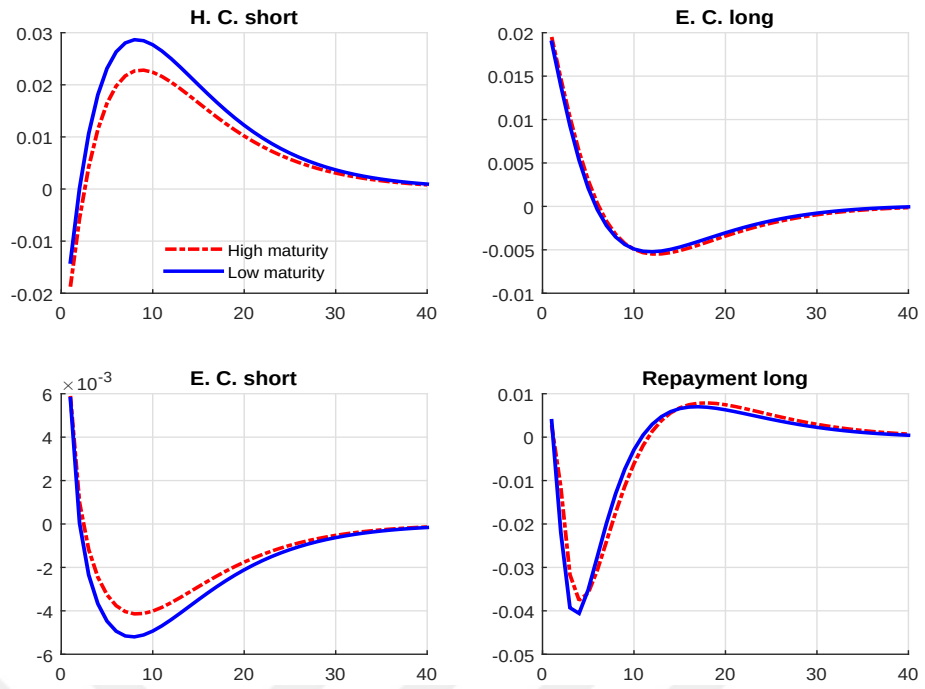


Figure 4.24: Comparison of High vs. Low Maturity: Responses to positive monetary policy surprise (2)

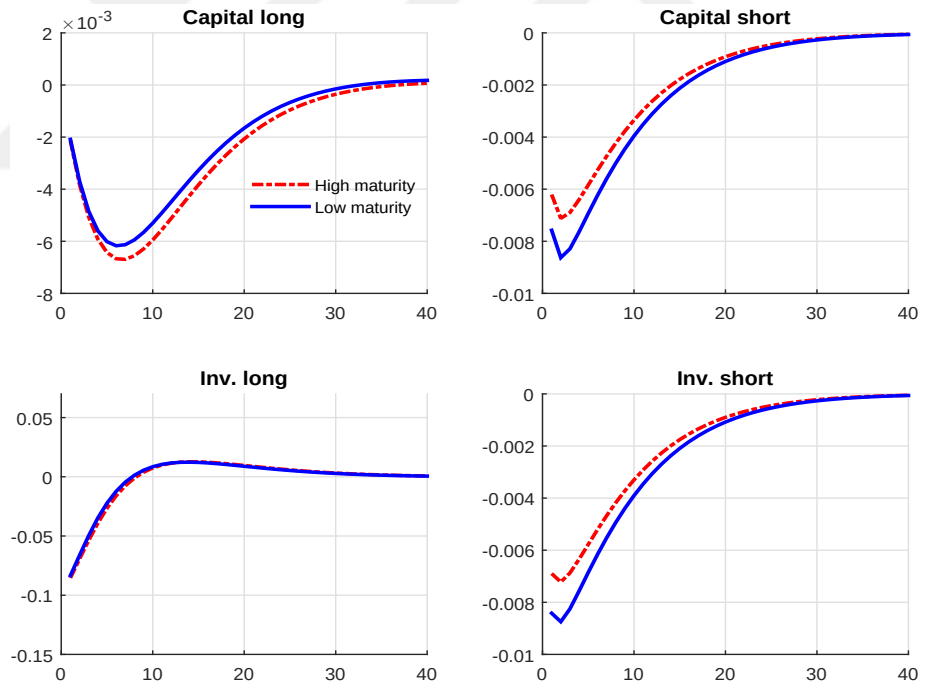


Figure 4.25: Comparison of High vs. Low Maturity: Responses to positive monetary policy surprise (3)

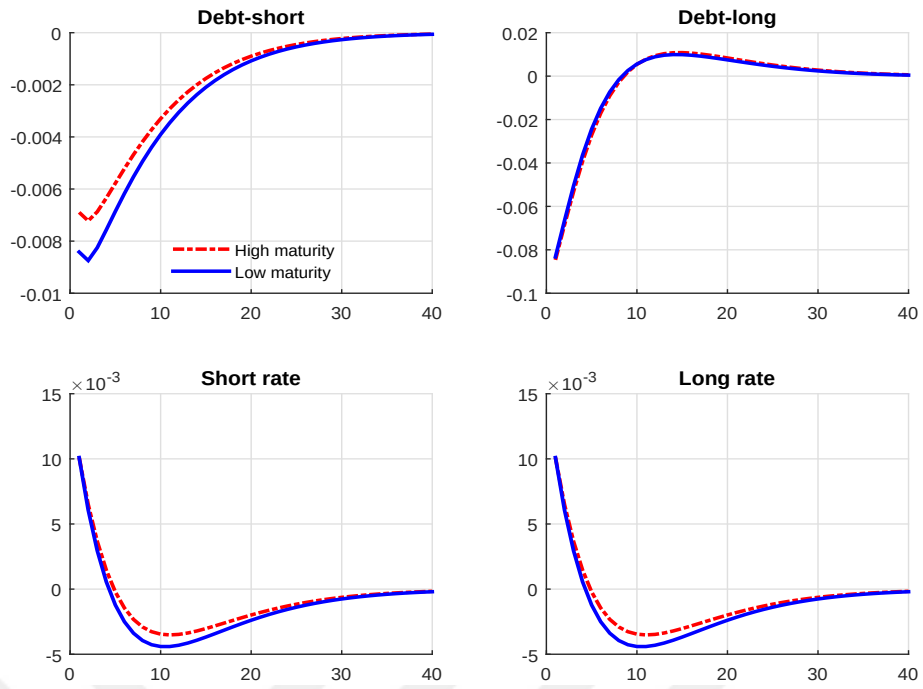


Figure 4.26: Comparison of High vs. Low Maturity: Responses to positive monetary policy surprise (4)

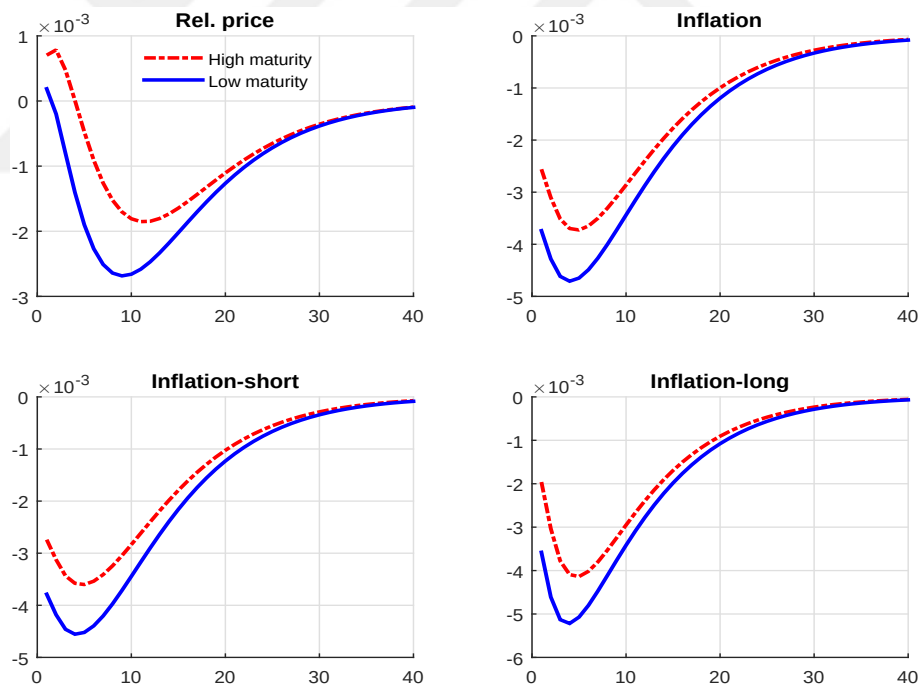


Figure 4.27: Comparison of High vs. Low Maturity: Responses to positive monetary policy surprise (5)

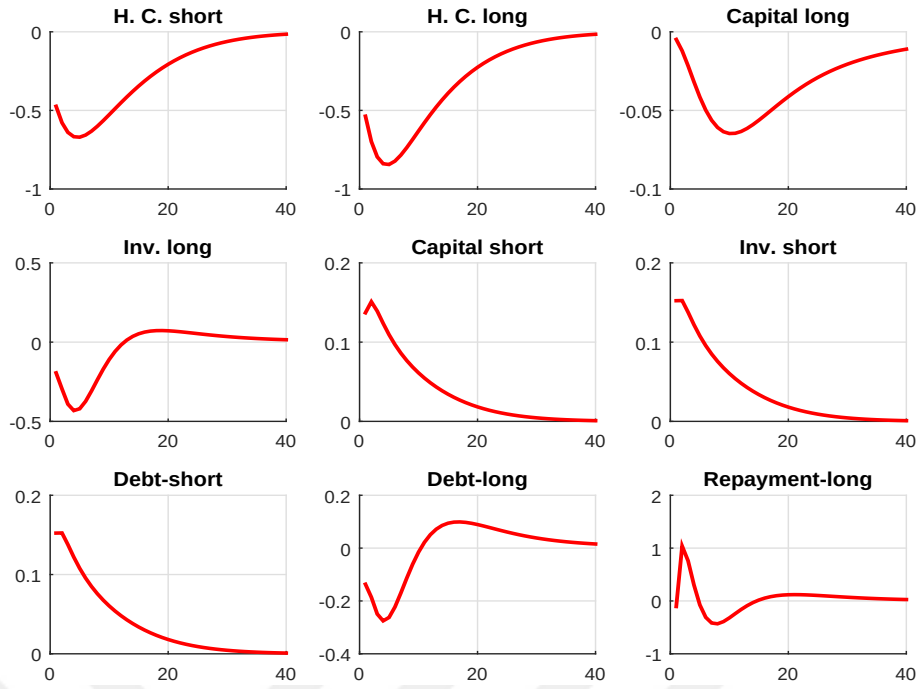


Figure 4.28: Impulse Responses Differences: High-Low Maturity

4.7.2 Compare Fixed vs. Floating: Responses to Monetary Policy Shock

This section compares the impulse responses of the two models to a positive monetary policy shock: one with fixed rate long-term debt, and the other with floating rate long-term debt. The impulse responses are presented in Figure 4.29-4.33. In the model with floating rate debt, the interest rates and inflation levels are more persistent. They both remain at higher levels in longer horizon. The differences across long-lived-capital good and short-lived-capital good sectors are noteworthy. The long-lived-capital sector suffers more with the floating rate debt model only after a couple pf periods. Household consumption of long-lived-capital good falls more compared to the fixed rate debt model. For the short-lived-capital good sector, investment and output are higher, but the household consumption is lower compared to the fixed rate model. The reason is, in the floating rate debt

model, the household spends more resources to finance producers. Moreover, the higher interest rates and inflation levels are, the lower real income is. In turn, final good consumption is lower for the floating rate debt model. The differences across two models are more apperent in the 4.34.

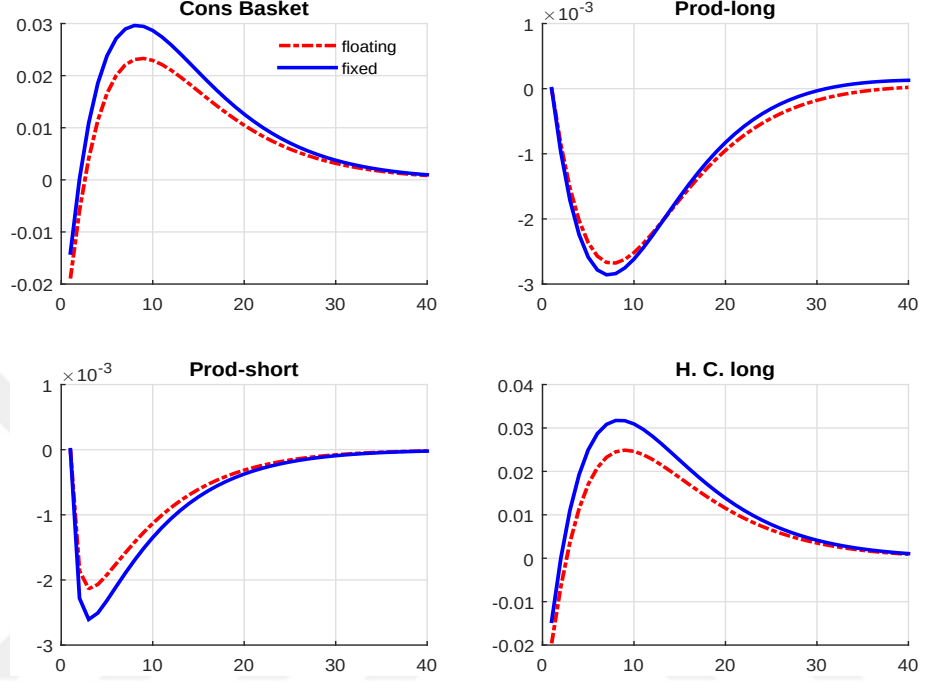


Figure 4.29: Comparison of Floating vs. Fixed: Responses to positive monetary policy surprise (1)

4.8 Conclusion

In Chapter 2, we examined the floating rate channel of monetary policy, presenting evidence from stock market reactions and also from future investment and profitability of S&P 500 firms. We established that debt maturity matters for the transmission of policy. In this chapter, I took another turn and study the role of debt maturity in a New Keynesian dynamic stochastic general equilibrium context. The baseline model with two sectors and two kinds of financial instruments constitute a basic framework to build on. The extended model with

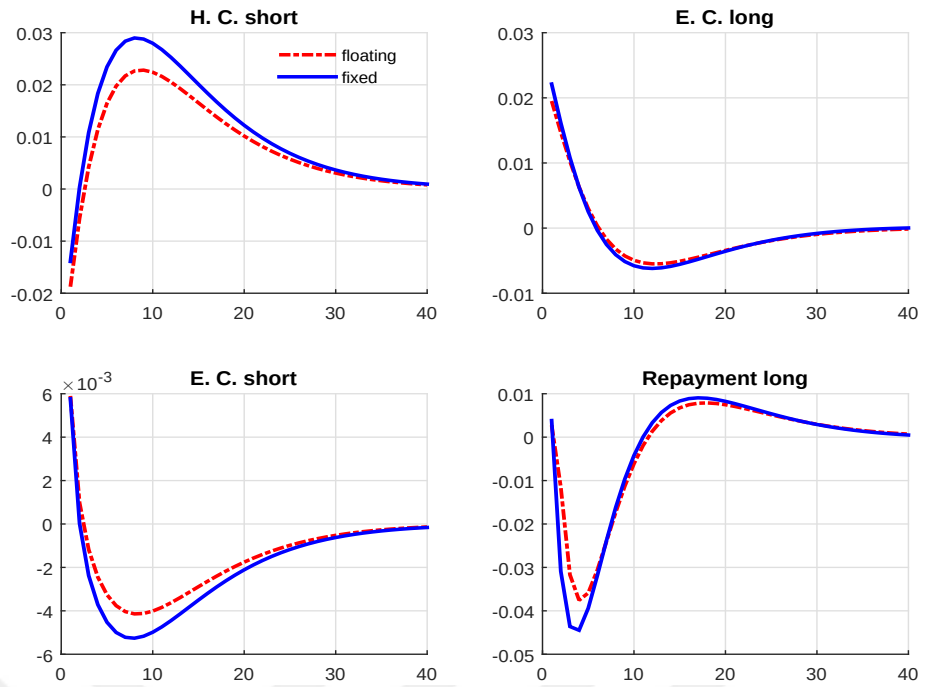


Figure 4.30: Comparison of Floating vs. Fixed: Responses to positive monetary policy surprise (2)

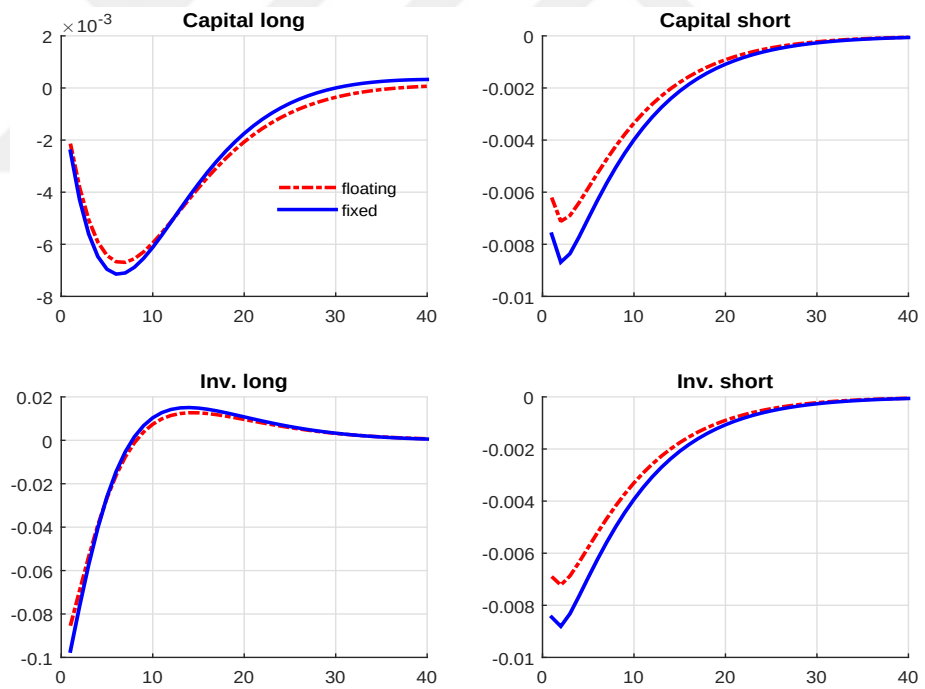


Figure 4.31: Comparison of Floating vs. Fixed: Responses to positive monetary policy surprise (3)

nominal rigidities and monetary policy enables one to investigate a variety of macro-prudential and monetary policy shocks.

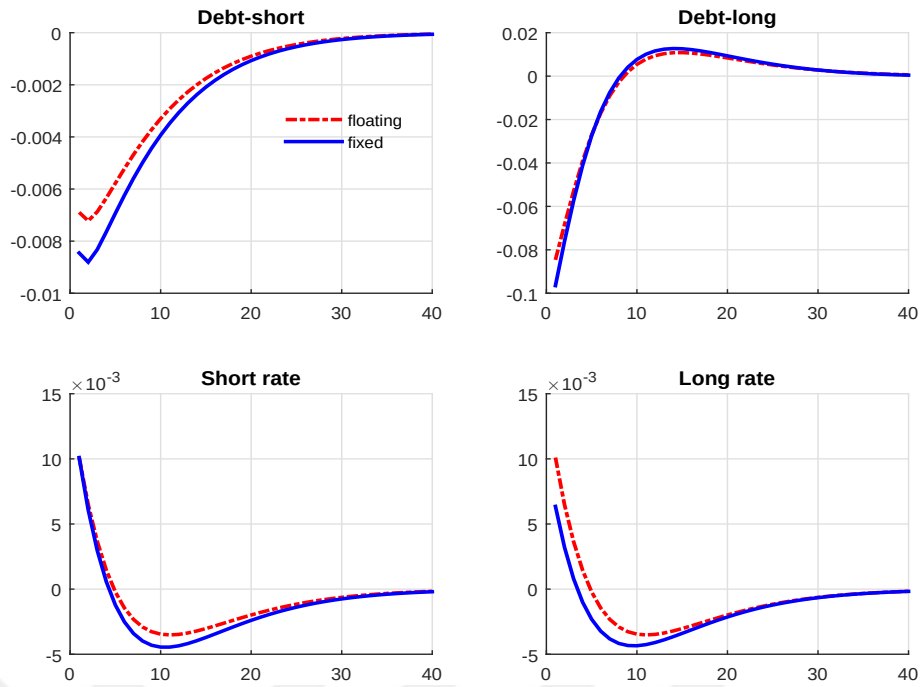


Figure 4.32: Comparison of Floating vs. Fixed: Responses to positive monetary policy surprise (4)

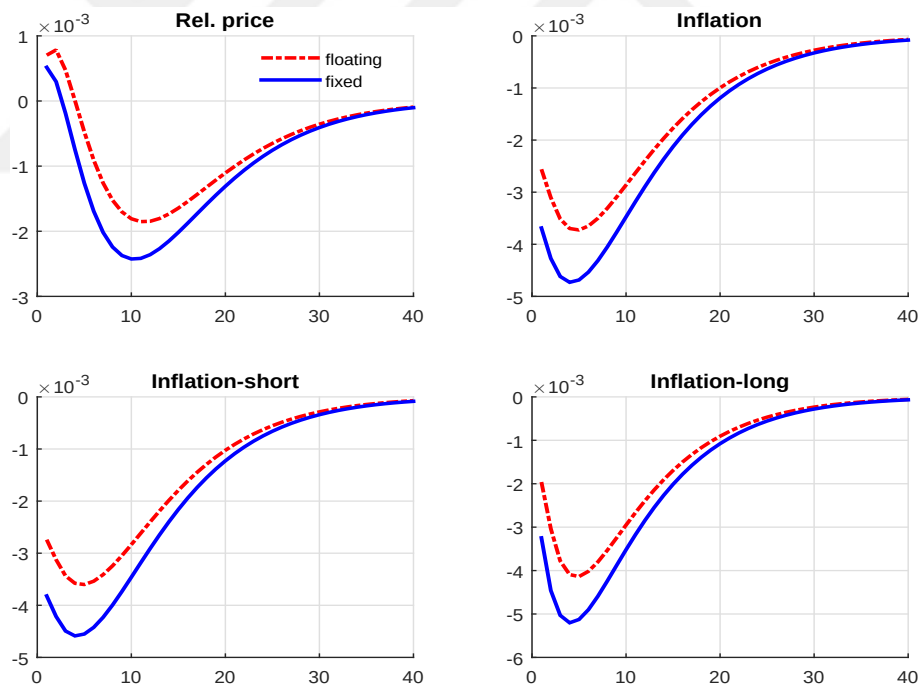


Figure 4.33: Comparison of Floating vs. Fixed: Responses to positive monetary policy surprise (5)

The exercises produce several findings. First, a macro-prudential shock, say a shock to the borrowing limit could have opposite effects on borrowers and lenders.

The reason is twofold. First, since the entrepreneurs' loan demand falls, the

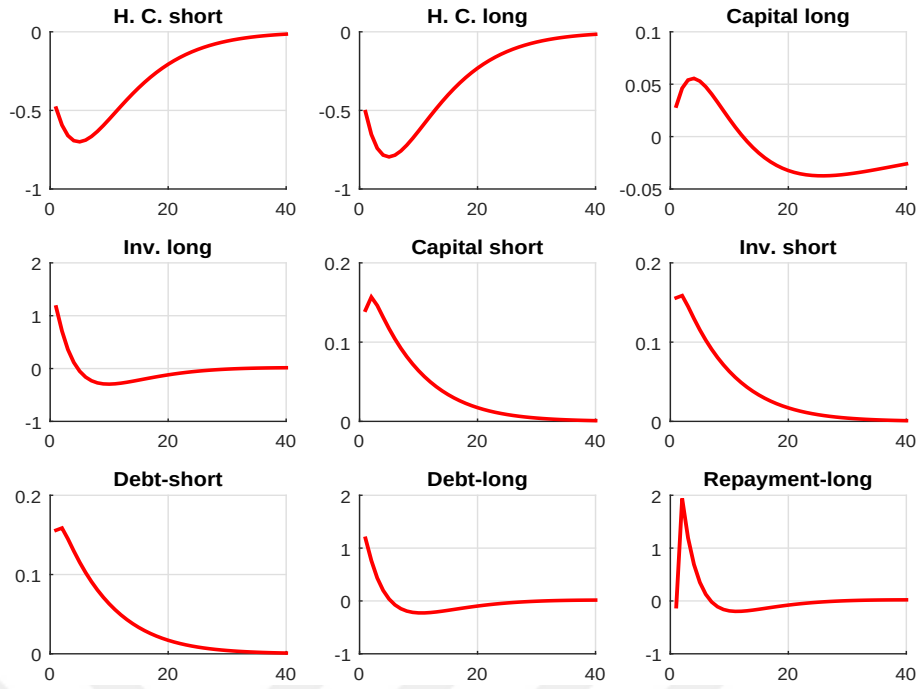


Figure 4.34: Impulse Responses Differences: Floating-Fixed Maturity

household ends up with more resources to consume instead of lending. Working with a similar model Justiniano et al. (2015) discuss this and claim that because of the same reason, this kind of leverage shocks cannot be the main drivers of credit or business cycles. Second the debt contracts are written in nominal terms, the decline in inflation will increase the real returns. This result is also relevant for the discussions on policy coordination. The contractionary effects of macro-prudential policies on entrepreneurs could have expansionary outcomes on consumers. Moreover loose monetary policy might support this pattern with low interest rates and inflation. If we add labor as a productivity factor and transfer lending facility from households to banks, those results might change. In a model in which households spend their labor income, they would have affected more from a financial tightening shock. Because the fall in production will end up with a fall in labor demand and wages.

Second, my results on the comparison of floating rate long-term debt and fixed

rate long-term debt show that floating rate debt hurts the consumption more compared to fixed rate debt and it also makes monetary policy less effective. The reason is, in the model with floating rate debt, the outstanding repayments are adjusted with the realized change in interest rates each period. The producers' prices do not fall as much as in the fixed rate model, because of the fact that their costs have mounted. This finding is in line with results of Calza et al. (2013) and Brzoza-Brzezina et al. (2014). It is also possible to support this theoretical model with time series analysis like a VAR similar to Iacoviello (2005) and Calza et al. (2013).

Third, the extended model can rationalize our empirical findings in Chapter 2. There, the main variable of interest, “exposure” was built as a floating rate debt leverage weighted by maturity. The model allows one to compare fixed rate long-term debt and floating rate long-term debt. Moreover with calibrating a single parameter, it allows to analyze the effect of average maturity of floating rate long-term debt.

The increase in the floating rate debt maturity leaves the firms those financed by long-term debt in a more vulnerable position when there is an interest rate hike. Here, I have used standard calibration for the US economy. The proper shares of long-term debt financed sectors and short-term debt financed sectors, the relevant maturity and borrowing constraint parameters could help to quantify the effects of aggregate shocks. Moreover the model could even be extended to include both fixed rate and floating rate debt used by the entrepreneur at the same time.

The model is open to many extensions such as incorporating equity finance, labor

choice, and investment adjustment costs to bring it closer to the standard financial frictions models. Moreover a micro-founded device such as search and matching frictions could help to model a single entrepreneur who can invest in both types with an endogenous decision between short and long-term debt.¹¹ I defer these as future research agenda.



¹¹See Appendix F for a discussion on this issue.

CHAPTER 5

THE EXPLANATORY POWER AND THE FORECAST PERFORMANCE OF CONSUMER CONFIDENCE INDICES FOR PRIVATE CONSUMPTION

5.1 Introduction

“Consumption is the largest component of Gross Domestic Product (GDP) in almost all economies and is quite important to understand the course of the economic activity. However, data regarding real economic activity are published with a considerable time lag. Accordingly, timely data, such as consumer confidence indices, become valuable as leading indicators for current and future economic activity. Sentiment surveys have been followed by analysts, policy makers and forecasters as well as the media because its basic premise is that they contain information about potential changes in consumption (Curtin, 2007). Contempo-

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aneous relationship between consumer sentiment and consumption expenditures is hardly surprising (Ludvigson, 2004). Low consumer confidence today should restrict the current spending. However, whether they provide information about the future path of consumer spending is an issue that needs to elaborate on.

Mueller (1963), in her pioneering study for the United States (US), proposes that consumer confidence indices may be useful in forecasting private consumption growth when its lagged values are included to the regressions along with the lagged values of consumption growth. Following her, many studies, mostly using the US data, have tested the same argument by introducing other relevant economic variables (Mishkin et al., 1978; Leeper, 1992; Carroll et al., 1994; Bram and Ludvigson, 1998; Howrey, 2001; Ludvigson, 2004). As a common finding, consumer sentiment indicators are shown to predict future changes in consumption expenditures; however, the predictive power is limited when they are used in conjunction with other indicators, mostly financial. Studies using real-time data (Croushore, 2005; Lahiri et al., 2012, Lahiri et al., 2016) did not reach to a clear consensus on the predictive ability of consumer sentiment either. On the other hand, Golinelli and Parigi (2004), Dion (2006) and Dees and Brinca (2013) find that consumer confidence can be an important independent factor in predicting consumption spending in European countries. The studies for developing countries are scarce. Among them, Cuenca et al. (2013) find only marginal effect of consumer confidence on consumption growth in Peru when other economic variables are present.

The predictive power of consumer confidence indices on future consumption growth

is also useful in testing economic theories. Carroll et al. (1994), Ludvigson (2004) and Lahiri et al. (2012) test whether their findings for the US can be explained by precautionary savings motive or permanent income hypothesis. They find no clear evidence for any of them with macro-level data. On the other hand, with micro-level data, Souleles (2004) and Cuenca et al. (2013) find evidence to support precautionary savings motive for the US and Peru, respectively.

In this study we address similar questions for Turkey. It is clear that the quarterly private consumption growth signals a close contemporaneous relationship with the main consumer confidence indices in Turkey (Figure 5.1). However, we follow the likes of Carroll et al. (1994), Bram and Ludvigson (1997), Ludvigson (2004), Croushore (2004) to find out whether past values of consumer sentiment indicators can help predict future consumption expenditures as well. To this end, we aim to measure explanatory and forecast power of consumer confidence indices on future private consumption growth through 3 questions: i) “Does consumer confidence provide information about future private consumption growth?” ii) “Does consumer confidence provide unique information about future private consumption growth?” iii) “Does consumer confidence improve out-of-sample forecasts of future private consumption growth?”. We think that adopting this approach at first place is useful to form the basis for the literature on this issue in Turkey to progress in a similar fashion to the developed countries. We use four different sentiment indicators to account for consumer sentiment from different aspects. These indicators are the overall indices of CNBC-e and Turksat-CBRT (CBRT) surveys and Consumer Expectations Index (CEI) and Propensity to Consume Index (PCI) from the former.

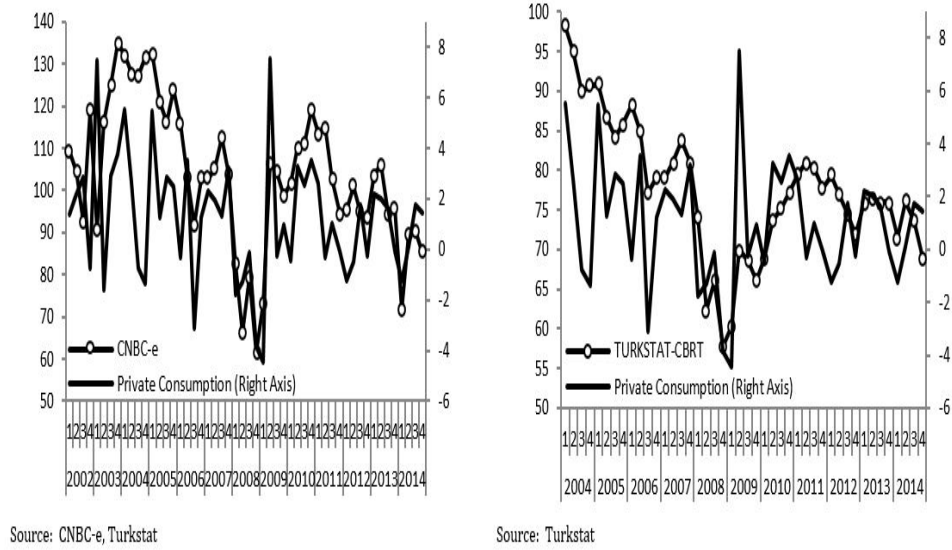


Figure 5.1: Consumer Confidence Indices and The Growth Rate of Private Consumption

Discretionary purchases can be postponed when sentiment deteriorates (Curtin, 2007). Since such purchases mostly contain purchases of homes, vehicles and other household durable goods, we extend our analysis also to durable and nondurable consumption. In addition, we check whether our results are in parallel with what permanent income hypothesis and precautionary savings motive would suggest for the link between consumer sentiment and next period's consumption growth.

Using the variables in real-time is an important issue to consider in short-term forecasting, as revisions in the data, the publication lags and release dates matter for the policy making purposes. Diron (2008), Giannone et al. (2008), and Lahiri et al. (2016) show examples of pseudo real-time and genuine real-time exercises in GDP forecasts. However, our empirical setup does not necessitate pursuing any kind of real-time exercise in our forecasting analysis. The reason has two folds: First, we do not use current period values and use only the lagged values of the explanatory variables in the estimations; contrary to the nowcasting analyses in

the aforementioned examples. Further, unlike US and European countries, there are no flash estimates of GDP in Turkey and all data we need at the time of the forecast is already available to the forecaster. We revisit data vintages, release dates, publication lags in more detail in the data section.

To the best of our knowledge, this is the first study for Turkey to test the power of consumer confidence on forecasting quarterly private consumption growth empirically and assess it in the light of consumption theories. Previous studies for Turkey have focused mostly on finding either a long-term relationship between consumer confidence and macroeconomic variables or the determinants of consumer confidence. Celik (2010) shows that movements in the consumer confidence indices are associated with changes in economic and financial variables like exchange rates, industrial production, and stock exchange index. Moreover, Kandir (2006), Sakir and Gunes (2010), Celik et al. (2010), Gurgur and Kilinc (2015), Karasoy (2015) focus on the relationship between consumer confidence and financial variables. Ceritoğlu (2013) shows that household expectations measured by Consumer Tendency Survey of Turkstat and CBRT have a direct role on consumption and saving decisions. He points out that expenditure on durables are more sensitive to changes in household expectations. Against this background, we contribute to the limited literature in the developing countries.

We find that the past values of consumer confidence indices have explanatory power on the growth of both total private consumption and its subcomponents, i.e. durable and nondurable consumption. However, the power either vanishes or diminishes once we control for real labour income, real stock prices, real inter-

est rate and exchange rate. CNBC-e for total consumption, CBRT and PCI for nondurable consumption preserve information about next period's consumption growth even after controlling for other available economic and financial indicators. Similarly, the gains in out-of-sample forecast over the benchmark models are present in the absence of other variables and disappear in almost all cases following the inclusion of additional explanatory variables to the estimations. Finally, we find that the role of consumer confidence on future total private consumption expenditures cannot be explained by either precautionary savings motive or permanent income hypothesis. The results on nondurable consumption are inconclusive.

The study proceeds as follows: Section 5.2 introduces the data. In Section 5.3, we run estimations to evaluate the significance of consumer confidence indices on future private consumption growth. In Section 5.4, we compare the out-of-sample forecast performance of the model specifications with and without consumer confidence indices. In section 5.5, we test precautionary savings motive and permanent income hypothesis for the link between consumer sentiment and future consumption growth. The last section concludes and addresses future research.

5.2 Data

The data spans the period 2002Q1 - 2014Q4. Private consumption is the dependent variable, while consumer confidence, real stock prices, real interest rate, real labour income and exchange rate are the independent variables. Consumer sen-

timent indicators are compiled from two different sentiment surveys of CNBC-e¹ and of Turkstat conducted in collaboration with Central Bank of the Republic of Turkey (CBRT). We use overall indices from both surveys and Consumer's Expectations Index (CEI) and Propensity to Consume Index (PCI) from the CNBC-e survey.

The private consumption data and its subcomponents² are from the 1998-based year GDP series. Real labour income data is our own calculations with the information from the Household Labour Force Survey (HLFS) and Labour Cost Index (LCI). For real stock price index, we deflate nominal stock exchange data from Borsa Istanbul by Consumer Price Index (2003=100). For exchange rate we use the basket of Euro and US dollar, calculated with equal weights. The rise in the basket means depreciation of the Turkish lira. Finally, we calculate real interest rate by deflating nominal Treasury bond rate at the maturity of 2 years by 2-year-ahead inflation expectations. All monthly data are transformed into quarterly data by taking simple averages of the associated months. Consumption and real labour income data are seasonally adjusted. The source of GDP, HLFS, LCI and CPI is Turkstat.

An important issue to consider in short-term forecasting studies in the literature is the vintage of the data. Lahiri et al. (2016) argue that what matters for the

¹It has been renamed as Bloomberg HT in October 2015.

²TURKSTAT does not publish nondurable or durable consumption under 1998-based GDP data. However from private consumption data under COICOP classification, we calculate proxy series for durable and non-durable consumption. We summed up furniture and household appliances, transport and communication and recreation and culture sub-items to yield a proxy for durable consumption. The rest of the private consumption is considered as nondurable consumption. Note that nondurable consumption is a proxy for the sum of semi durable goods, nondurable goods and services expenditures. It is impossible to separate further goods and services expenditures under this setting.

analysts and policymakers should be the real-time data as it is the data available at the time of forecasting to the forecaster; and the final vintage of the data regarding the historical values should be avoided. Diron (2008), Giannone et al. (2008) and Lahiri et al. (2016) show examples of pseudo real-time and genuine real-time exercises for GDP and consumption forecasts. This is a very valid concern especially when contemporaneous relationships between the explanatory and dependent variables are imposed in the regressions. However, our empirical setup does not necessitate pursuing any kind of real-time exercise in our forecasting analysis. The reason has two folds: First, contrary to the aforementioned nowcasting studies using real-time data we do not use current period values and use only the lagged values of the explanatory variables in the model specifications. Further, unlike US and European countries, there are no flash estimates of GDP in Turkey and all data needed at the time of the forecast in real time had already been available to the forecaster. As shown clearly in the data timeline in Figure 5.2, when we want to forecast the consumption growth in 2014Q1 after the release of 2013Q4 data in 31 March 2014, the data set we need for 2013Q4 and before were already known (Figure 2). If, as in the nowcasting studies, we had the current period value of the explanatory variables in our specifications, we had to use the most available data as of 31 March 2014 for the first quarter of 2014.³

One thing we have to decide on is whether to use the first vintage of consumption data instead of the final data, as consumption data is subject to revisions throughout the GDP data release periods. Ludvigson (2004) and Croushore (2004) claim that if data revisions are large and systematic, empirical results using the revised

³In fact, Diron (2008) shows that using real time data may not improve the forecasts compared to using revised data either.

data could give biased results. ANOVA test results show that the revision in the level of consumption and its periodical changes have no statistical significance. Thus biasedness should not be an issue in our estimations when we use the revised consumption data in our analyses.

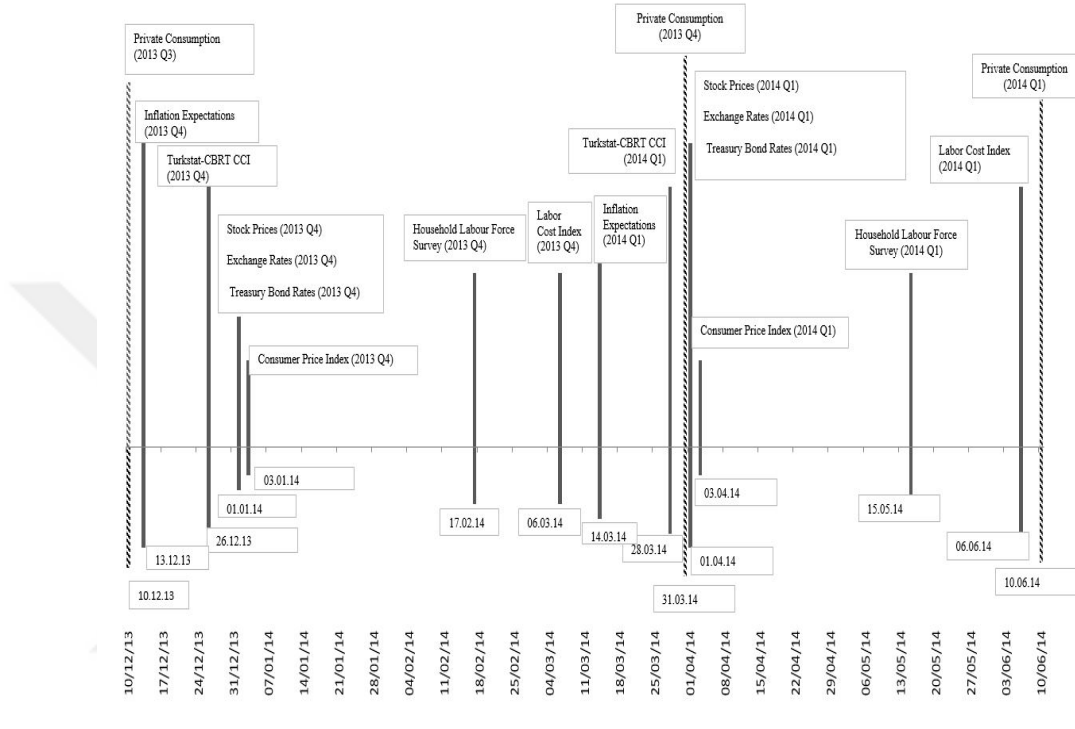


Figure 5.2: Timeline for Data Releases

5.3 Empirical Analysis

This section seeks answers to the following two questions: i) “Does consumer confidence provide information about future private consumption growth?” ii) “Does consumer confidence provide unique information about future private consumption growth?” We carry out estimations not only for total private consumption but also for the proxies we calculate for durable and nondurable consumption. The reason is that discretionary purchases can be postponed for a particular

time when sentiment deteriorates and such purchases mostly contain purchases of homes, vehicles and other household durable goods. Aggregation of consumption items may hinder the role of consumer sentiment on future private consumption growth.

We follow a two-step procedure in our empirical analysis. We start with estimating a basic benchmark model, which (a type of) quarterly private consumption growth is regressed only on its own lags (Equation 5.1). Next, we add the lagged values of (a measure of) consumer confidence to this basic specification (Equation 5.2). Here, the aim is to compare in-sample forecast performance of the models with and without consumer confidence indicators. If coefficient estimates for consumer confidence indices are statistically significant and adjusted R^2 increases after adding consumer confidence measures, then we conclude that lagged values of consumer sentiment have predictive power for private consumption growth.

$$\Delta \log C_t = \alpha_0 + \sum_{i=0}^k \beta_i \Delta \log C_{t-i} + \epsilon_t \quad (5.1)$$

$$\Delta \log C_t = \alpha_0 + \sum_{i=0}^k \beta_i \Delta \log C_{t-i} + \sum_{i=0}^k \gamma_i CCI_{t-i} + \epsilon_t \quad (5.2)$$

We add other indicators, which are thought to play a role on consumption growth, to identify the distinctive information content of consumer confidence on future private consumption growth other than the information already contained in some other economic and financial indicators. To this end, we again follow a two-step procedure. This time, we first determine a benchmark model containing the lags of additional control variables (Equation 5.3) and then add the lagged values of consumer confidence indicators (Equation 5.4). If confidence measures are

statistically significant and there is an improvement in the adjusted R^2 after adding consumer confidence measures, we conclude that consumer confidence provides unique information about future private consumption growth.

$$\Delta \log C_t = \alpha_0 + \sum_{i=0}^k \beta_i \Delta \log C_{t-i} + \sum_{i=0}^n \delta_i S_{t-i} + \epsilon_t \quad (5.3)$$

$$\Delta \log C_t = \alpha_0 + \sum_{i=0}^k \beta_i \Delta \log C_{t-i} + \sum_{i=0}^n \delta_i S_{t-i} + \sum_{i=0}^m \gamma_i CCI_{t-i} + \epsilon_t \quad (5.4)$$

Following Bram and Ludvigson (1997), Ludvigson (2004), Croushore (2004) and Lahiri et al. (2012), we include the change in the logarithm of real stock prices (RSTOCK), the growth rate of real labour income (RLI), the first difference of real interest rate (RINT) and the change in the logarithm of exchange rate basket (EXC), which are represented as the vector “S” in Equations 5.3 and 5.4. In addition, we insert two dummy variables. The first one (D09Q2) is for 2009Q2, when Turkish government exerted temporary tax reductions for durable goods, particularly for automobiles and home appliances. It is included in regressions for durable consumption and total consumption growth. The second one (DREC) is for the recessionary period during the global financial crisis period and is added to regressions for all consumption indicators.

At this point, two issues need clarification. First, in initial model specifications, we follow the literature and set the number of lags to four. However, since we do not have a long enough data to keep all four lags of each variable, we eliminate statistically insignificant lags of each variable by applying the General to Specific (GETS) method. Therefore, m, n and k values in the equations from 5.1 to 5.4 vary across each final model specification. The second issue is about

the transformation of consumer confidence indices. Most of the studies in the literature prefer using the levels of consumer confidence indices. Nevertheless, we run the regressions with both terms.⁴

5.3.1 Estimations for Total Private Consumption Growth

Estimation results for the benchmark model show that own lagged values of total private consumption growth are neither individually nor jointly statistically significant in explaining its current growth (Table 5.1). This is in sharp contrast to the European and the US private consumption data. Next, we add consumer confidence to the benchmark. Since auto regressive components are not statistically significant, total private consumption growth is regressed only on the first four lags of consumer confidence measures. Using GETS, the first 2 lags of the sentiment indicators are found statistically significant in explaining private consumption growth (Table 5.2). The incremental predictive power of sentiment indicators in level terms is higher than that of sentiment indicators in change terms. Looking at the adjusted R^2 s, CEI has the highest incremental predictive power across all measures in level terms.

Table 5.3 reports estimation results after including other control variables. At first, we cannot find a statistically significant coefficient for the sentiment measures. However, once we apply GETS to seek for individual significance, we find

⁴According to ADF test all the variables except CNBC-e, CBRT and CEI are found to be I(1). We also performed cointegration tests to every specification to be estimated but cointegration is rejected in almost all cases. Therefore, we cannot specify the models with levels of the variables other than consumer confidence measures. Among the sentiment indicators, PCI is found to be I(1) and might necessitate to be differenced to be stationary. However, since the statistical significance level of the test is very close to 10 %, we think that using PCI in levels will not create a big problem in assessing the estimation results.

that the third lag of $\Delta(CNBC - e)$ is statistically significant. Thus, we conclude that consumer confidence may contain independent information for total private consumption. However, this finding is not strong.

Table 5.1: Simple Benchmark Regressions on Consumption Aggregates

	Total Private Consumption	Durable Consumption	Nondurable Consumption	Nondurable Consumption
AR (-1)	0.141 (0.84)	0.236 (1.36)	-0.157 (-1.29)	-0.206* (-1.65)
AR (-2)	0.183 (1.38)	0.099 (0.70)	0.274** (2.67)	0.226** (2.14)
AR (-3)	0.029 (0.23)	0.114 (0.88)	0.106 (0.65)	-
AR (-4)	0.065 (0.43)	0.0807 (0.68)	-0.147 (-0.97)	-
D09Q2	0.083*** (5.02)	0.234*** (6.28)	-	-
Constant	0.0037 (0.68)	0.001 (0.11)	0.0079** (2.61)	0.0086*** (3.51)
Obs.	47	47	47	49
R^2	0.205	0.354	0.134	0.119
Adj. R^2	0.108	0.276	0.052	0.081
RMSE	0.0222	0.0427	0.0129	0.0134

Notes: Dependent variable for each equation is written on top of each column. AR denotes the lag of the dependent variable. t-statistics in parentheses, *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

Table 5.2: Total Private Consumption Growth Estimation Results with Consumer Confidence Indices

	CNBC-e	CEI	PCI	CBRT	$\Delta(\text{CNBC-e})$	$\Delta(\text{CEI})$	$\Delta(\text{PCI})$	$\Delta(\text{CBRT})$
CCI (-1)	0.00084*** (4.24)	0.0011*** (4.76)	0.00065*** (3.34)	0.0022** (2.68)	0.00094*** (2.75)	0.00097** (2.24)	0.00061*** (3.31)	0.0017* (1.94)
CCI (-2)	-	-	-0.00053** (-2.58)	-0.00153* (-1.81)	-	-	-	-
D09Q2	0.087*** (14.61)	0.092*** (14.01)	0.048*** (6.91)	0.073*** (6.94)	0.0513*** (8.88)	0.050*** (7.05)	0.045*** (6.91)	0.061*** (14.05)
Constant	-0.073*** (-3.78)	-0.089*** (-4.28)	-0.0037 (-0.34)	-0.046 (-1.15)	0.011*** (3.49)	0.011*** (3.40)	0.011*** (3.51)	0.0079** (2.46)
Obs.	51	51	50	42	50	50	50	42
R^2	0.413	0.469	0.308	0.342	0.316	0.277	0.283	0.287
Adj. R^2	0.389	0.447	0.263	0.291	0.287	0.246	0.253	0.251
RMSE	0.0191	0.0182	0.0212	0.0192	0.0208	0.0214	0.0213	0.0198

Notes: Dependent variable is the total private consumption growth for all equations and CCI denotes the consumer confidence index denoted at the top of each column. Δ denotes change in the variable. t-statistics in parentheses: *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

Table 5.3: Total Private Consumption Growth Estimation Results with Consumer Confidence and Additional Variables

	No CCI	CNBC-e	CEI	PCI	CBRT	Δ (CNBC-e)	Δ (CEI)	Δ (PCI)	Δ (CBRT)	Δ (CNBC-e)
RLI (-1)	0.004** (2.60)	0.0053*** (3.48)	0.0052*** (3.51)	0.0046** (2.73)	0.00247 (0.94)	0.005*** (2.99)	0.005*** (3.02)	0.0047*** (2.88)	0.0018 (0.68)	0.0048*** (3.08)
RLI (-2)	-0.003* (-1.89)	-0.0022 (-1.31)	-0.0024 (-1.47)	-0.0027 (-1.67)	-0.0033 (-1.53)	-0.0024 (-1.45)	-0.0025 (-1.53)	-0.003* (-1.91)	-0.0027 (-1.04)	-0.0027* (-1.80)
RLI (-3)	-0.003* (-2.00)	-0.0033* (-2.03)	-0.0037** (-2.42)	-0.0031* (-1.93)	-0.002 (-0.78)	-0.0036** (-2.20)	-0.0038** (-2.41)	-0.003** (-2.06)	-0.0018 (-0.60)	-0.0033** (-2.14)
RLI (-4)	0.004** (2.54)	0.0038* (2.03)	0.0037* (1.93)	0.004** (2.38)	0.00472* (1.97)	0.0036* (1.95)	0.0037* (1.83)	0.0038** (2.42)	0.0036 (1.30)	0.0035** (2.35)
RSTOCK (-1)	0.038** (2.32)	0.034 (1.67)	0.032 (1.63)	0.04* (2.03)	0.072** (2.43)	0.0313 (1.60)	0.031 (1.59)	0.038** (2.07)	0.075** (2.28)	0.036** (2.09)
RSTOCK (-3)	0.038* (1.92)	0.059** (2.50)	0.0537** (2.48)	0.0515** (2.25)	0.043** (2.06)	0.055** (2.34)	0.051** (2.52)	0.053** (2.38)	0.041** (2.10)	0.056** (2.62)
RINT (-1)	-0.004*** (-3.85)	-0.004*** (-3.01)	-0.004*** (-2.83)	-0.004*** (-3.42)	-0.0006 (-0.17)	-0.004*** (-3.02)	-0.004*** (-2.85)	-0.004*** (-3.18)	0.0005 (0.14)	-0.005*** (-3.94)
EXC (-2)	-0.065* (-1.95)	-0.0807* (-1.87)	-0.086** (-2.06)	-0.067 (-1.59)	-0.094 (-1.68)	-0.082* (-1.85)	-0.088** (-2.17)	-0.051 (-1.26)	-0.091 (-1.62)	-0.061* (-1.75)
DREC	-0.02*** (-2.97)	-0.019** (-2.47)	-0.0198** (-2.42)	-0.0175** (-2.20)	-0.02** (-2.30)	-0.0187** (-2.40)	-0.019** (-2.52)	-0.018** (-2.57)	-0.019** (-2.12)	-0.019*** (-2.91)
D09Q2	0.09*** (7.84)	0.096*** (7.79)	0.096*** (7.02)	0.091*** (7.94)	0.101*** (4.39)	0.097*** (8.03)	0.097*** (7.83)	0.087*** (7.21)	0.11*** (3.81)	0.094*** (8.29)
CCI (-1)	- (0.48)	0.00016 (0.57)	0.0002 (0.41)	0.000074 (0.01)	0.000006 (0.01)	0.0002 (0.66)	0.00025 (0.76)	0.0001 (0.51)	0.0001 (0.13)	-
CCI (-2)	- (-1.25)	-0.0003 (-1.25)	-0.00037 (-1.37)	-0.0001 (-0.48)	-0.00039 (-0.33)	-0.0001 (-0.38)	-0.0001 (-0.42)	0.000003 (0.02)	-0.00005 (-0.06)	-
CCI (-3)	- (-1.12)	-0.0003 (-1.12)	-0.00027 (-0.89)	-0.000135 (-0.64)	-0.00007 (-0.06)	-0.00035 (-1.32)	-0.00033 (-1.06)	-0.00014 (-0.97)	-0.00045 (-0.46)	-0.0004* (-1.71)
CCI (-4)	- (1.46)	0.00033 (1.46)	0.00033 (1.26)	0.00014 (0.96)	0.00028 (0.34)	-0.000004 (-0.02)	0.00004 (0.17)	-0.0001 (-0.79)	0.0002 (0.27)	-
Constant	0.0059 (1.04)	0.0159 (0.75)	0.0139 (0.59)	0.00814 (0.77)	0.021 (0.49)	0.0053 (0.92)	0.006 (1.04)	0.0054 (1.02)	0.008 (1.18)	0.0052 (0.99)
Obs.	47	47	47	47	40	47	47	47	39	47
R^2	0.766	0.787	0.786	0.776	0.758	0.785	0.785	0.779	0.736	0.779
Adj. R^2	0.7	0.694	0.692	0.678	0.622	0.692	0.692	0.683	0.582	0.709
RMSE	0.0129	0.013	0.013	0.0134	0.0141	0.0131	0.0131	0.0132	0.0143	0.0127

Notes: Dependent variable is the total private consumption growth for all equations. CCI denotes the consumer confidence index written at the top of each column. Δ denotes change in the variable. t-statistics in parentheses, *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

5.3.2 Estimations for Durable and Nondurable Consumption

Estimation results for durable consumption show that similar to the regressions for total private consumption growth, lags of durable consumption growth are unable to predict its own current growth rate (Table 5.1), whereas lagged values of consumer confidence do predict (Table 5.4). CEI has the highest explanatory power among all confidence measures. However, once we control for the other indicators, we do not find any single or joint significance regardless of the type and definition of consumer sentiment. One reason may be the close relation between consumer confidence indices and exchange rate in Turkey, which is well documented in Karasoy (2015) and Gurgur and Kilinc (2015). It is interesting that although PCI is intended to measure durable consumption propensity, it does not provide extra information for future durable consumption growth. This hints that the responses to PCI question is formed by financial conditions, which are thought to affect durable consumption spending and are probably captured by the exchange rate and stock price movements. Another reason may probably be that the propensity of purchasing durable goods is stronger for individuals with higher income, and the sentiment surveys cover individuals from all income levels, which weakens the link between PCI and the durable consumption.

Finally, estimations for quarterly nondurable consumption growth show that unlike for total private and durable consumption growth, it has an autoregressive structure (Table 5.1). Thus, basic benchmark model for nondurable consumption growth contains autoregressive terms of order two. When we add the lagged

values of consumer confidence to this benchmark, we again find that consumer confidence has a predictive power on consumption growth (Table 5.5). Here, again consumer confidence indices in level terms perform better than the differenced indices. Among all measures, the increment in adjusted R^2 is the highest for CNBC-e. Estimations of confidence-augmented equations show that CBRT, PCI and $\Delta(PCI)$ can provide extra information on nondurable consumption growth, while the gain is the highest for PCI (Table 5.6). This is an interesting finding, since by definition this question is not intended to measure the tendency for nondurable consumption. However, we should note that our proxy for nondurable consumption also covers services sector. As argued by Lahiri et al. (2016), services expenditures can also be considered as discretionary spending. In addition, the share of services in all expenditures is constantly increasing over time (Curtin, 2007; Lahiri et al., 2016). This makes such expenditures to be sensitive to sentiment changes as well. Thus, although we cannot distinguish services consumption due to data unavailability, our result for nondurables may be considered in harmony with that of Lahiri et al. (2016), who find that the highest gains from including consumer sentiment in forecasting are observed in services spending equations.

Table 5.4: Durable Consumption Growth Estimation Results Regressions with Consumer Confidence Indicators

	CNBC-e	CEI	PCI	CBRT	$\Delta(\text{CNBC-e})$	$\Delta(\text{CEI})$	$\Delta(\text{PCI})$	$\Delta(\text{CBRT})$
CCI (-1)	0.0014*** (3.57)	0.002*** (5.23)	0.001*** (2.70)	0.004*** (2.72)	0.0014** (2.25)	0.0013* (1.75)	0.001*** (2.69)	0.0035* (1.92)
CCI (-2)	-	-	-0.0009** (-2.30)	-0.0031* (-1.84)	-	-	-	-
D09Q2	0.226*** (18.60)	0.237*** (22.19)	0.159*** (12.21)	0.203*** (9.23)	0.169*** (17.44)	0.168*** (14.43)	0.157*** (13.01)	0.182*** (21.73)
Constant	-0.125*** (-3.28)	-0.167*** (-4.91)	0.002 (0.10)	-0.085 (-1.02)	0.0125** (2.17)	0.0126** (2.12)	0.013** (2.25)	0.006 (0.97)
Obs.	51	51	50	42	50	50	50	42
R^2	0.475	0.556	0.386	0.471	0.379	0.348	0.382	0.437
Adj. R^2	0.453	0.538	0.346	0.429	0.353	0.32	0.356	0.408
RMSE	0.0361	0.0332	0.0398	0.0374	0.0396	0.0406	0.0395	0.0381

Notes: Dependent variable is the durable consumption growth for all equations. CCI denotes the consumer confidence index written at the top of each column.

Δ denotes change in the variable. t-statistics in parentheses, *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

Table 5.5: Nondurable Consumption Growth Estimation Results with Consumer Confidence Indicators

	No CCI	CNBC-e	CEI	PCI	CBRT	Δ (CNBC-e)	Δ (CEI)	Δ (PCI)	Δ (CBRT)
AR (-1)	-0.206* (-1.65)	-0.525*** (-4.64)	-0.454*** (-3.58)	-0.353*** (-2.88)	-0.321* (-1.93)	-0.15 (-1.33)	-0.138 (-1.17)	-0.236** (-2.04)	-0.212 (-1.64)
AR (-2)	0.226** (2.14)	-0.041 (-0.37)	0.0125 (0.11)	0.175 (1.15)	0.163 (0.98)	0.296** (2.24)	0.284** (2.16)	0.289** (2.30)	0.270** (2.03)
CCI (-1)	-	0.0006*** (5.48)	0.0006*** (4.59)	0.0004*** (4.61)	0.0015** (2.58)	0.0006*** (3.04)	0.00057** (2.58)	0.0004*** (4.12)	0.0012** (2.21)
CCI (-2)	-	-	-	-0.0003*** (-2.93)	-0.0011** (-2.14)	-	-	-	-
Constant	0.0086*** (3.51)	-0.042*** (-4.52)	-0.041*** (-3.69)	-0.0038 (-0.66)	-0.022 (-1.00)	0.0076*** (3.23)	0.0076*** (3.15)	0.0087*** (3.72)	0.0083*** (3.30)
Obs.	49	49	49	49	42	49	49	49	42
R^2	0.119	0.436	0.379	0.394	0.219	0.324	0.279	0.337	0.173
Adj. R^2	0.0805	0.398	0.338	0.339	0.135	0.279	0.231	0.292	0.107
RMSE	0.0134	0.0108	0.0114	0.0114	0.0121	0.0119	0.0123	0.0118	0.0123
F-Stat	4.522	14.41	9.417	9.292	3.799	6.189	6.273	7.02	4.508

Notes: Dependent variable is the nondurable consumption growth for all equations. AR denotes the lag of the dependent variable. CCI denotes the consumer confidence index written at the top of each column. Δ denotes change in the variable. t-statistics in parentheses, *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

Table 5.6: Nondurable Consumption Growth Estimation Results with Additional Variables and Consumer Confidence Indices

	No CCI	CNBC-e	CEI	PCI	CBRT	Δ (CNBC-e)	Δ (CEI)	Δ (PCI)	Δ (CBRT)	PCI	CBRT	Δ (PCI)
AR (-1)	-0.53*** (-4.85)	-0.53*** (-4.38)	-0.5*** (-4.04)	-0.59*** (-5.26)	-0.5*** (-3.38)	-0.49*** (-4.14)	-0.45*** (-3.74)	-0.516*** (-4.45)	-0.45*** (-3.15)	-0.54*** (-4.65)	-0.53*** (-4.11)	-0.55*** (-4.78)
RSTOCK (-1)	0.05*** (6.23)	0.05*** (3.26)	0.06*** (4.29)	0.04*** (2.85)	0.06*** (5.11)	0.051*** (3.67)	0.059*** (4.85)	0.04*** (3.19)	0.055*** (4.87)	0.043*** (3.23)	0.055*** (5.59)	0.039*** (3.45)
EXC (-2)	-0.03*** (-3.59)	-0.03** (-2.59)	-0.03** (-2.70)	-0.03 (-1.59)	-0.04*** (-2.95)	-0.03*** (-2.91)	-0.02** (-2.58)	-0.024** (-2.59)	-0.025** (-2.32)	-0.036** (-2.25)	-0.039*** (-3.49)	-0.03*** (-3.56)
DREC	-0.02*** (-5.19)	-0.02*** (-3.27)	-0.02*** (-2.93)	-0.02*** (-4.26)	-0.02*** (-4.32)	-0.02*** (-4.19)	-0.01*** (-4.22)	-0.02*** (-4.95)	-0.02*** (-4.49)	-0.02*** (-4.94)	-0.02*** (-4.71)	-0.02*** (-4.91)
CCI (-1)		0.0002 (0.76)	0.0001 (0.44)	0.0002* (1.86)	-0.0002 (-0.43)	0.0001 (0.56)	-0.00001 (-0.07)	0.0002* (1.88)	0.00003 (0.06)	0.0002* (1.79)		0.0002** (2.46)
CCI (-2)		-0.0002 (-1.00)	-0.0002 (-1.11)	-0.0002 (-1.24)	-0.0004 (-0.97)	0.00001 (0.06)	-0.0001 (-0.95)	0.00005 (0.64)	-0.0004 (-1.23)	-0.0002** (-2.45)	-0.0004* (-1.70)	
CCI (-3)		-0.00005 (-0.31)	0.00006 (0.37)	-0.00007 (-0.60)	0.00023 (0.43)	-0.00001 (-0.07)	-0.00003 (-0.21)	0.00002 (0.23)	0.00001 (0.02)			
CCI (-4)		-0.000004 (-0.03)	0.00003 (0.20)	-0.00001 (-0.10)	0.0001 (0.26)	-0.0001 (-0.79)	-0.0001 (-0.85)	-0.0001 (-1.33)	-0.0004 (-1.10)			
Constant	0.04*** (5.45)	0.039* (1.69)	0.032 (1.46)	0.033 (1.63)	0.06** (2.07)	0.03*** (4.85)	0.028*** (4.41)	0.031*** (4.83)	0.029*** (3.73)	0.041** (2.31)	0.067*** (3.13)	0.035*** (5.61)
Obs.	50	48	48	48	40	47	47	47	39	50	42	50
R^2	0.553	0.597	0.594	0.632	0.57	0.57	0.572	0.627	0.529	0.613	0.532	0.611
Adj. R^2	0.514	0.514	0.511	0.557	0.46	0.479	0.482	0.548	0.403	0.559	0.467	0.567
RMSE	0.00979	0.00976	0.00979	0.00932	0.00979	0.00959	0.00956	0.00894	0.00978	0.00932	0.00953	0.00923

Notes: Dependent variable is the nondurable consumption growth for all equations. AR denotes the lag of the dependent variable. CCI denotes the consumer confidence index written at the top of each column. Δ denotes change in the variable. t-statistics in parentheses, *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

5.4 Out of Sample Forecast Performance

This section presents the comparison of out-of-sample forecast performance of the models with and without the lagged values of consumer confidence measures, whose specifications were finalized in Section III. To achieve this, we carry out recursive one-step ahead forecasts in an expanding window. As Hansen and Timmermann (2012) discuss, there is no standard way of splitting the sample period for the initial parameter estimation and the number of out-of-sample forecasts.

We take the first 40 observations for the initial estimation and the remaining 12 observations for the out-of-sample forecast evaluation. As a measure of forecast accuracy, we calculate Root Mean Squared Forecast Errors (RMSFE) for each model. If RMSFE of equations with consumer confidence index is lower (higher) than that of benchmark equation, i.e. relative RMSFE takes value lower (higher) than 1, we conclude that consumer confidence measures improve (deteriorate) forecasting future consumption growth. We also test the significance of the differences between RMSFEs by the methodology proposed by Clark and West (2007) for nested models.⁵

Table 5.7 shows RMSFEs calculated for each specification with and without consumer sentiment and additional explanatory variables for quarterly total private consumption, durable consumption and nondurable consumption growth. For total private consumption, when not used in conjunction with other explanatory variables, out-of-sample forecast errors fall with the use of any of the consumer confidence measures, except CNBC-e. However, only PCI, $\Delta(CNBC - e)$

⁵We did not use Diebold-Mariano Test as it does not perform well in small samples and should not be used when competing models are nested (Diebold (2015)).

$\Delta(CEI)$ and $\Delta(PCI)$ have statistically different out-of-sample performance than that of the benchmark model. On the other hand, when used in conjunction with economic and financial variables, we cannot observe an improvement in out-of-sample forecast performance. Similar to total private consumption growth, some consumer confidence indicators improves the forecasts over the benchmark model for durable goods, however once explained by other economic and financial variables, adding the lagged values of consumer confidence indicators do not improve the out-of-sample forecasts. Finally, consumer confidence measures do not provide statistically significant improvement over benchmark models in predicting nondurable consumption growth either.

Table 5.7: RMSFEs for Various Forecast Models for Consumption Aggregates

		Without any Additional Explanatory Variable				With Additional Explanatory Variables			
		CCI		$\Delta(\text{CCI})$		CCI		$\Delta(\text{CCI})$	
A. Total Private Consumption									
		RMSFE	Relative RMSFE	RMSFE	Relative RMSFE	RMSFE	Relative RMSFE	RMSFE	Relative RMSFE
	No CCI	0.0134	1	0.0134	1	0.012	1	0.012	1
	CNBC-e	0.0142	1.062	0.0119	0.892**	0.014	1.181	0.013	1.086
	CEI	0.0129	0.964	0.0115	0.863***	0.013	1.079	0.013	1.051
	PCI	0.0131	0.982**	0.0115	0.858**	0.017	1.367*	0.016	1.298
	CBRT	0.0132	0.985	0.0123	0.919	0.015	1.203	0.012	1.02
B. Durable Consumption									
		RMSFE	Relative RMSFE	RMSFE	Relative RMSFE	RMSFE	Relative RMSFE	RMSFE	Relative RMSFE
	No CCI	0.0325	1	0.0325	1	0.03	1	0.03	1
	CNBC-e	0.0352	1.082	0.0289	0.889*	0.032	1.065**	0.031	1.05
	CEI	0.0331	1.02	0.0302	0.93	0.032	1.066*	0.032	1.062
	PCI	0.0313	0.963*	0.029	0.894**	0.032	1.071	0.032	1.063
	CBRT	0.0332	1.023	0.0315	0.971	0.034	1.122	0.031	1.05
C. Nondurable Consumption									
		RMSFE	Relative RMSFE	RMSFE	Relative RMSFE	RMSFE	Relative RMSFE	RMSFE	Relative RMSFE
	No CCI	0.0121	1	0.0121	1	0.01	1	0.01	1
	CNBC-e	0.0105	0.867	0.0106	0.878	0.01	1.047	0.011	1.125
	CEI	0.0115	0.951	0.011	0.903	0.011	1.077	0.011	1.176
	PCI	0.0106	0.873	0.0099	0.814	0.01	0.987	0.009	0.948
	CBRT	0.0119	0.979	0.0117	0.968	0.01	1.011	0.011	1.143

Notes: *, **, *** show significance of the difference between the RMSFE of the corresponding equation and that of the benchmark model, indicated as No CCI, at 10 %, 5 %, 1 %, respectively, according to Clark and West (2007) test.

5.5 Consumer Confidence and Consumption Theories

In this section, we investigate whether there is a link between the predictive power of consumer confidence indices on future private consumption growth and what consumption theories suggest it to be. Carroll et al. (1994), Souleles (2004), Ludvigson (2004), Lahiri et al. (2012) and Cuenca et al. (2013) examine whether precautionary savings motive (PSM) or the permanent income hypothesis (PIH) are capable of explaining their results. While none of them could find an evidence to support the validity of PIH in explaining predictive power of consumer confidence on future consumption changes, only Souleles (2004) and Cuenca et al. (2013) confirmed the existence of PSM for the US and Peru, respectively.

From a simple PSM perspective, if we consider consumer confidence as a measure of uncertainty, a negative shock to consumer sentiment in the previous period would mean increasing level of uncertainty and more precautionary savings at the same period. As a result, consumption level falls with the rising uncertainty. Accordingly, in the subsequent period, consumption growth rate will be higher because consumption level in the previous period is lower than it would have been in the absence of negative confidence shock (Carroll et al., 1994). However, as depicted in the estimations, we rather find a positive relationship between consumer sentiment in the previous period and consumption growth today in almost all estimations. Therefore, we cannot interpret the role of consumer sentiment on predicting future consumption growth by a simple PSM perspective.

As an alternative, the PIH may explain the role of consumer confidence on predicting future consumption growth. Recall that, consumption can only change as a consequence of unexpected changes in permanent income according to the PIH. Therefore, if the PIH holds, consumer sentiment can influence future consumption expenditures only indirectly through its predictive power on future real labour income (Lahiri et al., 2012). Ludvigson (2004) tests the possibility of that channel by regressing labour income growth on its own lags and the lags of confidence measures. She shows that the lags of consumer confidence are jointly statistically significant and has explanatory power for labour income growth. We reach the same conclusion for Turkey, except for the case PCI is used. However, this does not confirm that consumer sentiment affects future consumption growth only indirectly as the PIH states. Carroll et al. (1994)), Ludvigson (2004) and Lahiri et al. (2012) apply a two-step procedure to solve out this issue. In the first step, labour income growth is regressed on the lagged values of consumption and the other available indicators introduced in the previous sections. Later, in the second step, consumption growth is regressed on predicted value of labour income growth from the first step and the lagged values of consumer sentiment measures. If consumer sentiment measures are found statistically significant in the second step, consumer sentiment has also direct effects on future consumption growth, which contradicts PIH.

Below, we present the results of this two-step analysis for total and nondurable consumption with the consumer sentiment measures, which have been found to provide unique information for the said consumption indicators in the previous sections. Recall that for durable consumption we find that consumer sentiment

provides no marginal information for future expenditures. For this reason, we do not run regressions for durable consumption in this section.

Table 5.8: Consumption Growth Estimation Results for Testing Permanent Income

	Total Consumption	Nondurable Consumption	
	CNBC-e	PCI	CBRT
Predicted RLI	0.004 (1.57)	0.0017 (1.01)	0.0032 (1.41)
CCI(-1)	0.0007*** (2.79)	0.00034*** (3.05)	0.0004 (0.65)
CCI(-2)	-0.0003 (-0.96)	-0.0004** (-2.46)	-0.001 (-1.63)
CCI(-3)	-0.00013 (-0.46)	0.0002 (1.31)	0.0009 (1.22)
CCI(-4)	-0.0001 (-0.42)	-0.00008 (-0.74)	-0.00005 (-0.09)
D09Q2	0.085*** (4.35)	-	-
DREC	-0.0147 (-1.62)	-0.0066 (-1.15)	-0.0034 (-0.49)
Constant	-0.0158 (-0.68)	-0.0017 (-0.20)	-0.0026 (-0.10)
Obs.	47	47	40
R^2	0.567	0.356	0.231
Adj. R^2	0.489	0.259	0.0909
RMSE	0.0168	0.0114	0.0127

Notes: Dependent variable for each model specification is written at the top of each column. CCI denotes the consumer confidence index written at the top of each column. t-statistics in parentheses. *, **, *** show significance at 10 %, 5 %, 1 %, respectively.

Table 5.8 shows that for total consumption, the first lag of CNBC is statistically significant, pointing that consumer confidence affects consumption not only through its indirect effects on real labour income growth, but also directly. For the nondurable consumption, the results are mixed. While the lags of PCI are significant, no significance is found when CBRT is used. Therefore, we find that PIH is not sufficient to explain the predictive power of consumer sentiment measures on total consumption in Turkey. For nondurable consumption, the result is ambiguous, because it depends on the definition of the consumer sentiment.

5.6 Conclusion

In this study we have investigated the role of consumer confidence indices on explaining and forecasting future quarterly consumption growth in Turkey. We have shown that the lagged values of consumer confidence indices have explanatory power on the future growth of total private consumption and its subcomponents under the absence of other related indicators for consumption. However, once other economic and financial variables, which are thought to play role on consumption growth, are included in the models, the predictive power either decreases or vanishes. CNBC-e for total consumption growth; CBRT and PCI for nondurable consumption growth maintain their predictive power even after controlling for other indicators. Therefore, one can conclude that consumer confidence may provide unique information for consumption growth depending on which definition of consumer sentiment is used. Moreover, our results regarding consumer confidence indices' role on improving out-of-sample forecasting power do not differentiate significantly from the results of in-sample estimations, although there are some minor differences. Finally, our results do not support the implications of permanent income hypothesis and precautionary savings motive for the role of consumer sentiment on future total consumption growth. It is inconclusive for the nondurable consumption. Our findings are in accordance with most of the studies in the literature, which signifies that specifically the financial variables embeds most of the information consumer confidence provides for future consumption growth.

The methodology we employ and our findings are not new for the US or advanced

economies; but still it contributes to the Turkish literature as it is the first study to assess the role of consumer sentiment on consumption. In this regard, this study will be a benchmark to the further studies and help the literature on this issue in Turkey to progress in a similar fashion to the developed countries. It also adds to the limited literature in the developing countries.

We should note that the data unavailability have restricted the scope of the empirical analysis. Firstly, monthly sentiment data would have been more informative about consumption changes than using the quarterly averages, if they were available. Secondly, it would have been more preferable to analyse durable goods, nondurable goods and services, separately similar to Lahiri et al. (2016). Thirdly, as more consumer sentiment data accumulates, the opportunities to study further topics will increase. For instance, estimation methods like VAR may be utilized to incorporate simultaneous relations between the variables and to allow identifying the dynamics of an impact of a confidence shock to other macroeconomic variables (Leeper, 1992; Dees and Brinca, 2013). Further research could also investigate the existence of confidence channel, which aims to identify the spillover effects of shocks in international economies to domestic economies through deteriorated consumer confidence (Avery and Zemsky, 1998; Dees and Brinca, 2013). On the other hand, threshold analysis would be beneficial to understand how large the confidence shock should be to bring extra information beyond other available indicators. It is also possible that the movements in consumer confidence may not be fully explained by economic and financial variables (Fuhrer, 1993). Further studies may investigate in detail the other factors that influence consumer confidence, such as psychological factors or political environment (Ramalho et

al., 2011). As shown by Yüncüler (2016) for Turkey, the sub questions forming consumer confidence indices may have different implications for the consumption decisions, and accordingly, can also be used separately instead of overall indices. Finally, augmenting a wider set of explanatory variables that are relevant to consumption spending may be another option by applying dynamic factor modelling as in Lahiri et al. (2016).”



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APPENDICES

A Breakdowns of Debt Items and Additional Regression Results

Table 1: Total Debt Composition

Categories	No. of Observations	Percentage	Cum. Percentage
Notes payable	36321	44.48	44.48
Other borrowings	6106	7.48	51.96
Debentures	5925	7.26	59.21
Revolving credit facility	4352	5.33	64.54
Bonds and notes	4081	5.00	69.54
Capital leases	3983	4.88	74.41
Trust Preferred Securities	3243	3.97	78.39
Revolving credit	3185	3.90	82.29
Term loan	2848	3.49	85.77
Mortgage bonds	2610	3.20	88.97
Commercial paper	2185	2.68	91.65
Bank loans	1766	2.16	93.81
Mortgage notes	1283	1.57	95.38
FHLB borrowings	715	0.88	96.26
Mortgage loans	652	0.80	97.05
Securities sold under agreement to repurchase	500	0.61	97.67
Term loan facility	384	0.47	98.14
Commercial paper facility	328	0.40	98.54
Securitization facility	323	0.40	98.93
Federal Funds Purchased	261	0.32	99.25
Bank overdraft	255	0.31	99.57
Securities loaned	162	0.20	99.76
Notes Payable Facility	64	0.08	99.84
Federal Reserve Bank Borrowings	41	0.05	99.89
Letter of Credit Outstanding	40	0.05	99.94
Letter of Credit Facility	12	0.01	99.96
FHLB Facility	11	0.01	99.97
Federal Reserve Facility	11	0.01	99.98
Bank overdraft facility	6	0.01	99.99
General borrowings	5	0.01	100.00
Bills payable	3	0.00	100.00
Total	81661	100.00	

Table 2: Total Floating Rate Debt Composition

Categories	No. of Observations	Percentage	Cum. Percentage
Revolving credit facility	2727	20.70	20.70
Notes payable	2304	17.49	38.18
Revolving credit	1921	14.58	52.76
Term loan	1558	11.82	64.58
Trust Preferred Securities	917	6.96	71.54
Bank loans	808	6.13	77.67
Bonds and notes	772	5.86	83.53
Other borrowings	366	2.78	86.31
Term loan facility	312	2.37	88.68
Commercial paper	293	2.22	90.90
FHLB borrowings	247	1.87	92.78
Mortgage bonds	235	1.78	94.56
Securitization facility	140	1.06	95.62
Mortgage notes	121	0.92	96.54
Debentures	106	0.80	97.34
Mortgage loans	102	0.77	98.12
Capital leases	89	0.68	98.79
Commercial paper facility	52	0.39	99.19
Securities sold under agreement to repurchase	34	0.26	99.45
Bank overdraft	18	0.14	99.58
Letter of Credit Outstanding	18	0.14	99.72
Notes Payable Facility	18	0.14	99.86
Letter of Credit Facility	9	0.07	99.92
Federal Funds Purchased	6	0.05	99.97
Federal Reserve Bank Borrowings	3	0.02	99.99
Federal Reserve Facility	1	0.01	100.00
Total	13177	100.00	

Table 3: Descriptive Statistics for Floating Rate Debt Items

	Mean	SD
Bank loans	6.11	18.60
Bank overdraft	2.21	2.99
Bonds and notes	10.22	39.27
Capital leases	1.00	1.07
Commercial paper	6.78	13.32
Commercial paper facility	18.90	19.14
Debentures	7.65	21.76
Federal Reserve Bank Borrowings	257.07	108.84
FHLB borrowings	28.97	78.77
Federal Funds Purchased	64.49	77.99
Federal Reserve Facility	353.43	.
Letter of Credit Facility	9.28	4.90
Letter of Credit Outstanding	7.81	4.84
Mortgage bonds	4.18	14.48
Mortgage loans	1.46	1.80
Mortgage notes	1.67	2.22
Notes Payable Facility	1.90	1.35
Notes payable	16.82	57.97
Other borrowings	29.61	143.16
Revolving credit	3.26	5.50
Revolving credit facility	9.96	27.14
Securities sold under agreement to repurchase	284.44	774.41
Securitization facility	10.93	33.50
Term loan	6.92	14.05
Term loan facility	8.43	21.53
Trust Preferred Securities	2.33	4.11
Total	10.38	58.01
Observations	13177	

Note: We divide each item (in million USD) by CPI. The table shows means and standard deviations in real terms.

Table 4: Maturity/Interest Rate Type Pairs for Debts

	Interest Rate Type ID				Total
	NA	Variable	Fixed	Zero Coupon	
0-1 year	354	890	2,820	7	4,071
1-5 years	3,876	6,086	17,736	34	27,732
5-10 years	1,403	2,023	14,041	29	17,496
10-20 years	1,486	929	6,391	34	8,840
20-30 years	503	1,004	7,627	19	9,153
30 years or more	7,437	2,245	4,654	33	14,369
Total	15,059	13,177	53,269	156	81,661

Note: The entries give numbers of observations.

Table 5: Descriptive Statistics for Debts by Maturity

	Mean	SD
0-1 year	5.37	26.73
1-5 year	11.66	91.75
5-10 year	8.80	66.02
10-20 year	25.56	325.76
20-30 year	23.51	555.81
more than 30 years	22.24	131.18
Total	15.43	230.24
Observations	81661	

Note: We divide each item (in million USD) by CPI. The table shows means and standard deviations in real terms.

Table 6: A Replication of Ippolito et al. (2017)

VARIABLES	(Bank Debt Leverage) Stock Return	(Floating Rate Debt Leverage) Stock Return
target	-17.046*** (4.935)	-16.341*** (5.489)
leverage	1.606 (1.438)	1.452 (1.375)
target#leverage	-17.239* (9.668)	-16.691** (7.761)
hedge	0.020 (0.187)	-0.001 (0.203)
hedge#target	-1.053 (2.377)	-0.295 (1.529)
hedge#leverage	-0.837 (1.338)	-0.559 (1.160)
hedge#target#leverage	23.379** (11.338)	14.291* (8.046)
Observations	10,681	11,517
R-squared	0.048	0.050

Notes: The event studies above are based on 47 FOMC announcements between January 2004 and December 2008. The first column follows Ippolito et al. (2017) model specification with the two-day stock return bracketing an FOMC announcement as the dependent variable. Firm-level controls (size, book leverage, market-to-book ratio, profitability) and their interactions with policy surprise are included. The second column is based on the same specification, but with floating rate debt leverage in place of bank debt leverage. The numbers in the parentheses are standard errors. The regression is run with firm-level fixed effects, and standard errors are clustered at the event-level. * stands for $0.05 < p \leq 0.1$, ** for $0.01 < p \leq 0.05$, and *** for $p \leq 0.01$.

Table 7: Balance Sheet Regressions: Cash Holding

VARIABLES	(t+1) Cash	(t+2) Cash	(t+3) Cash	(t+4) Cash	(t+5) Cash	(t+6) Cash	(t+7) Cash	(t+8) Cash
exposure	-0.270 (0.237)	-0.250 (0.318)	-0.311 (0.310)	-0.440 (0.365)	-0.534 (0.429)	-0.285 (0.705)	-0.076 (0.903)	-0.116 (1.119)
change#exposure	-0.291 (0.354)	-0.634 (0.494)	-0.295 (0.503)	-1.291** (0.562)	-1.380** (0.695)	-1.116* (0.629)	-0.962 (0.692)	-1.492 (0.993)
hedge#exposure	0.198 (0.276)	0.155 (0.357)	0.070 (0.382)	0.137 (0.431)	0.079 (0.491)	-0.251 (0.739)	-0.402 (0.907)	-0.212 (1.110)
hedge#change#exposure	-0.141 (0.388)	0.268 (0.537)	0.299 (0.557)	1.158* (0.615)	1.326* (0.727)	1.044 (0.669)	1.020 (0.752)	1.718 (1.057)
zlb#change#exposure	5.858 (5.033)	7.514 (7.569)	5.492 (8.427)	-2.660 (9.140)	-4.283 (9.776)	-0.609 (10.276)	1.484 (9.143)	14.931 (11.068)
hedge#zlb#change#exposure	-2.009 (6.476)	-1.555 (8.973)	-6.345 (9.040)	2.492 (9.806)	7.021 (10.344)	1.358 (10.666)	7.713 (9.357)	-5.693 (11.734)
R-squared	0.142	0.179	0.222	0.269	0.315	0.327	0.355	0.375
Leverage								
leverage	-0.410 (0.969)	0.525 (1.346)	-0.695 (1.274)	-1.176 (1.428)	-2.229 (1.752)	-0.963 (2.533)	-0.451 (2.993)	0.649 (3.544)
change#leverage	-2.151 (1.601)	-2.929 (2.216)	-2.072 (2.347)	-5.306** (2.166)	-5.928** (2.871)	-5.667** (2.832)	-6.195** (2.507)	-8.468** (3.483)
hedge#leverage	-0.835 (1.069)	-1.995 (1.460)	-2.185 (1.647)	-2.441 (1.811)	-1.750 (2.020)	-2.788 (2.483)	-2.943 (2.889)	-3.161 (3.330)
hedge#change#leverage	-0.557 (1.782)	0.494 (2.439)	2.160 (2.680)	4.006 (2.487)	5.238* (3.037)	4.742 (3.092)	5.002* (2.851)	7.987** (3.832)
zlb#change#leverage	28.253 (24.776)	-9.024 (23.415)	3.422 (31.365)	-64.904* (35.885)	-17.646 (32.337)	51.693 (77.559)	55.540 (71.679)	108.439 (85.793)
hedge#zlb#change#leverage	-14.758 (30.339)	24.487 (32.429)	-14.860 (32.745)	45.792 (40.454)	-3.751 (37.127)	-65.455 (79.075)	-37.891 (72.211)	-86.882 (89.227)
Observations	6,757	6,735	6,693	6,653	6,614	6,568	6,518	6,464
R-squared	0.143	0.178	0.221	0.269	0.314	0.326	0.354	0.374

Table 8: Balance Sheet Regressions: Coverage Ratio

VARIABLES	(t+1) Coverage	(t+2) Coverage	(t+3) Coverage	(t+4) Coverage	(t+5) Coverage	(t+6) Coverage	(t+7) Coverage	(t+8) Coverage
exposure	-3.287** (1.643)	-4.104* (2.139)	-4.760* (2.714)	-1.912 (2.471)	-0.064 (2.931)	0.713 (3.641)	3.536 (2.917)	3.669 (2.608)
change#exposure	-5.951** (2.418)	-8.291** (3.388)	-9.425** (3.780)	-6.059 (3.776)	-3.385 (4.090)	-4.071 (4.867)	-5.821 (4.222)	-4.083 (3.608)
hedge#exposure	2.847* (1.612)	3.694* (2.067)	4.488* (2.588)	1.639 (2.381)	-0.141 (2.776)	-0.823 (3.437)	-3.248 (2.721)	-3.290 (2.512)
hedge#change#exposure	6.113** (2.490)	8.964** (3.502)	9.231** (3.920)	6.093 (3.915)	3.438 (4.219)	4.464 (4.980)	5.838 (4.322)	4.181 (3.656)
zlb#change#exposure	11.261 (18.487)	28.997 (21.308)	-0.367 (12.554)	4.174 (20.487)	20.825 (25.136)	31.785 (25.820)	24.970 (25.122)	2.434 (18.903)
hedge#zlb#change#exposure	-14.735 (19.754)	-32.836 (23.009)	4.375 (14.856)	-12.921 (23.085)	-29.627 (26.695)	-40.624 (27.955)	-22.500 (24.360)	-4.201 (19.128)
R-squared	0.201	0.200	0.230	0.242	0.247	0.205	0.251	0.262
Leverage								
leverage	-1.530 (6.098)	-2.911 (7.526)	-10.367 (9.344)	-9.821 (9.781)	5.083 (11.724)	4.497 (12.240)	12.254 (13.200)	15.086 (11.337)
change#leverage	-21.265** (9.091)	-24.491** (12.465)	-29.334** (12.379)	-30.405** (13.935)	-23.113 (15.006)	-27.047 (16.507)	-38.903** (15.739)	-34.429** (13.703)
hedge#leverage	1.449 (5.872)	2.797 (7.108)	9.702 (8.536)	7.743 (9.253)	-7.808 (10.847)	-7.002 (11.262)	-13.264 (11.777)	-14.317 (10.464)
hedge#change#leverage	18.748* (9.708)	24.112* (13.188)	24.285* (13.470)	27.793* (15.305)	19.587 (16.131)	24.722 (17.438)	33.866** (16.680)	29.717** (14.333)
zlb#change#leverage	210.883 (164.182)	291.444* (172.704)	-26.507 (95.298)	214.681 (149.049)	203.373 (166.011)	205.309 (150.176)	241.140 (170.786)	71.439 (105.787)
hedge#zlb#change#leverage	-245.080 (167.180)	-300.637* (175.510)	64.517 (115.933)	-216.851 (152.194)	-225.038 (168.863)	-187.665 (151.398)	-186.056 (156.507)	-23.422 (121.967)
Observations	5,673	5,601	5,396	5,201	5,023	4,833	4,646	4,463
R-squared	0.200	0.198	0.228	0.242	0.247	0.205	0.252	0.262

Notes: The cash holding is defined as the change in cash and short-term investments from period t-1 to t+x divided by total assets in t-1. The coverage ratio is defined as the sum of interest rate expenses and cash flow (earnings before extraordinary items plus depreciation) divided by interest rate expenses. The dependent variables and the regression specifications for Tables A7 and A8 are adopted from Ippolito et al. (2017). Other conventions are identical to those in Tables 10 to 12.

B Summary of Data Construction

Table 9: Summary of Data Construction

Variable (Frequency)	Type	Definition	Data Source
Stock return (daily)	Regressand	Log-difference of a stock price the day before and the day after an FOMC announcement	CRSP database
Monetary policy target and path surprises (FOMC meetings)	Regressor	Market-based (i.e., futures contracts) monetary policy innovations Target factor: a surprise to the current policy target Path factor: a surprise to the future policy rates	Authors' calculations following Gürkaynak et al. (2005)
Floating rate exposure (annual)	Regressor	The sum of maturity weighted floating rate debts, expressed as a fraction of total assets	CIQ and Compustat database
Bank debt leverage (annual)	Regressor	Bank debts over total assets, where bank debts = term loans + credit lines	CIQ and Compustat database
Floating rate debt leverage (annual)	Regressor	Total floating rate debts over total assets	CIQ and Compustat database
Hedge (annual)	Regressor	A dummy variable whose value is one if a firm hedges against interest rate risks of its floating rate obligations by entering into interest rate derivative contracts	10-K report in SEC database
ZLB	Regressor	A dummy variable whose value is one from January 2009 to September 2014 (the end period of the extended sample)	Not Applicable
Size (quarterly)	Regressor	Logarithm of the book value of total assets, deflated by CPI	Compustat database
Book leverage (quarterly)	Regressor	The ratio of total debts to the sum of total debts and the book value of equity	Compustat database
Market-to-book ratio (quarterly)	Regressor	The ratio of the sum of the market value of equity and total debts to total assets	Compustat database
Profitability (quarterly)	Regressor	The ratio of operating income before depreciation to total assets	Compustat database
Capital investment (quarterly)	Regressand	Total fixed capital (property, plant, and equipment); log-difference relative to the reference quarter is used	Compustat database
Inventory investment (quarterly)	Regressand	A standalone item in database (code: INVTQ); log-difference relative to the reference quarter is used	Compustat database
Profit (quarterly)	Regressand	Sales minus cost of goods sold and interest rate expenses; expressed as a fraction of total assets to be used	Compustat database
Cash holding (quarterly)	Regressand	The change in cash and short-term investments relative to the reference quarter; divided by total assets in the reference quarter to be used	Compustat database
Coverage ratio (quarterly)	Regressand	The sum of interest rate expenses and cash flow (defined below), divided by interest rate expenses	Compustat database
Change (quarterly)	Regressor	The sum of all changes in the federal funds rate during the reference quarter	FRED
Short-term debt (quarterly)	Regressor	Current liabilities (maturity less than a year), deflated by CPI	Compustat database
Cash flow (quarterly)	Regressor	Earnings before extraordinary items + depreciation, deflated by CPI	Compustat database

C On Borrowing Constraint

I assume that the entrepreneurs can only demand to borrow a certain proportion of their investment ($b_t \leq \chi i_t$). The rationale behind this constraint is limited enforcement. If a firm rejects to repay his debt; then lender can obtain borrower's assets by paying a proportional cost $(1 - \chi)i_t$. This would constraint borrowers

to take debt up to χi_t . Obviously, lenders will refrain from such cases when $\chi > 1$. (Lenders protect themselves by demanding a collateral). Even though in principle borrower can still reject to pay for debt, this constraint would leave him with nothing; so he will not do so in equilibrium.

One might question what will prevent entrepreneurs from borrowing and self-finance themselves. It is primarily the fact that the entrepreneurs are less patient compared to households, who are lenders in our economy, which prevents such outcome. To maximize their strictly increasing utility, they will choose to borrow up to the limit.

To see this, consider the following problem:

Assume entrepreneur maximizes his lifetime utility, with the discount factor, γ , which is less than β , the household's discount factor. He solves:

$$Max \ E_0 \sum_{t=0}^{\infty} \gamma^t \{\log C_t\} \quad (5)$$

subject to budget constraint:

$$C_t + I_t + r_{t-1}B_{t-1} = B_t + f(K_{t-1}) \quad (6)$$

borrowing constraint:

$$B_t \leq \chi I_t \quad (7)$$

accumulation of capital:

$$K_t = (1 - \delta)K_{t-1} + I_t \quad (8)$$

Let μ_t be the Lagrange multiplier associated with the borrowing constraint in (7), I end up with following first order condition:

$$\frac{1}{C_t} - \gamma r_t \frac{1}{C_{t+1}} = \mu_t \quad (9)$$

Assume that the economy is at its steady state. There, the interest rate for the debt is determined only by household's Euler equation which implies $r = 1/\beta$.

The assumption of $\gamma < \beta$ imposes the Lagrange multiplier, μ_t (e.g., the shadow value of debt) to be positive at steady state. So, the increase in the life time utility from borrowing an additional unit is positive.

Linearizing the model around the steady state and investigating dynamics around it, I can assume that it will bind always.

To summarize;

- The borrowing constraint justifies enforcement of debt contracts.
- It provides conditions for both household and entrepreneur to act in accordance with the contract.
- The borrowing constraint, written in this way, limits the amount of debt, so that entrepreneurs can not borrow as much as they want. In other words, it provides stability.
- As long as entrepreneurs have a strictly increasing utility function and less patient than the household, the constraint will bind around the steady state. I assume that shocks are as small enough, to prevent deviations from this assumption.

D Impulse Response Functions for Selected Shocks

A Positive Shock to A_t^S :

Figures 3 and 4 present impulse responses for selected variables to a 10 percent positive productivity shock in non-capital good sector. When the productivity in the non-capital sector increases, the total production of this good increases. Both household and the non-capital entrepreneur increase their consumption levels almost one to one. Overall, the consumption basket will increase up to 10 percent. Related to the demand for short-term investment goods, the demand for short term bonds will also increase.

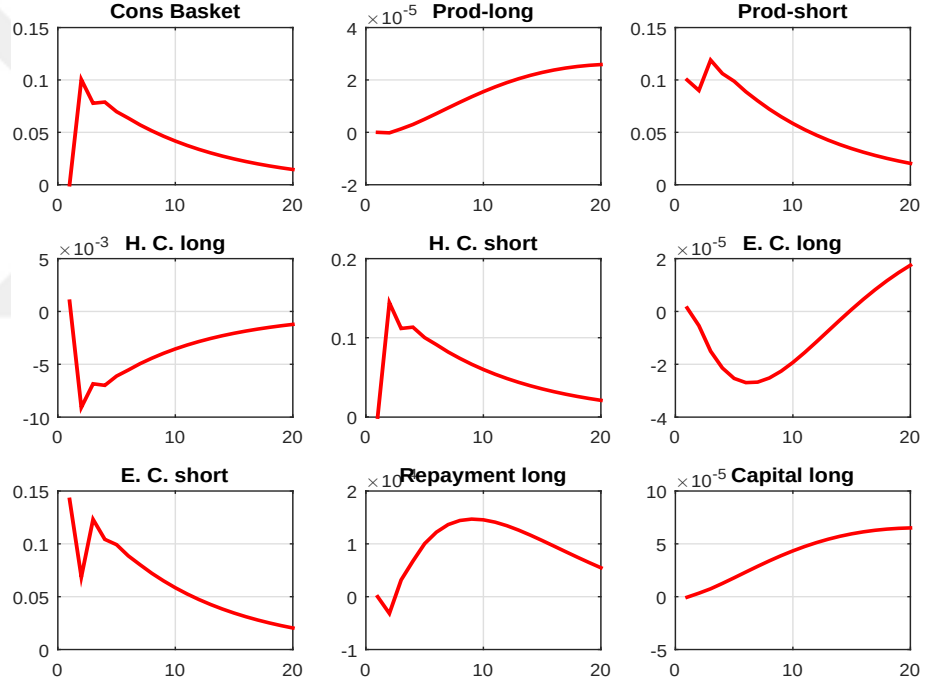


Figure 3: Baseline Model IRFs: A Positive Shock to A_t^S (1)

A Negative Shock to χ_t^S :

A decrease in χ_t^S enables entrepreneurs to finance less of their investment with a given amount short-term debt. So, this shock can be interpreted as a financial distress shock. The impulse responses are presented in Figures 5 and 6. In the first period, there is no obvious effect on the economy. The reason is that

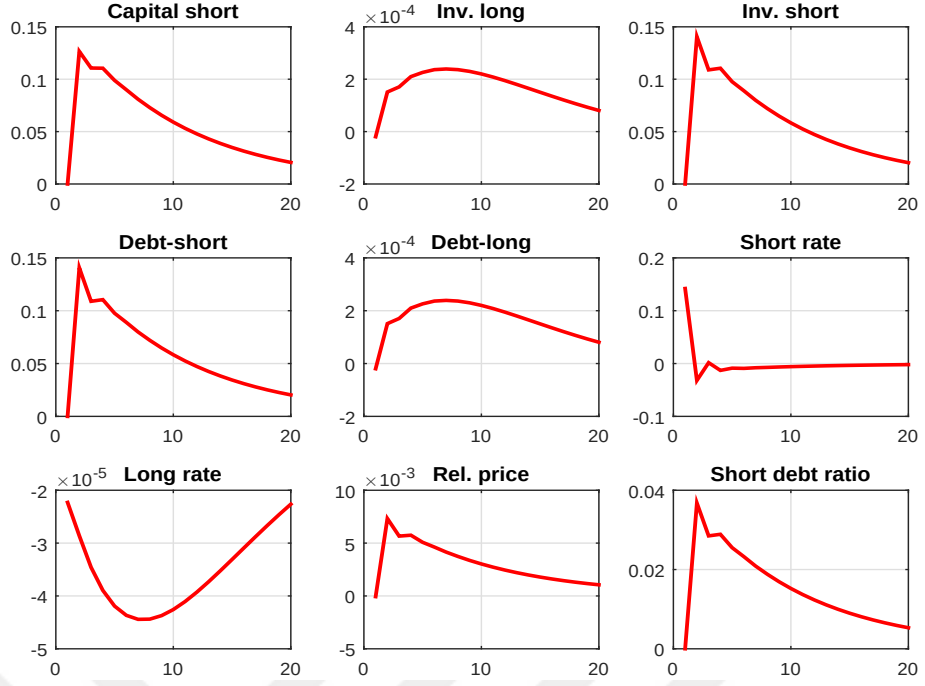


Figure 4: Baseline Model IRFs: A Positive Shock to A_t^S (2)

entrepreneurs produce with the accumulated capital. So, the effect happens with one period lag. The interpretations are similar to the capital good case, which is discussed in Section 4.4.

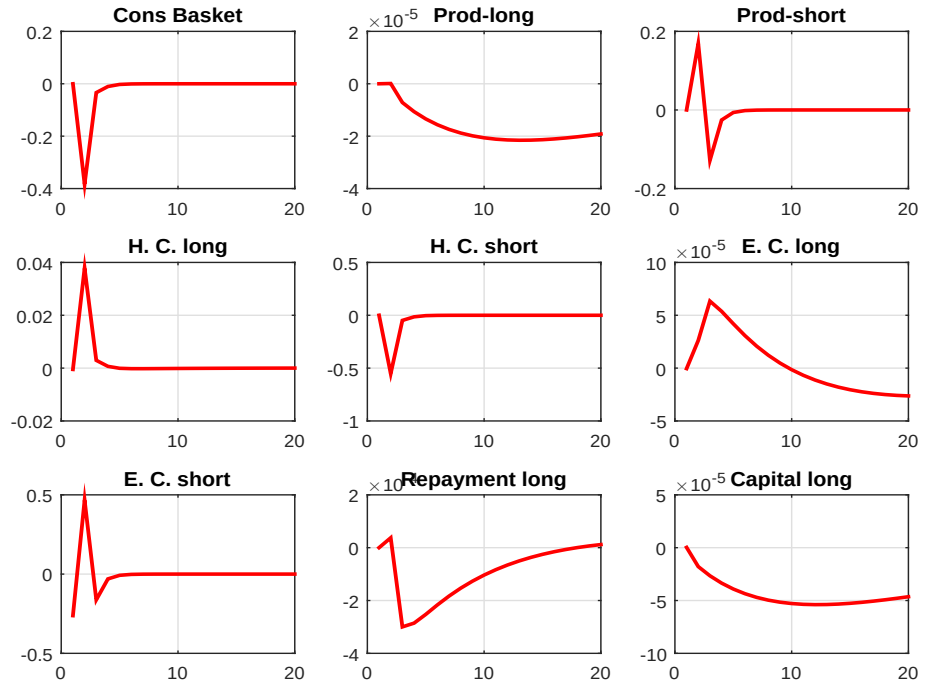


Figure 5: Baseline Model IRFs: A Negative Shock to χ_t^S (1)

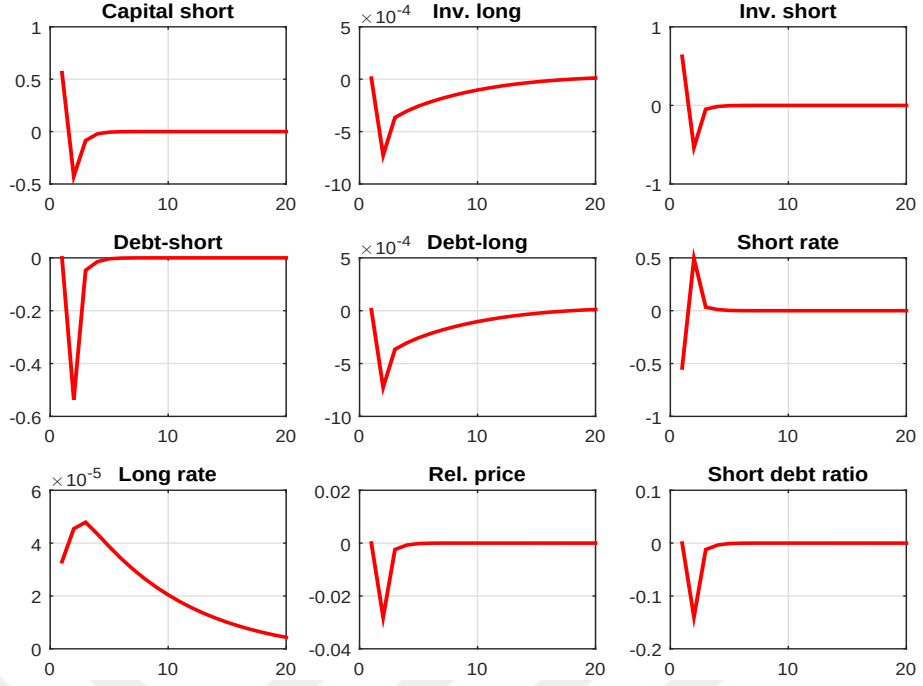


Figure 6: Baseline Model IRFs: A Negative Shock to χ_t^S (2)

E Selected Impulse Responses in the Extended Model

A Positive Shock to A_t^S :

The impulse responses are presented in Figures 7-9. After a 10 percent positive productivity shock to non-capital sector, the production in that sector increases. Household and the entrepreneurs who produce in this sector increase their consumption by more than 10 percent from this good. The interpretations are similar to those for capital good productivity shock.

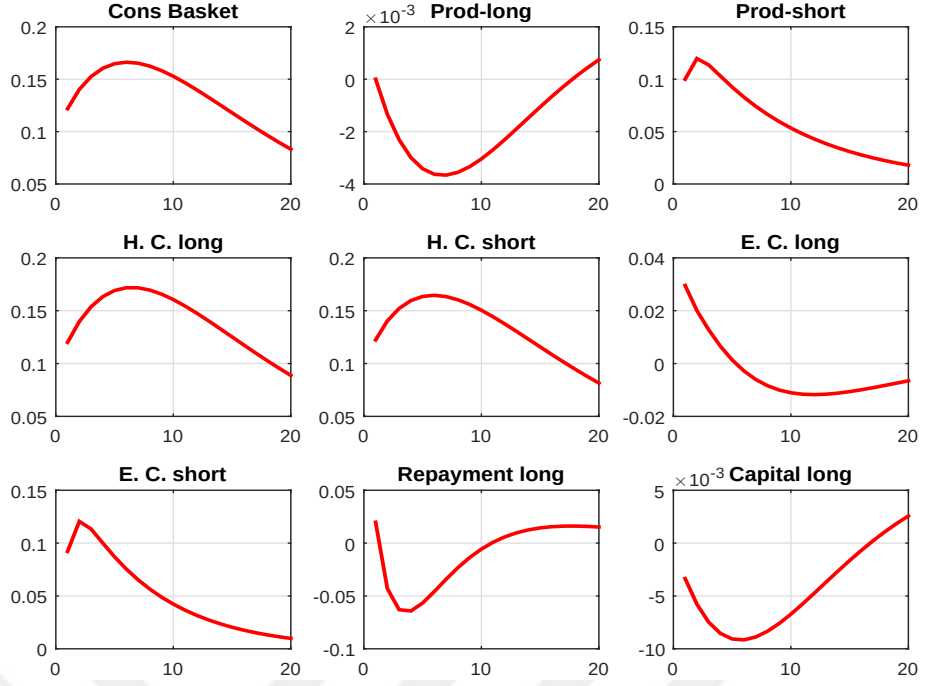


Figure 7: Extended Model IRFs: A Positive Shock to A_t^S (1)

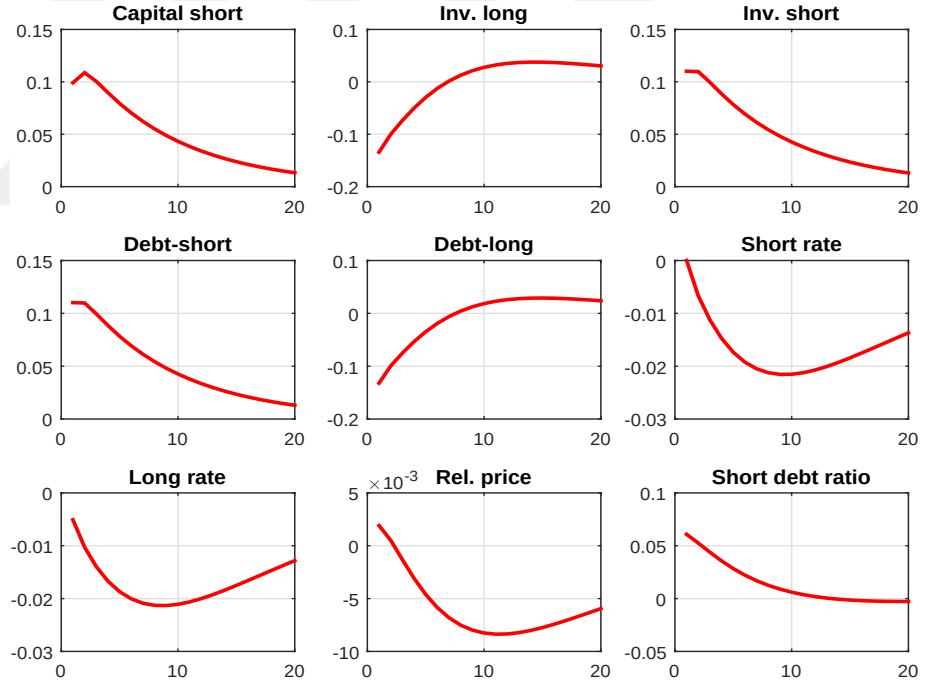


Figure 8: Extended Model IRFs: A Positive Shock to A_t^S (2)

F A Final Word on Micro-founded Debt Maturity Choice

How do firms decide the maturity of their debt? Why do they hold both short-term and long-term debt? Is this decision process significant for the aggregate economy or transmission of shocks? I find this issue of endogenous maturity

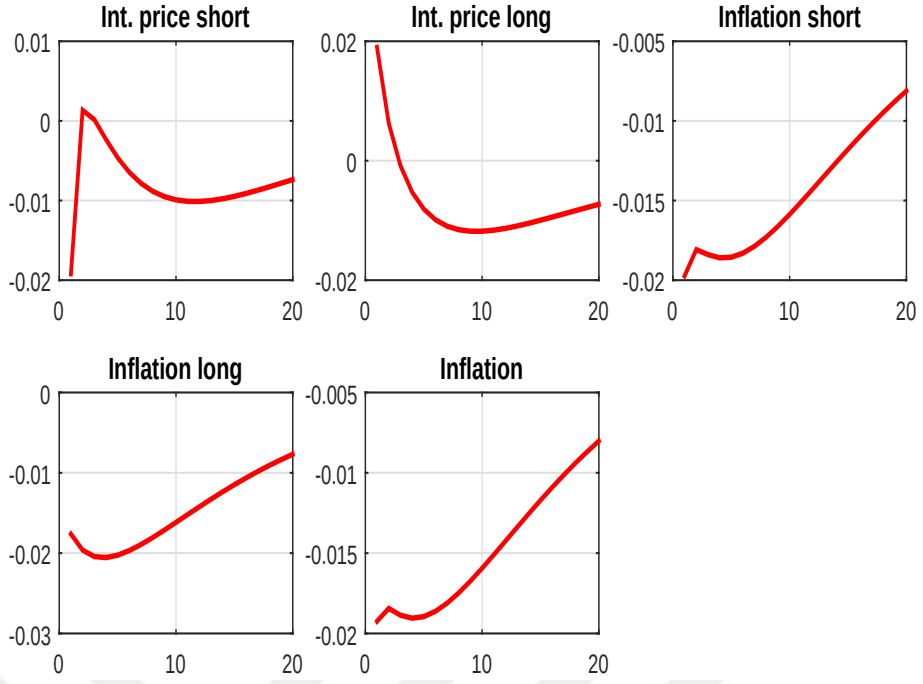


Figure 9: Extended Model IRFs: A Positive Shock to A_t^S (3)

choice very thought-provoking.

Colla et al. (2013) examine debt structure for public US firms. They point out a significant concentration in debt types. They indicate that the degree of debt specialization varies across different subsamples; large and rated firms tend to diversify across multiple debt types, however small and unrated firms specialize in fewer types. Their explanations for these pattern include economies in information collection costs, and enhanced incentives to monitor and supply side factors. These arguments closely related to early theories of maturity structure mentioned in Section 4.2.1.

However standard macro-economic models lack to reflect such an endogenous structure and co-existence of both kinds of debts. A tractable and intuitive way to model long-term debt together with short-term debt is using “search” frictions to the financial market. As supported by the empirical findings of Colla et al. (2013); finding a creditor to finance a long-term project is time consuming and costly. In other words, search and matching frictions can be employed to represent technological constraints, transaction costs, and information frictions related to

financial markets.

A recent literature studies credit markets with search and matching frictions. Cui and Radde (2016) model asset liquidity premium using search frictions. Radde et al. (2015) extends their structure to model long-term government debt and discuss sovereign debt crisis. Beaubrun-Diant and Tripier (2015) use search frictions to model net interest margins of banks.

To model corporate debt in a similar vein, the model built in this chapter can be improved. In such a model, both kinds of investment projects are pursued by the same class of entrepreneurs, which makes the endogenous decision relevant. Short-term debt is supplied in a frictionless manner. To finance short-term expenditures such as wage payments or production factor rents, the creditors might simply give the entrepreneur one period debt. However the entrepreneurs might be in difficulty when it comes to long-term projects. For example buying a land or building factory might require a search effort to find a long-term creditor. On the other hand, rolling over short-term debt might also be costly. So the agent would compare the costs of rolling over short-term debt and search cost of long-term debt when he decides to make a long-term investment.

In such a model, financial intermediaries plays the role of collecting borrowing and lending demands and correspondence is characterized by a matching function. The Nash bargaining problem between borrowers and lenders determines the equilibrium lending rate of long-term debt. In such a model the amplification and propagation mechanism will work through this search friction. Because, in response to an aggregate shock the entrepreneurs will trade off the long run return from the projects and premium requested by financial intermediaries.

I defer to develop such a structure to my future research agenda.