Fisher, Jonas D. M.

Working Paper

On the structural interpretation of the Smets-Wouters "risk premium" shock

Working Paper, No. 2014-08

Provided in Cooperation with:
Federal Reserve Bank of Chicago


This Version is available at:
http://hdl.handle.net/10419/130658

Terms of use:
Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Standard-Nutzungsbedingungen:
Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privategebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.
On the Structural Interpretation of the Smets-Wouters “Risk Premium” Shock

Jonas D.M. Fisher

October 2014

WP 2014-08
On the Structural Interpretation of the Smets-Wouters “Risk Premium” Shock

Jonas D.M. Fisher*

Federal Reserve Bank of Chicago
jfisher@frbchi.org

October 22, 2014

Abstract

This article shows that the “risk premium” shock in Smets and Wouters (2007) can be interpreted as a structural shock to the demand for safe and liquid assets such as short-term US Treasury securities. Several implications of this interpretation are discussed.

JEL Classification Numbers: E00, E1, E3, E4, E5, G1
Keywords: Smets-Wouters model, safe and liquid assets, money demand, risk premium shock, New Keynesian model, DSGE, flight-to-quality, liquidity preference

*I thank Bob Barsky and Alejandro Justiniano for very helpful conversations. Any views expressed herein are those of the author and not necessarily of the Federal Reserve Bank of Chicago or the Federal Reserve System.
1. Introduction

In their seminal paper Smets and Wouters (2007) (hereafter referred to as SW) introduce a so-called “risk premium” shock into a medium-scale New Keynesian DSGE model. This shock was specified as an exogenous term appended to the representative household’s linearized inter-temporal consumption Euler equation. As such the risk premium shock was not given a rigorous structural interpretation as it would have if it were specified as a feature of either preferences, technology or market structure. This is one reason Chari, Kehoe, and McGrattan (2009) cite to discredit the SW model.

The risk premium shock is important in New Keynesian DSGE models because of its capacity to generate business cycle co-movement among output, hours, consumption and investment. This makes it a significant driver of aggregate fluctuations and influences the identification of other shocks. Recent incarnations of the SW model used by Barsky, Justiniano, and Melosi (2014) and Christiano, Eichenbaum, and Trabandt (2014) find this shock is particularly important for post-2008 dynamics. If the shock is not plausibly structural then these and similar findings are difficult to interpret and the ex ante legitimate critique of this shock by Chari et al. (2009) stands.

The primary contribution of this article is to show how to re-interpret the SW risk premium shock as a structural shock to the demand for safe and liquid assets such as short-term Treasury securities. To do so I build on recent work by Krishnamurthy and Vissing-Jorgensen (2012) (KVJ). These authors describe a simple model of demand for the safety and liquidity of short-term Treasuries and use it to show the quantitative significance of these attributes. The structural interpretation that results from introducing their framework into the SW model suggests a new source of aggregate fluctuations that up until now has received relatively little attention – shocks to the demand for safe and liquid assets. KVJ do not connect their framework to the SW model.

KVJ use episodic “flight-to-quality” as an example of safety and liquidity shocks. Chari et al. (2009) conjecture that the risk premium shock in SW may pick up variation in flight-

1Christiano, Motto, and Rostagno (2003) is an important exception as they show a similar shock is important for understanding the Great Depression.
to-quality as well. Unfortunately Chari et al. (2009) do not provide a foundation for why they believe this to be true. This article provides such a foundation. Doing so suggests new lines of research inquiry, including how to address potential flaws in SW’s identification of the shock which become apparent only when a structural foundation is specified.

2. Interpreting the Shock

To demonstrate the structural nature of the SW shock we need only consider the household side of their model.\(^2\) Since they are not consequential for the main result there is no growth, labor is homogeneous and consumption and leisure are separable in preferences that do not include habit. Using \(c_t\) and \(n_t\) to denote consumption and labor supply, and \(E_t\) to denote the date \(t\) conditional expectations operator, preferences for the representative household are

\[
E_0 \sum_{t=0}^{\infty} \beta_t [\ln c_t + \eta \ln(1 - n_t) + s_t U(B_{t+1}/P_t)].
\]  

(1)

The special feature of (1) is the term \(s_t U(B_{t+1}/P_t)\) where \(U(\cdot)\) is positive, increasing and concave. This represents the household’s preference for holding one-period nominally risk-free assets \(B_{t+1}\) that have unit price in dollars and pay a fixed nominal return \(R_t\) in period \(t+1\). For simplicity we refer to these securities as risk-free bonds. The household cares about the real value of risk-free bonds and so the nominal quantity \(B_{t+1}\) is deflated by the price of consumption goods \(P_t\). These preferences are similar to how KVJ model the various benefits derived from the liquidity and safety of short-term Treasuries and they are analogous to the money-in-utility approach pioneered by Sidrauski (1967).\(^3\) The variable \(s_t\) is an exogenous stationary random disturbance. The main result is that under certain assumptions detailed below \(s_t\) corresponds to the SW risk premium shock. Safe and liquid assets being separable in (1) is essential to this result.

KVJ discuss why the liquidity and safety of short-term Treasuries justify including a

\(^2\)Knowledge of the SW model is assumed throughout.

\(^3\)The only difference with KVJ is that consumption and the safety and liquidity services derived from holding short-term Treasuries are not perfect substitutes in (1) while they are in KVJ.
motive for holding them in addition to the usual intertemporal substitution and risk aversion motives found in traditional representative agent asset-pricing models. The liquidity motive is justified by theoretical findings in Vayanos and Vila (1999) and Rocheteau (2009) who show how the price of assets with superior liquidity can command a premium and why the marginal liquidity service these assets provide is diminishing in the quantity of them held. KVJ describe three reasons why the perceived safety of short-term Treasuries also justifies a premium for holding them: costly acquisition of information on risky assets; their value as collateral in many financial transactions; and because they inherit the medium-of-exchange convenience of money via their use by commercial banks and money market funds as backing for checkable deposits. The function $U(\cdot)$ summarizes the derived demand for short-term Treasuries and other assets with similar characteristics generated by these factors, including fiat money. The variable $s_t$ captures the idea that the demand for safe and liquid assets is time-varying.

The household maximizes (1) subject to a period-by-period budget constraint and the capital accumulation equation given by:

$$c_t + x_t + B_{t+1}/P_t = r_t k_t + w_t n_t + R_{t-1} B_t/P_t + T_t;$$

$$k_{t+1} = (1 - \delta) k_t + (1 - Q(x_t/x_{t-1})) x_t.$$ 

Here $r_t$ and $w_t$ denote the date $t$ real rental rate on capital and the real wage, $T_t$ denotes lump sum transfers to satisfy the government budget constraint, $x_t$ denotes date $t$ investment, $k_{t+1}$ denotes capital installed for use in production at date $t + 1$, and $Q(\cdot)$ is the adjustment cost function introduced by Christiano, Eichenbaum, and Evans (2005). Define $\lambda_t$ to be the Lagrange multiplier on the budget constraint in the household’s optimization problem which corresponds to the marginal utility of consumption.
The first order conditions for risk-free bonds and date $t+1$ installed capital can be written

$$\lambda_t - s_t U'(b_{t+1}) = E_t \beta \lambda_{t+1} \pi_{t+1}^{-1} R_t; \quad (2)$$

$$\lambda_t q_t = E_t \beta \lambda_{t+1} \{r_{t+1} + q_{t+1} (1 - \delta)\}. \quad (3)$$

The variables $b_{t+1}$ and $q_t$ denote the real quantity of bonds carried into $t+1$ and the price of date $t+1$ installed capital; $\pi_{t+1} \equiv P_{t+1}/P_t$ denotes consumer price inflation. The key feature of these equations is the extra term $s_t U'(b_{t+1})$ in the bond equation (2) and the absence of a similar term in the capital equation (3). Equation (2) is new while (the linearized version of) (3) appears in SW. An exogenous increase in $s_t$ lowers the marginal cost of saving in the risk-free bond thereby increasing the incentive to save and save through this vehicle rather than via capital accumulation. The net result is a tendency for consumption and capital investment to move in the same direction. This is the underlying reason for why the SW shock plays such an important role in New Keynesian DSGE models.

Under certain assumptions the variable $s_t$ is equivalent to the SW risk premium shock. To see this study the log linearized version of the first order condition for risk-free bonds equation (2):

$$\hat{\lambda}_t = \theta \left( \hat{R}_t - E_t \hat{\pi}_{t+1} + E_t \hat{\lambda}_{t+1} \right) + \lambda^{-1} U'(b) (s_t - s) + \lambda^{-1} s b U''(b) \hat{b}_{t+1}, \quad (4)$$

where $\hat{z}_t \equiv \ln z_t - \ln z$ for any variable $z_t$ and the absence of a time subscript indicates the steady state value of a variable. The coefficient $\theta$ is the steady state discount on the risk-free interest rate relative to its value in the version of the model without a preference for the liquidity and safety of risk free bonds, $R^* \equiv \pi/\beta$:

$$\theta \equiv \frac{R}{R^*} = 1 - \lambda^{-1} s U'(b) \leq 1$$

The inequality in the last line follows from the assumption that $s \geq 0$. 5
The bond equation in SW is obtained if we linearize around \( s = 0 \). In this situation \( \theta = 1 \) so that
\[
\hat{\lambda}_t = \hat{R}_t - E_t \hat{\pi}_{t+1} + E_t \hat{\lambda}_{t+1} + \lambda^{-1} U'(b) s_t,
\]
which corresponds to equation (2) in SW where the risk premium shock equals \( s_t \) scaled by the steady state marginal rate of substitution between consumption and risk free bonds, \( \lambda^{-1} U'(b) s_t \).

Since no other equations of the SW model are affected by including a preference for safety and liquidity their results are unchanged by linearizing around \( s = 0 \). From this perspective the SW risk premium shock can be interpreted as a shock to the demand for safe and liquid assets. This sheds a whole new light on their findings and points research in a direction that has been given little attention in the recent business cycle literature. At the very least it suggests re-labeling the shock in SW. Calling it “safety and liquidity premium” is consistent with KVJ. Other possibilities include “liquidity preference” or “money demand.” The latter is the shorthand used below.

3. Discussion

It may be more natural to linearize (4) around \( b = 0 \) with \( U'(0) > 0 \) and \( s > 0 \). In this case we obtain a slightly different version of (5),
\[
\hat{\lambda}_t = \theta \left( \hat{R}_t - E_t \hat{\pi}_{t+1} + E_t \hat{\lambda}_{t+1} \right) + \lambda^{-1} U'(0) s_t.
\]
If \( s > 0 \) then \( \theta < 1 \) and so in this case the direct connection to SW is broken. From this perspective interpreting the SW shock as a money demand shock requires an adjustment to the consumption Euler equation. To gauge the possible impact on measurement we can calibrate the adjustment factor \( \theta \) using KVJ’s estimates. KVJ find that the safety and liquidity of short-term treasuries translate to an average discount of 73 annualized basis points. This implies \( \theta = .18 \), which is much less than 1. Therefore not making the adjustment is a potentially serious source of miss-measurement of the money demand shock and its
Another source of miss-measurement arises if we linearize around a positive value of $b$ and we assume $U''(b) < 0$. Equation (4) with $b > 0$, $s > 0$ and $U''(b) < 0$ means that in addition to using the wrong value of $\theta$ the SW equation is missing a variable, namely the supply of safe and liquid assets, $b_{t+1}$. This would be consistent with the important role for the supply of these securities in determining their price found by KVJ. Still, the ultimate effects of accounting for the supply of safe and liquid assets for understanding business cycles remains to be determined.

While this article has developed a structural interpretation of the SW risk premium shock in the sense that it connects the shock to a preference for safe and liquid assets, these shocks are not plausibly structural if variation in the demand for safety and liquidity is mostly driven by other factors such as monetary policy shocks. Chari et al. (2009) assert a structural relationship between flight-to-quality and monetary policy. It is hard to imagine traditional monetary policy shocks causing a flight-to-quality, at least in the US. An example of reverse causality might be the liquidity facilities introduced by the Fed in the wake of the financial crisis. These policy actions have nothing to do with the interest rate setting function of monetary policy included in the SW model so that it is hard to see that shocks to the monetary policy rule within this model would be correlated with shocks to the demand for short-term Treasuries. The decline in activity brought on by events leading to the flight-to-quality would be accounted for by the policy reaction function and therefore poses no problem for identification.

These considerations notwithstanding the structural plausibility of money demand shocks as identified in DSGE models remains an open question. However the framework introduced here suggests a way forward for addressing this issue. For example, it suggests how to distinguish such shocks from monetary policy shocks by accounting for the supply of safe and liquid assets and the role of monetary policy in influencing this supply. Deeper modeling of the demand and supply of safe and liquid assets should help as well.

SW describe their shock as having “similar effects as so-called net-worth shocks in Bernanke, Gertler, and Gilchrist (1999) and Christiano et al. (2003), which explicitly model
the external finance premium (p. 589).” The financial accelerator described in these papers may be an important channel by which money demand shocks are propagated to the rest of the economy. However, based on the findings of this article interpreting SW’s risk premium shock as a shock to net-worth is misleading.

Barsky et al. (2014)’s and Christiano et al. (2014)’s findings interpreted through the lens of this article’s framework means that money demand shocks account for a significant fraction of the post-crisis variation in aggregate data. This interpretation seems consistent with many accounts of the episode and therefore lends credibility to the New Keynesian framework used in these papers. Clearly a deeper foundation for the demand for safe and liquid assets is preferable to the nominally-risk-free-assets-in-utility approach taken here. Nevertheless the important role for the money demand shock in explaining business cycles suggests that developing a foundation that is amenable to the empirical analysis of aggregate data should be a high priority.

References


Working Paper Series

A series of research studies on regional economic issues relating to the Seventh Federal Reserve District, and on financial and economic topics.

Corporate Average Fuel Economy Standards and the Market for New Vehicles
*Thomas Klier and Joshua Linn*  
WP-11-01

The Role of Securitization in Mortgage Renegotiation
*Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff*  
WP-11-02

Market-Based Loss Mitigation Practices for Troubled Mortgages Following the Financial Crisis
*Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, and Douglas D. Evanoff*  
WP-11-03

Federal Reserve Policies and Financial Market Conditions During the Crisis
*Scott A. Brave and Hesna Genay*  
WP-11-04

The Financial Labor Supply Accelerator
*Jeffrey R. Campbell and Zvi Hercowitz*  
WP-11-05

Survival and long-run dynamics with heterogeneous beliefs under recursive preferences
*Jaroslav Borovička*  
WP-11-06

A Leverage-based Model of Speculative Bubbles (Revised)
*Gadi Barlevy*  
WP-11-07

Estimation of Panel Data Regression Models with Two-Sided Censoring or Truncation
*Sule Alan, Bo E. Honoré, Luojia Hu, and Søren Leth–Petersen*  
WP-11-08

Fertility Transitions Along the Extensive and Intensive Margins
*Daniel Aaronson, Fabian Lange, and Bhaskar Mazumder*  
WP-11-09

Black-White Differences in Intergenerational Economic Mobility in the US
*Bhaskar Mazumder*  
WP-11-10

Can Standard Preferences Explain the Prices of Out-of-the-Money S&P 500 Put Options?
*Luca Benzoni, Pierre Collin-Dufresne, and Robert S. Goldstein*  
WP-11-11

Business Networks, Production Chains, and Productivity:
A Theory of Input-Output Architecture
*Ezra Oberfield*  
WP-11-12

Equilibrium Bank Runs Revisited
*Ed Nosal*  
WP-11-13

Are Covered Bonds a Substitute for Mortgage-Backed Securities?
*Santiago Carbó-Valverde, Richard J. Rosen, and Francisco Rodríguez-Fernández*  
WP-11-14

The Cost of Banking Panics in an Age before “Too Big to Fail”
*Benjamin Chabot*  
WP-11-15
Working Paper Series (continued)

Import Protection, Business Cycles, and Exchange Rates:
Evidence from the Great Recession
Chad P. Bown and Meredith A. Crowley
WP-11-16

Examining Macroeconomic Models through the Lens of Asset Pricing
Jaroslav Borovička and Lars Peter Hansen
WP-12-01

The Chicago Fed DSGE Model
Scott A. Brave, Jeffrey R. Campbell, Jonas D.M. Fisher, and Alejandro Justiniano
WP-12-02

Macroeconomic Effects of Federal Reserve Forward Guidance
Jeffrey R. Campbell, Charles L. Evans, Jonas D.M. Fisher, and Alejandro Justiniano
WP-12-03

Modeling Credit Contagion via the Updating of Fragile Beliefs
Luca Benzoni, Pierre Collin-Dufresne, Robert S. Goldstein, and Jean Helwege
WP-12-04

Signaling Effects of Monetary Policy
Leonardo Melosi
WP-12-05

Empirical Research on Sovereign Debt and Default
Michael Tomz and Mark L. J. Wright
WP-12-06

Credit Risk and Disaster Risk
François Gourio
WP-12-07

From the Horse’s Mouth: How do Investor Expectations of Risk and Return Vary with Economic Conditions?
Gene Amromin and Steven A. Sharpe
WP-12-08

Using Vehicle Taxes To Reduce Carbon Dioxide Emissions Rates of New Passenger Vehicles: Evidence from France, Germany, and Sweden
Thomas Klier and Joshua Linn
WP-12-09

Spending Responses to State Sales Tax Holidays
Sumit Agarwal and Leslie McGranahan
WP-12-10

Micro Data and Macro Technology
Ezra Oberfield and Devesh Raval
WP-12-11

The Effect of Disability Insurance Receipt on Labor Supply: A Dynamic Analysis
Eric French and Jae Song
WP-12-12

Medicaid Insurance in Old Age
Mariacristina De Nardi, Eric French, and John Bailey Jones
WP-12-13

Fetal Origins and Parental Responses
Douglas Almond and Bhaskar Mazumder
WP-12-14
Working Paper Series (continued)

Repos, Fire Sales, and Bankruptcy Policy  
*Gaetano Antinolfi, Francesca Carapella, Charles Kahn, Antoine Martin, David Mills, and Ed Nosal*  
WP-12-15

Speculative Runs on Interest Rate Pegs  
The Frictionless Case  
*Mario Bassetto and Christopher Phelan*  
WP-12-16

Institutions, the Cost of Capital, and Long-Run Economic Growth:  
Evidence from the 19th Century Capital Market  
*Ron Alquist and Ben Chabot*  
WP-12-17

Emerging Economies, Trade Policy, and Macroeconomic Shocks  
*Chad P. Bown and Meredith A. Crowley*  
WP-12-18

The Urban Density Premium across Establishments  
*R. Jason Faberman and Matthew Freedman*  
WP-13-01

Why Do Borrowers Make Mortgage Refinancing Mistakes?  
*Sumit Agarwal, Richard J. Rosen, and Vincent Yao*  
WP-13-02

Bank Panics, Government Guarantees, and the Long-Run Size of the Financial Sector:  
Evidence from Free-Banking America  
*Benjamin Chabot and Charles C. Moul*  
WP-13-03

Fiscal Consequences of Paying Interest on Reserves  
*Marco Bassetto and Todd Messer*  
WP-13-04

Properties of the Vacancy Statistic in the Discrete Circle Covering Problem  
*Gadi Barlevy and H. N. Nagaraja*  
WP-13-05

Credit Crunches and Credit Allocation in a Model of Entrepreneurship  
*Marco Bassetto, Marco Cagetti, and Mariacristina De Nardi*  
WP-13-06

Financial Incentives and Educational Investment:  
The Impact of Performance-Based Scholarships on Student Time Use  
*Lisa Barrow and Cecilia Elena Rouse*  
WP-13-07

The Global Welfare Impact of China: Trade Integration and Technological Change  
*Julian di Giovanni, Andrei A. Levchenko, and Jing Zhang*  
WP-13-08

Structural Change in an Open Economy  
*Timothy Uy, Kei-Mu Yi, and Jing Zhang*  
WP-13-09

The Global Labor Market Impact of Emerging Giants: a Quantitative Assessment  
*Andrei A. Levchenko and Jing Zhang*  
WP-13-10
Working Paper Series (continued)

Size-Dependent Regulations, Firm Size Distribution, and Reallocation
*François Gourio and Nicolas Roys*  
WP-13-11

Modeling the Evolution of Expectations and Uncertainty in General Equilibrium
*Francesco Bianchi and Leonardo Melosi*  
WP-13-12

Rushing into American Dream? House Prices, Timing of Homeownership, and Adjustment of Consumer Credit
*Sumit Agarwal, Luojia Hu, and Xing Huang*  
WP-13-13

The Earned Income Tax Credit and Food Consumption Patterns
*Leslie McGranahan and Diane W. Schanzenbach*  
WP-13-14

Agglomeration in the European automobile supplier industry
*Thomas Klier and Dan McMillen*  
WP-13-15

Human Capital and Long-Run Labor Income Risk
*Luca Benzoni and Olena Chyryk*  
WP-13-16

The Effects of the Saving and Banking Glut on the U.S. Economy
*Alejandro Justiniano, Giorgio E. Primiceri, and Andrea Tambalotti*  
WP-13-17

A Portfolio-Balance Approach to the Nominal Term Structure
*Thomas B. King*  
WP-13-18

Gross Migration, Housing and Urban Population Dynamics
*Morris A. Davis, Jonas D.M. Fisher, and Marcelo Veracierto*  
WP-13-19

Very Simple Markov-Perfect Industry Dynamics
*Jaap H. Abbring, Jeffrey R. Campbell, Jan Tilly, and Nan Yang*  
WP-13-20

Bubbles and Leverage: A Simple and Unified Approach
*Robert Barsky and Theodore Bogusz*  
WP-13-21

The scarcity value of Treasury collateral:
Repo market effects of security-specific supply and demand factors
*Stefania D'Amico, Roger Fan, and Yuriy Kitsul*  
WP-13-22

Gambling for Dollars: Strategic Hedge Fund Manager Investment
*Dan Bernhardt and Ed Nosal*  
WP-13-23

Cash-in-the-Market Pricing in a Model with Money and Over-the-Counter Financial Markets
*Fabrizio Mattesini and Ed Nosal*  
WP-13-24

An Interview with Neil Wallace
*David Altig and Ed Nosal*  
WP-13-25
Firm Dynamics and the Minimum Wage: A Putty-Clay Approach  
Daniel Aaronson, Eric French, and Isaac Sorkin  
WP-13-26

Policy Intervention in Debt Renegotiation:  
Evidence from the Home Affordable Modification Program  
Sumit Agarwal, Gene Amromin, Itzhak Ben-David, Souphala Chomsisengphet, Tomasz Piskorski, and Amit Seru  
WP-13-27

The Effects of the Massachusetts Health Reform on Financial Distress  
Bhashkar Mazumder and Sarah Miller  
WP-14-01

Can Intangible Capital Explain Cyclical Movements in the Labor Wedge?  
François Gourio and Leena Rudanko  
WP-14-02

Early Public Banks  
William Roberds and François R. Velde  
WP-14-03

Mandatory Disclosure and Financial Contagion  
Fernando Alvarez and Gadi Barlevy  
WP-14-04

The Stock of External Sovereign Debt: Can We Take the Data at ‘Face Value’?  
Daniel A. Dias, Christine Richmond, and Mark L. J. Wright  
WP-14-05

Interpreting the Pari Passu Clause in Sovereign Bond Contracts:  
It’s All Hebrew (and Aramaic) to Me  
Mark L. J. Wright  
WP-14-06

AIG in Hindsight  
Robert McDonald and Anna Paulson  
WP-14-07

On the Structural Interpretation of the Smets-Wouters “Risk Premium” Shock  
Jonas D.M. Fisher  
WP-14-08