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Abstract

On April 18, 2001 US Federal Reserve Open Market Committee (FOMC) surprised financial markets by lowering the Federal Funds Target rate $\frac{1}{2}$% between regularly scheduled FOMC meeting dates. Securities markets in the US and Australia responded. The US 30-Euro$ rate fell by $\frac{1}{2}$%.and US and Australian five year bond yields fell by about 13 basis points. Equity returns increased by 3% in the US and 1 $\frac{1}{2}$% in Australia. This paper is the first to examine international monetary policy surprise spillovers and to estimate the response of security prices to unobservable monetary and nonmonetary surprises.

Our estimates of the impact of domestic monetary policy surprises on domestic yields and returns are similar to other studies. The following results are new. US monetary policy surprises spill over and affect Australian yields and equity returns. Australian monetary surprises do not spill over to the US. Nonmonetary surprises are more important in explaining the movements in longer maturity yields and returns than monetary policy surprises.

Keywords: Monetary policy surprises, international spillovers, factor model, biases

JEL Classification: E44, G12

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1 Introduction

On April 18, 2001 the US Federal Reserve Open Market Committee (FOMC) surprised financial markets by lowering the Federal Funds Target rate by $\frac{1}{2}$% between regularly scheduled FOMC meeting dates. US short maturity rate fell by $\frac{1}{2}$% mirroring the cut in the Target rate and the Australian short maturity rates fell by 20 basis points. The yield on US and Australian five year bonds fell by about 13 basis points. US equity prices increased by almost 3% and the Australian equity prices rose by 1 $\frac{1}{2}$%. A month later, on May 15 at the regularly scheduled FOMC meeting, the Fed again lowered the Target rate by $\frac{1}{2}$%. This widely anticipated reduction in the Target rate had no effect on security markets in the US and abroad.

On July 31, 1996 the Reserve Bank of Australia surprised markets by lowering its Target rate by $\frac{1}{2}$%. That day Australia's short maturity rates fell by $\frac{1}{2}$% mirroring the cut in the Target rate and Australian longer maturity yields fell by 20 to 30 basis points. Australian equity returns rose by 2 $\frac{1}{2}$%. US equity and bond markets did not react to the change in the Australian Target rate.

In the last week of August of 1998 there were no US or Australian monetary policy changes or surprises. But, a cascade of continual bad news about the depth of the Russian financial crisis hit the financial markets culminating in the suspension of trading in the Ruble. Equity markets in the US and Australia fell by over 6%. Australian five and ten year bond yields rose by 30 basis points while comparable US bond yields fell by 25 basis points as investors fled to "quality".

These carefully selected episodes illustrate the main results of this paper. Monetary and nonmonetary *surprises* affect security prices. US and Australian domestic short maturity rates respond to domestic monetary policy surprises as the short maturity rate adjusts immediately to match the newly announced Target. Low risk expected profit opportunities keep domestic short maturity rates close to the domestic Target rate. Nonmonetary, or foreign monetary, surprises cannot have a big effect on short rates. The response of Australian long maturity yields to a US monetary policy surprise is essentially the same as the response to an Australian monetary policy surprise. US monetary surprises affect Australian security prices, but Australian monetary policy surprises do not affect US security prices. There are monetary policy surprise spillovers from the US to Australia. Nonmonetary surprises have a much larger impact than monetary policy surprises on long maturity yields and equity returns.

A number of recent papers document that domestic monetary surprises affect domestic bond yields and equity returns; for example, see Bernanke and Kuttner (2005), Cochrane and Piazzesi (2002), and Zettelmeyer (2003). Other papers show that nonmonetary surprises spill over in financial markets, e.g., see Dungey et al(2005) for a review. This paper is the first to examine international monetary policy surprise spillovers and to jointly estimate the impact of unobserved monetary and nonmonetary surprises on yields and returns.

The empirical monetary surprise literature begins with Kuttner's (2001) seminal "event study" paper. Monetary event days are days when the Central Bank policy committee meets so that they could change the Target rate or days when they actually change the Target rate. Monetary policy surprises occur only on monetary event days. Kuttner reasoned, correctly, that in an efficient market only monetary policy surprises affect current security prices. The trick is to filter the unobservable surprise from the observable data.

Kuttner used a very simple filter. He defined a monetary policy surprise as the (weighted) change in the Federal Funds Futures rate on an event day. Most of the literature on monetary policy surprises follows Kuttner's lead and equates the monetary policy surprise to an observable change in a short maturity yield.

Regressing a yield change, or equity return, on the change in the short maturity yield on monetary policy event days gives an estimate of the impact of the money surprise on the security price. The event study specification is straightforward and easy to apply. If, however, news other than monetary policy, such as the outbreak of war in the Middle East, causes short maturity rates to change on monetary policy event days, then the change in the short maturity rate measures the monetary policy surprise with error leading to inconsistent estimates of the impact of money surprises on yields and returns. Furthermore, the event study specification still says nothing about the impact of nonmonetary surprises on yield changes or returns on monetary event or nonevent days. A natural question is how important are monetary surprises relative to other surprises and what happens on nonmonetary event days?

We specify a two-country linear simultaneous equation model for the US and Australia to address these questions. The specification generalizes the one-country two-security model in Rigobon and Sack (2003, 2004) to two countries (in principle l) and nine (in principle n) securities. Monetary surprises and nonmonetary surprises affect US and Australian yields and equity and exchange rate returns on monetary event days. Nonmonetary surprises also affect yields and equity and exchange rate returns on nonevent days. The reduced form of the simultaneous model can be written as a factor model. The factors are the monetary and nonmonetary surprises. The factor loadings are the coefficients of interest. The loadings measure the response of yield changes and equity and exchange rate returns to a surprise. The monetary factors are identified *a priori* by heteroskedasticity. US money surprises occur only on US event days and Australian money surprises occur only on Australian event days. Nonmonetary surprises occur everyday. One cannot identify the individual nonmonetary factors *a priori*.

We estimate two versions of the factor model. The general version imposes only the economic restrictions that the monetary factors are heteroskedastic and orthogonal to the nonmonetary factors, and the statistical assumption that the nonmonetary factors are homoskedastic. The general factor model provides estimates of the loadings on the monetary factors, but imposes no restrictions on the number of nonmonetary factors and it gives no information on how individual nonmonetary factors affect security prices. The second model is a parsimonious specification that restricts the number of common nonmonetary surprises and idiosyncratic errors to the number of securities, n. The factor structure of the parsimonious specification is similar to the factor structure in affine models of the yield curve; see for example, Piazzesi (2006). The parsimonious specification provides estimates of the loadings on the monetary and nonmonetary factors. Finally we calculate the bias in event study estimator implied by the general model.

Our estimates show that a domestic monetary surprise twists the domestic yield curve. Our estimates of the impact of domestic monetary policy surprises on the domestic yield curve are similar to other studies; see for example, Poole et. al. (2002). The following results are new. US monetary policy surprises spill over and affect Australian yields and equity returns. Australian five and ten year yields show essentially the same response to Australian and US monetary surprises. Nonmonetary factors are important for understanding the movement in longer maturity yields and equity returns. The ratio of the sample variance on nonevent days to the sample variance monetary event days is greater than 75% for all securities except the short rate. We find four common nonmonetary factors that explain most of the variance in long maturity yield changes and returns: a local bond factor for Australia and another for the US, a world bond factor, and a world equity factor.

The estimates of the biases in the event study coefficients implied by the general model are quantitatively small, and insignificant for the US. For Australia the implied bias is also small, but statistically significant. Empirically the event estimator is a good approximation even when the event model is misspecified.

The paper is organized as follows: Section 2 presents the models, Section 3 explains the data and presents summary statistics. Section 4 presents and analyzes the empirical results, and concluding comments are contained in Section 5.

2 The Model and Econometric Tests

This section gives the details of the models and statistical tests that are reported in Section 4.

2.1 Linear Simultaneous Equation Model

Start with a linear simultaneous equation representation

$$By_t = Cx_t + D\varepsilon_t \tag{1}$$

where y is a $(n \times 1)$ vector of endogenous changes in securities prices[1], x is a vector of *unobservable* exogenous surprises, and ε is a $(n \times 1)$ vector of unobservable – idiosyncratic surprises. The idiosyncratic surprises include monetary policy surprises, $m \in \varepsilon$. The specification in Equation (1) generalizes Rigobon and Sack's two security one country specification to n securities and many countries. For the rest of the paper we adopt an n security two country framework – consisting of the US and Australia–that we use in the empirical section.

[1] We refer to the dependent variables as the change in security prices. In fact, we follow the monetary surprise literature and use the change in bond yields, and equity and currency returns.

All surprises, by definition, are serially uncorrelated (unpredictable). The monetary policy surprises are identified by *a priori* structural information. As Kuttner pointed out monetary policy surprises can occur only on monetary event days. We assume that the variance of the monetary surprise is constant on monetary event days and by definition it is zero on nonmonetary event days. Monetary policy surprises are heteroskedastic and the pattern of heteroskedasticity is known *a priori*. In addition, monetary policy surprises are exogenous and independent of the nonmonetary surprises.[2] The Central Bank uses the information in security prices and all economic data to set policy, but on the day the policy decision is announced the causality runs from the policy surprise to security prices. The nonmonetary surprises are *not* identified with *a priori* structural information. Nonmonetary surprises occur every day. We assume that the nonmonetary surprises are homoskedastic. With no loss in generality we standardize all surprises to be uncorrelated with each other and we normalize them to have unit variances.[3]

The reduced form of equation (1) is obtained by expressing the observables (y) in terms of the unobservables (x_t, ε_t)

$$y_t = B^{-1}Cx_t + B^{-1}D\varepsilon_t \tag{2}$$

We separate the unobservables into the identified monetary policy surprises and unidentified nonmonetary surprises. Label the identified monetary surprises as, $m^{US} = \varepsilon_1$ (US) and $m^{AU} = \varepsilon_2$ (Australia). The remaining surprises cannot be distinguished from one another *a priori*, so we label them as factors, say, $f_1 = \varepsilon_3, f_2 = \varepsilon_3, ...f_{n-1} = x_1, f_n = x_2...$

Rewriting the reduced form as a factor representation emphasizes the coefficients of interest,

$$y_t = \alpha^{US} m_t^{US} + \alpha^{AU} m_t^{AU} + \sum_k \beta_k f_{k,t} \tag{3}$$

The factor loadings, the αs and βs, are $(n \times 1)$ vectors. The factors, the ms and fs, are scalars. The factor loadings measure the impact of a one standard deviation surprise on the change in security prices, e.g., α_1^{US}, is the response of security 1 to a one-standard deviation US money surprise.

The *a priori* classification of observations into monetary and nonmonetary event days decomposes the model into regimes: A regime for US monetary policy event days, a regime for Australian monetary

[2] See Cochrane and Piazzesi for a succient compelling argument.

[3] Standardizing the factors allows us to compare the impact of monetary and nonmonetary factors, see Section 4.

policy event days, and a regime for nonevent days. The nonmonetary surprises link the regimes together. The second moment conditions summarize the model,

$$\begin{aligned} Ey_t y_t' &= \alpha^{US}\alpha^{US\prime} + \textstyle\sum_k \beta_k\beta_k'; \quad t \in E^{US} \\ Ey_t y_t' &= \alpha^{AU}\alpha^{AU\prime} + \textstyle\sum_k \beta_k\beta_k'; \quad t \in E^{AU} \\ Ey_t y_t' &= \textstyle\sum_k \beta_k\beta_k'; \quad t \in NE \end{aligned} \tag{4}$$

where E^{US} and E^{AU} denote the set (and number) of monetary policy event days in the US and Australia respectively and NE is the set (and number) of nonevent days.

2.2 Representations

2.2.1 General Factor Model

The economic structure determines the number of monetary factors – one for each country. The economic structure does not determine the number of nonmonetary factors except that there must be at least as many nonmonetary factors $N \geqq n$ as securities since the rank of the covariance matrix of securities on nonmonetary event days is n, i.e., $rank(\sum_k^N \beta_k\beta_k') = rank(Ey_t, y_t | t \in NE)$. The general model in (3) can be rewritten succinctly as a linear function of the monetary factors plus a weighted sum of the nonmonetary factors,

$$y_t = \alpha^{US} m_t^{US} + \alpha^{AU} m_t^{AU} + u_t \tag{5}$$

where

$$\begin{aligned} u_t &\sim WS(0,\Omega) \text{ for all t} \\ m_t^{US} &\sim WS(0,1) \text{ for t on a US monetary event day, 0 otherwise} \\ m_t^{AU} &\sim WS(0,1) \text{ for t on an Australian monetary event day, 0 otherwise} \end{aligned}$$

where $u = \sum_k^N \beta_k f_k$ represents the sum of the effect of the nonmonetary factors, with variance-covariance matrix

$$\Omega = E\left[\mathrm{u\,u'}\right] = \sum_k^{N \geqq n} \beta_k\beta_k'$$

where $\omega_{ij} \in \Omega$. Here WS denotes a (wide sense) distribution with zero mean and a constant variance.

Moment Conditions The second moments summarize the model and restrictions,

$$\begin{aligned} Ey_t y_t' &= \alpha^{US}\alpha^{US\prime} + \Omega; \quad t \in E^{US} \\ Ey_t y_t' &= \alpha^{AU}\alpha^{AU\prime} + \Omega; \quad t \in E^{AU} \\ Ey_t y_t' &= \Omega; \quad t \in NE \end{aligned} \tag{6}$$

Estimation: GMM GMM seems like the obvious technique to estimate the unknown parameters in Equation (6). GMM chooses estimates of the model parameters to make the observable sample moments as close as possible to the theoretical moments implied by the model, e.g., see Hamilton, (1994), Chapter 14; see also Sentana and Fiorentini (2001) who discuss the estimation of factor models in the presence of heteroskedasticity.

For monetary event days in the US and Australia, the GMM moment conditions are respectively

$$\begin{aligned} h_{ijt\in E^{US}}^{US} &= y_{it\in E^{US}} y_{jt\in E^{US}} - (\alpha_i^{US}\alpha_j^{US} + \omega_{ij}) \\ h_{ijt\in E^{AU}}^{AU} &= y_{it\in E^{AU}} y_{jt\in E^{AU}} - (\alpha_i^{AU}\alpha_j^{AU} + \omega_{ij}) \end{aligned} \tag{7}$$

whereas for nonevent days the moment conditions are

$$h_{ijt\in NE}^{NE} = y_{it\in NE} y_{jt\in NE} - \omega_{ij} \tag{8}$$

For each of the three regimes there are $n(n+1)/2$ unique elements which are stacked into the respective vectors $h_t^{US}, h_t^{AU}, h_t^{NE}$. Let G denote the average of the $3n(n+1)/2$ GMM moment conditions,

$$G \equiv \begin{bmatrix} g_{US} \\ g_{AU} \\ g_{NE} \end{bmatrix} = \begin{bmatrix} \frac{1}{E^{US}} \sum_{t\in E^{US}} h_t^{US} \\ \frac{1}{E^{AU}} \sum_{t\in E^{AU}} h_t^{AU} \\ \frac{1}{NE} \sum_{t\in NE} h_t^{NE} \end{bmatrix}$$

The GMM estimates of the unknown parameters $\theta_g = \left\{\alpha^{US}, \alpha^{AU}, \Omega\right\}$ minimize the loss function,

$$\min_{\theta} L(\theta_g) = G\left(\alpha^{US}, \alpha^{AU}, \Omega\right)' S^{-1} G\left(\alpha^{US}, \alpha^{AU}, \Omega\right) \tag{9}$$

where S^{-1} is an efficient weighting matrix,

$$\begin{aligned} S &= \begin{bmatrix} S_{US} & & \\ & S_{AU} & \\ & & S_{NE} \end{bmatrix} \\ &= \begin{bmatrix} \frac{1}{E^{US}} \sum_{t\in E^{US}} h_t^{US} h_t^{US\prime} & & \\ & \frac{1}{E^{AU}} \sum_{t\in E^{AU}} h_t^{AU} h_t^{AU\prime} & \\ & & \frac{1}{NE} \sum_{t\in NE} h_t^{NE} h_t^{NE} \end{bmatrix} \end{aligned} \tag{10}$$

which is the covariance matrix of the GMM moments. The weighting matrix is block diagonal in this case as the observations are serially uncorrelated.

Asymptotic Distribution of the Estimates The GMM estimates are normally distributed given standard regularity conditions; see Hamilton, (1994), Chapter 14,

$$\begin{aligned} \widehat{\theta}_g &\sim N\left(\theta_g, \widehat{V}/T\right) \\ \widehat{V} &= \{\widehat{D}\widehat{S}^{-1}\widehat{D}\}^{-1} \\ \widehat{D}' &= \left.\frac{\partial G(\theta)}{\partial \theta_g'}\right|_{\theta=\widehat{\theta}_g} \\ \widehat{S} &= S|_{\theta=\widehat{\theta}_g} \end{aligned}$$

where $T = E^{US} + E^{AU} + NE$ is the total sample size.

Rigobon and Sack's Specification Rigobon and Sack's estimation strategy focuses on the loadings on the monetary surprises. They use the difference between the GMM moments on monetary event days and nonevent days, i.e., equation(7) minus equation(8),

$$h^{US}_{ijt\in E^{US}} - h^{NE}_{ijt\in NE}$$

$$h^{AU}_{ijt\in E^{AU}} - h^{NE}_{ijt\in NE}$$

to estimate the unknown parameters.

The expected value of the difference between the monetary event day GMM moments and the nonevent day GMM moments does not depend on the unknown nonmonetary parameters, e.g.,

$$E[h^{US}_{ijt\in E^{US}} - h^{NE}_{ijt\in NE}] = E[\{y_{it\in E^{US}}y_{jt\in E^{US}} - (\alpha^{US}_i\alpha^{US}_j + \omega_{ij})\} - \{y_{it\in NE}y_{jt\in NE} - \omega_{ij}\}]$$

The variance of the difference between the monetary event day GMM moments and the nonevent day GMM moments equals the sum of the variance of the monetary event day GMM moments and the variance of the nonevent day GMM moments[4],

$$var[h^{US}_{ijt\in E^{US}} - h^{NE}_{ijt\in NE}] = var\{y_{it\in E^{US}}y_{jt\in E^{US}} - (\alpha^{US}_i\alpha^{US}_j + \omega_{ij})\} + var\{y_{it\in NE}y_{jt\in NE} - \omega_{ij}\}$$

The variance of the difference of the moments *depends* on the unknown nonmonetary parameters.

[4] The covariance between the monetary event day moments and nonevent day moments is zero because the regimes are independent.

The Rigobon and Sack specification is a linear combination of the moments in the general model. Define the matrix,

$$RS \equiv \begin{bmatrix} I & 0 \\ 0 & I \\ -I & -I \end{bmatrix} \tag{11}$$

Then, the average of Rigobon and Sack GMM moments can be written as,

$$G_{RS} = RS' \times G = \begin{bmatrix} g_{US} - g_{NE} \\ g_{AU} - g_{NE} \end{bmatrix}$$

and the covariance matrix of the Rigobon and Sack moments using (10) equals,

$$S_{RS} = RS' \times S \times RS = \begin{bmatrix} S_{US} + S_{NE} & S_{NE} \\ S_{NE} & S_{AU} + S_{NE} \end{bmatrix}$$

2.2.2 A Parsimonious Factor Model

Nonmonetary factors are important quantitatively in explaining the change in all security prices except for very short maturity yields. The general model gives no information about how individual nonmonetary factors affect security prices. We specify a parsimonious factor model containing $K < n$ common nonmonetary factors and $n - K$ idiosyncratic errors, where n is the number of securities. The parsimonious model is specified as

$$y_t = \alpha^{US} m_t^{US} + \alpha^{AU} m_t^{AU} + \sum_{k=1}^{K<n} \beta_k f_{k,t} + \gamma e_t \tag{12}$$

where γ is a diagonal matrix with rank $n - K$. This specification gives the loadings on each nonmonetary factor.

The factor structure for the parsimonious model is similar to the factor structure in affine yield curve models; for example, see the survey by Piazzesi.

Estimation: GMM The parsimonious model imposes restrictions on the structure of the nonmonetary factors. The moment conditions are the conditions in equations (7) and (8) with the restrictions imposed on the nonmonetary factor structure,

$$\Omega = \sum_{k=1}^{K<n} \beta_k \beta_k' + \gamma\gamma' \tag{13}$$

We estimate the parsimonious model by GMM.

Let,

$$\min_{\theta} L(\theta_p) = G(\alpha^{US}, \alpha^{AU}, \beta_1.., \gamma)' S^{-1} G(\alpha^{US}, \alpha^{AU}, \beta_1.., \gamma) \tag{14}$$

denote the loss function for the parsimonious model where $\theta_p = \left\{\alpha^{US}, \alpha^{AU}, \beta_1.., \gamma\right\}$.

Test of Additional Restrictions Imposed by Parsimonious Specification We want to test the marginal impact of adding restrictions to the general factor model. The loss function for each specification is distributed $\chi^2(\#moment\ conditions - \#estimated\, parameters)$. As the general model nests the parsimonious model the difference in the loss functions,

$$DL \equiv T\left(L(\widehat{\theta}_g) - L(\widehat{\theta}_p)\right) \tag{15}$$

is distributed χ^2 with degrees of freedom equal to the difference in the number of parameters in the two models, and T is the sample size.

2.2.3 Event Study Specification

The event model specifies that an observable change in a short maturity rate, say Δi, on monetary policy event days is the monetary policy surprise, m. Regressing the yield change, say y_j, on the change in the short maturity yield gives an estimate of the impact of the money surprise on the yield change. If, however, the observable change in a short rate also contains the effect of nonmonetary surprises, then the estimate of the impact of the monetary policy surprise on the j^{th} security is biased and inconsistent. The operational question is how big is the bias?

Event Bias Calculations The expected value of the least squares estimator of the impact coefficient in the event specification is $Ey_j\Delta i/E\Delta i^2$. Using the factor representation from the general model in (5) the least squares estimator can be written in terms of the factor loadings,

$$\frac{Ey_j\Delta i}{E\Delta i^2} = \frac{\alpha_j\alpha_{\Delta i}}{\alpha_{\Delta i}^2 + \omega_{\Delta i\Delta i}} + \frac{\omega_{j\Delta i}}{\alpha_{\Delta i}^2 + \omega_{\Delta i\Delta i}} \tag{16}$$

If the event estimator were unbiased, then it would equal the ratio of the factor loadings, $\alpha_j/\alpha_{\Delta i}$, i.e., the event specification assumes that an observable short rate equals the monetary policy surprise on monetary event days which implies that $\omega_{\Delta i\Delta i} = \omega_{j\Delta i} = 0$ on monetary event days.

We test the validity of the event model by estimating the size and significance of the bias implied by the general model,

$$bias_j = \frac{\alpha_j}{\alpha_{\Delta i}}\left(1 - \frac{\alpha_{\Delta i}}{\alpha_{\Delta i} + \omega_{\Delta i \Delta i}/\alpha_{\Delta i}}\right) - \frac{\omega_{j\Delta i}}{\alpha_{\Delta i}^2 + \omega_{\Delta i \Delta i}} \tag{17}$$

The bias in the estimated coefficient decomposes into two pieces. The first term in brackets on the right-hand-side (rhs) of Equation (17) reflects the standard bias towards zero when the regressor is measured with error; for example, Poole, et al.. If the event specification is approximately correct – the variance of the money surprise[5], $\alpha_{\Delta i}^2$ is large relative to the variance of the nonmonetary surprises – then the errors in variables bias is small.

The second term in (17) reflects the bias that comes from the covariance between the omitted variables in the short rate equation and the change in the j^{th} yield or the return.

3 Data

In 1994 the US Federal Reserve Open Market Committee (FOMC) began to pursue a more transparent policy that made it easier for market participants to forecast Target changes; see Poole (2005) for an excellent history of the evolution of US policy openness. Starting in February 1994 most policy changes took place on FOMC meeting days and the Fed announced changes in the Target before US markets closed. In 1996 the Reserve Bank of Australia made their policy more transparent. They usually changed the interest rate target on meeting days and made the change effective the next day when it was announced. Our ten year sample of daily data begins on January 3, 1994 and ends on December 31, 2003 – over 2500 observations.[6]

[5] If the event specification is approximately correct, then the variance of the short rate $\left(E\Delta i^2\right)$ should be approximately the variance of the money surprise $\left(\alpha_{\Delta i}^2\right)$, as

$$\frac{E\Delta i^2}{\alpha_{\Delta i}^2} = 1 + \frac{\omega_{\Delta i \Delta i}}{\alpha_{\Delta i}^2} \approx 1$$

[6] We use every day that trades occurred on the New York Stock Exchange, except September 17, 2001 (the US market was closed for a week after 9/11 and the US Federal Reserve Bank lowered the target rate on 9/17 by $\frac{1}{2}\%$), and October 27-28, 1997 during the Asian crisis. We also exclude the seven days that the US Federal Reserve and the Australian Reserve Bank shared event days as there are insufficient observations to estimate the covariances for this regime.

3.1 Variables

Wherever possible we chose securities with identical features for the US and Australia. We selected the 30 day Euro$ rate[7], five year, and ten year constant maturity Treasury yields, the value weighted index return from CRSP for the US and the S&P200 Australian index return, plus the US/AU exchange rate.[8]

As a result of time zone differences between the US and Australia, the US rates are lagged one period relative to the Australian yields so as to focus on spillovers from US monetary surprises to Australian securities. The US and Australian Euro rates are based on London time, in which case the Euro yields are not lagged.

The full set of variables y_t, nine in total, consists of the changes in the six yields, the equity returns in the US and Australia, and the US/AU exchange rate return. Yields are expressed in basis points at annual rates and the three returns are expressed in daily rates in percentages by computing the differences of the logarithms of the index with the result multiplied by 100.[9] All variables are demeaned.[10]

3.2 A Preliminary Look at the Data

3.2.1 Standard Deviations

Table 1 shows the standard deviations for yield changes, equity and the exchange rate returns for the three regimes: US event days, Australian event days, and nonevent days.

The standard deviations show that:

1. Event days are different. The standard deviation of the domestic 30-day Euro$ rate on event

[7] Most event study models for the US follow Kuttner's seminal paper and pick the Fed Funds Futures rate (FFF) as the short rate that reveals the money surprise on event days. We chose the 30-day Euro$ rate because (1) it is available for the US and Australia – Australia does not have the equivalent of a FFF contract, (2) it doesn't make much difference if you use Euro$ rate or the FFF in event models, see Cochrane and Piazessi, and (3) in the simultaneous or factor models the money shock is not associated with any particular security.

[8] We use mostly publicly available data. The US yields, US Euro$ data, and the exchange rate come from the Federal Reserve Board's website www.federalreserve.gov/releases/. The Australian yields come from the Reserve Bank's website www.rba.gov.au/Statistics/. Australian Euro$ data come from British Bankers Association webpage www.bba.org.uk/.

The US equity series comes from CRSP and the Australia equity series is the S&P200 from Datastream.

The event days for the US come from the Minneapolis and New York Federal Reserve web sites. Phil Manners of the Reserve Bank of Australia gave us the Australian event days.

[9] The log return is defined as $r(k)_t \equiv \ln((P(k) + d(k))_t/P(k)_{t-1})$ the natural log of the price, P, (index value, or exchange rate) plus the flow payoff, d, divided by last period's price.

[10] The sample means of the data (daily yield changes and returns) are not significantly different from zero. Adjusting the variables for autoccorrelation by estimating a VAR containing all variables with one lag and a constant, does not change the qualitative results.

Table 1:

Standard deviations for changes in yields, and equity and exchange rate returns. The yields are measured at annual rates in basis points and daily returns are expressed in percentages.

Asset	Standard deviation		
	US-Event	AU-Event	Nonevent
US 30 day Euro	10.670	2.152	4.352
US 5 yr yield	7.234	6.624	6.572
US 10 yr yield	6.385	5.978	6.219
US equity return	0.999	1.099	0.966
AU 30 day Euro	5.593	11.473	4.433
AU 5 yr yield	10.500	9.271	8.036
AU 10 yr yield	10.376	8.297	8.102
AU equity return	0.885	0.875	0.791
Currency return	0.768	0.738	0.611
No. of days	77	109	2321

days is more than twice the standard deviation on domestic non-event days, and the standard deviation of other yield changes or returns is (almost always) higher on event days than nonevent days.

2. Australian yield changes are more volatile than US yield changes.

3. Equity and exchange rate returns are much more volatile than bond yield changes. For example, multiplying the returns (equity or exchange rate) by 100 expresses daily returns in basis points. The volatility of daily returns measured in basis points exceeds the most volatile yield changes which are measured in basis points and at an annual rate.

3.2.2 Principal Components

A principal component decomposition gives an indication of the rank of the linearly independent information in the covariance matrix of yields changes and returns on nonevent days. For our data the first four (largest) cumulative normalized eigenvalues are $0.667, 0.828, 0.914, 0.972$, or the first four principal components explain 97% of the variation in the data on nonevent days. This decomposition indicates that four nonmonetary systematic factors could pick up almost all the variation on nonevent days.

4 Empirical Results

This section presents estimates of the impact of money surprises and nonmonetary surprises on US and Australian yields, equity returns, and the exchange rate return. The questions we want to answer are: (1) What is the impact of monetary surprises on yield changes and returns both nationally and internationally? (2) How important are monetary policy surprises relative to nonmonetary policy surprises? (3) Can we identify individual nonmonetary surprises? (4) How good an approximation is the event study specification?

4.1 Impact of Monetary Surprises on Yield Changes

The general model in Equation (5) identifies the loadings on the monetary policy surprises without imposing additional restrictions on the nonmonetary factors. Table 2 presents the parameter estimates of the monetary factor loadings for the general factor model, with the GMM standard errors given in parentheses. The value of the GMM loss function in (9) is given at the bottom of the table. The column labeled "US Money" shows the security responses to a one standard deviation US monetary policy surprise. The column labeled "AU Money" shows the security responses to a one standard deviation Australian monetary policy surprise.

Domestic monetary policy surprises twist the domestic yield curve. Figure 1 shows the Australian Target rate and yields for the period 2000 to 2003. The Target rate is the solid line step function. The Reserve Bank adjusts the Target on event days. The Australian 30-day Euro$ tracks the domestic Target rate and never gets far from it. The Target rate influences the yields on five and ten year maturity bonds, but they are not tied as closely to the Target rate.

A corresponding figure for the US looks similar. Short maturity domestic yields must stay close to the Central Bank Target rate.

Figure 2 illustrates the estimates of the response of US yields to a US monetary policy surprise

Table 2:

Parameter estimates of the monetary factor loadings of the general factor model in (5). GMM standard errors in parentheses.

Asset	Monetary Factors	
	US Money	AU Money
US 30 day Euro	10.679	-0.067
	(2.467)	(0.166)
US 5 yr yield	1.918	
	(1.150)	
US 10 yr yield	0.491	
	(1.012)	
US equity return	-0.598	
	(0.176)	
AU 30 day Euro	4.875	12.110
	(1.149)	(0.724)
AU 5 yr yield	4.268	4.677
	(1.487)	(0.647)
AU 10 yr yield	2.465	2.162
	(1.606)	(0.651)
AU equity return	-0.301	-0.059
	(0.146)	(0.071)
Currency return	-0.375	0.329
	(0.103)	(0.035)
$L(\theta_g)$	99.914	

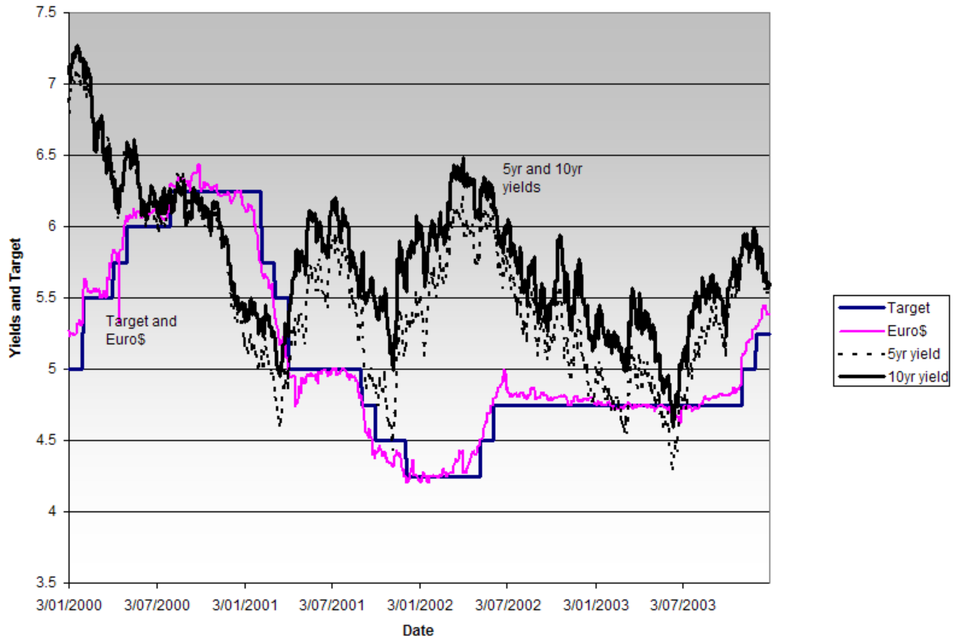

Figure 1: Australian Target and yields.

with their two standard deviation errorbars. A one standard deviation monetary policy surprise causes the 30-day US Euro$ to move by 11 times the surprise and the estimated response has a p value of approximately zero. Longer maturity rates move much less and the statistical significance is relatively lower. The five year yield moves by nearly twice the surprise with a standard error of 1.151 (from Table 2) yielding a p value of 0.09. The ten year yield moves only by 1/2 of the surprise and is statistically insignificant. Similar qualitative estimates are obtained by Poole et. al.

Figure 3 shows the estimates of the response of Australian yields to an Australian monetary policy surprise (bold line) and to a US monetary policy surprise (dashed line) with their two standard deviation errorbars. The Australian yield curve response to an Australian monetary surprise is similar to the US yield curve response to a US monetary surprise presented in Figure 2. Short maturity yields respond much more than long maturity yields. The major difference between the response of yield curves to a domestic monetary surprise is that the response coefficients for longer maturity Australian yields are statistically significant for an Australian monetary surprise.

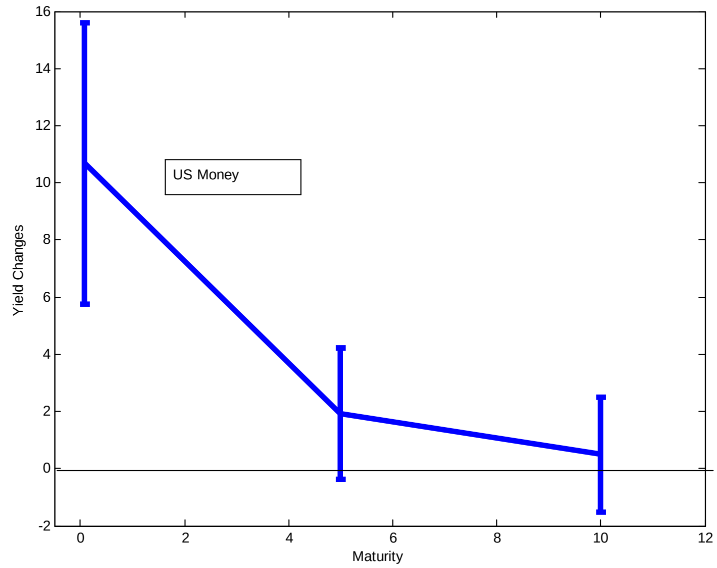

Figure 2: Response of US yields to a one-standard deviation US money surprise. Vertical lines represent two standard deviation error bars. Parameter estimates based on the general factor model.

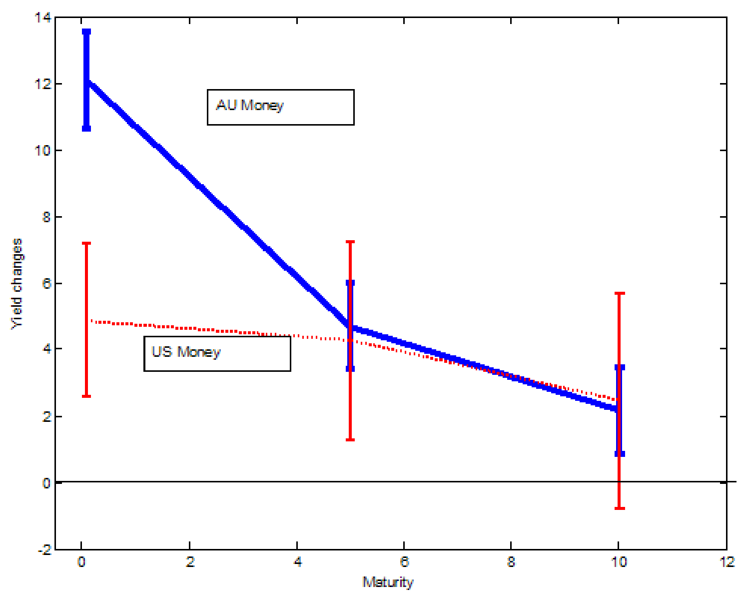

Figure 3: Response of Australian yields to a one-standard deviation money surprise in Australia (bold line) and in the US (dashed line). Vertical lines represent two standard deviation error bars. Parameter estimates based on the general factor model.

4.1.1 Spillovers

The narrow dashed line in Figure 3 shows the estimates of the Australian yield curve response to a US monetary surprise with two standard deviation errorbars.

At the long maturity end of the yield curve the point estimates of the response of Australian yields to a US monetary surprise are essentially the same as the response to an Australian monetary surprise. The errorbars reveal that the Australian response to US monetary surprises are estimated less precisely than the response to Australian monetary surprises.

At the short maturity end of the yield curve a US monetary surprise has a much smaller impact on the Australian 30-day Euro$ rate than an Australian monetary surprise. The 30-day Australian Euro$ rate must stay close to the Australian Target rate.

We found no spillovers from Australian monetary surprises to US yields.[11]

4.2 Parsimonious Factor Model Estimates

Monetary policy surprises dominate the change in the 30-day Euro$ rate. The ratio of the sample variance for the 30-day Euro$ rate on nonevent days to the sample variance for monetary event days in Table 1 is less that 15%. But by the same metric nonmonetary factors are much more important than monetary factors in determining longer maturity yield changes and equity returns. The ratio of the sample variance for nonevent days to the sample variance for monetary event days is more than 75% for longer maturity yields and equity returns.

The general model imposes no restrictions on the number of nonmonetary factors and gives no information on the individual nonmonetary factor loadings. We specify a parsimonious model in order to isolate important nonmonetary factors and to measure the responses of securities to these nonmonetary factors. Affine models of the yield curve usually find that two or three common factors explain most of the movements in yields of all maturities for a country. For our data containing yields and equity and exchange rate returns for two countries, the first four principal components on

[11] In the general model the coefficients on the Australian money surprises are restricted to have no effect on the 5 and 10 year US yields and US equities, as the US series are lagged one day. However, preliminary tests of spillovers from Australia to the US using the event specification yielded no significant results. We regressed the change in the US yields and equity returns on the change in the Australian 30-day Euro$ rate on Australian event days, all measured on the same calendar day.

nonevent days, see Section 2, explain 97% of the sample variance. Based on this principal components decomposition we specify a parsimonious factor model of the $n = 9$ series, with $K = 4$ nonmonetary common factors and $n-K = 5$ idiosyncratic errors in (12). The parsimonious model provides estimates of the impact of the *nonmonetary* and the monetary factors on yield changes and returns.

Table 3 gives the estimates of the parameters of the parsimonious factor model with their GMM standard errors in parentheses. The value of the GMM loss function is given at the bottom of the table. A comparison of the estimates of the monetary factor loadings in Tables 2 and 3 respectively shows that the parameter estimates from the general and parsimonious models are very close although the standard errors of the coefficient estimates differ.

A formal test of the restrictions imposed on the nonmonetary factors in the general model is given by the DL test statistic in Equation (15). The value of the statistic is $DL = 19.574$, and the number of restrictions is $86 - 74 = 12$ degrees of freedom. This produces a $p - value$ of 0.076, showing that the restrictions are not rejected at the 5% level.

4.2.1 Nonmonetary Factors

The nonmonetary factors are not identified *a priori*. We named them according to their contribution to the variance of the security price change.

The factor contributions to the theoretical variance[12] of the security price changes on nonmonetary event days are given in Table 4. The **bold** entries in each column indicate that this factor explains a large portion of the variance of a security price change.

We call the 1^{st} factor AU Bond because it explains 63% of the variance of the yield change on the five year Australian bond and 39% of the variance on the ten year Australian yield change. It has very little impact on the other securities. We call the 2^{nd} factor a W Bond (World) because it affects mostly US and Australian five and ten year bond yields. The 3^{rd} factor, W Equity, affects equity returns in both countries and the currency return. The 4^{th} factor, US Bond, affects mostly US longer maturity bond yields. The last column shows the idiosyncratic factors. The idiosyncratic

[12] The theoretical model equates the variance of the security price change to the sum of the squared factor loadings on an event, or nonevent, day, see equation (9). The theoretical variance decomposition on nonevent days is the contribution of the jth factor to the variance of the ith security, $\frac{\beta_{ij}^2}{\sum_i \beta_{ij}^2}$.

Table 3:

Parameter estimates of the monetary and nonmonetary factor loadings of the parsimonious factor model in (12). GMM standard errors in parentheses.

Asset	Monetary Factors		Nonmonetary Factors				
	US	AU	AU Bond	W Bond	W Equity	US Bond	Idio.
US 30 day Euro	10.533	0.114	0.445	0.172	0.087	0.650	3.136
	(1.161)	(0.119)	(0.084)	(0.072)	(0.080)	(0.085)	(0.291)
US 5 yr yield	1.911	0.000	1.309	3.799	-0.324	5.108	0.000
	(0.758)		(0.356)	(0.273)	(0.052)	(0.144)	
US 10 yr yield	0.518	0.000	1.273	3.727	0.000	4.353	1.707
	(0.697)		(0.321)	(0.015)		(0.149)	(0.046)
US equity return	-0.558	0.000	-0.244	0.148	-0.715	0.000	0.556
	(0.129)		(0.072)	(0.032)	(0.054)		(0.069)
AU 30 day Euro	4.790	11.532	1.179	0.000	0.000	0.000	3.162
	(0.627)	(1.761)	(0.142)				(0.300)
AU 5 yr yield	4.039	3.794	6.233	4.315	-1.927	0.624	0.000
	(1.267)	(1.293)	(0.401)	(0.478)	(0.460)	(0.202)	
AU 10 yr yield	2.287	1.524	4.936	6.155	-0.882	0.000	0.000
	(1.530)	(1.006)	(0.470)	(0.378)	(0.374)		
AU equity return	-0.279	-0.007	-0.267	0.000	-0.458	0.000	0.575
	(0.114)	(0.065)	(0.047)		(0.042)		(0.030)
Currency return	-0.323	0.289	0.021	0.020	-0.077	0.000	0.582
	(0.081)	(0.062)	(0.017)	(0.014)	(0.017)		(0.015)
$L(\theta_p)$	119.488						

Table 4:

Variance decompositions of variables in terms of the contribution of the factors on nonevent days, expressed as a proportion of the total. Based on the parsimonious parameter estimates in Table 3.

Asset	Nonmonetary Factor				
	AU Bond	W Bond	W Equity	US Bond	Idio
US 30 day Euro	1.886	0.281	0.072	4.026	**93.735**
US 5 yr yield	4.065	**34.080**	0.248	**61.607**	0.000
US 10 yr yield	4.350	**37.166**	0.000	**50.686**	7.798
US equity return	6.554	2.438	**56.744**	0.000	**34.264**
AU 30 day Euro	12.189	0.000	0.000	0.000	**87.811**
AU 5 yr yield	**63.192**	**30.171**	6.005	0.632	0.000
AU 10 yr yield	**38.740**	**60.031**	1.229	0.000	0.000
AU equity return	11.629	0.000	**34.343**	0.000	**54.028**
Currency return	0.130	0.118	1.698	0.000	**98.055**

factors explain about 90% of the variance of the US and Australian 30-day Euro$ rate on nonevent days.

Tables A1 and A2 in the Appendix respectively give the variance decompositions on US and Australian monetary event days and show the same basic pattern for the nonmonetary factors as presented in Table 4.

4.2.2 Yield Curve Response to Monetary and Nonmonetary Surprises

The US Figure 4 represents graphically the response of US yields to a US money surprise and to a US and World bond surprise. The error bars give the two standard deviation confidence band.

The bold solid line labeled US Money taken from Figure 2, shows the response of the yields to a one-standard deviation US money surprise. The solid line labeled US Bond shows the response to the nonmonetary factor that affects mostly US bond yields. The thin line labeled W Bond shows the response to the factor that affects US and Australian bond yields. The loadings on the two bond factors are large in magnitude and these factors explain over 85% of the variance of the 5 and 10 year maturity yield changes on monetary event days; see also Table 4.

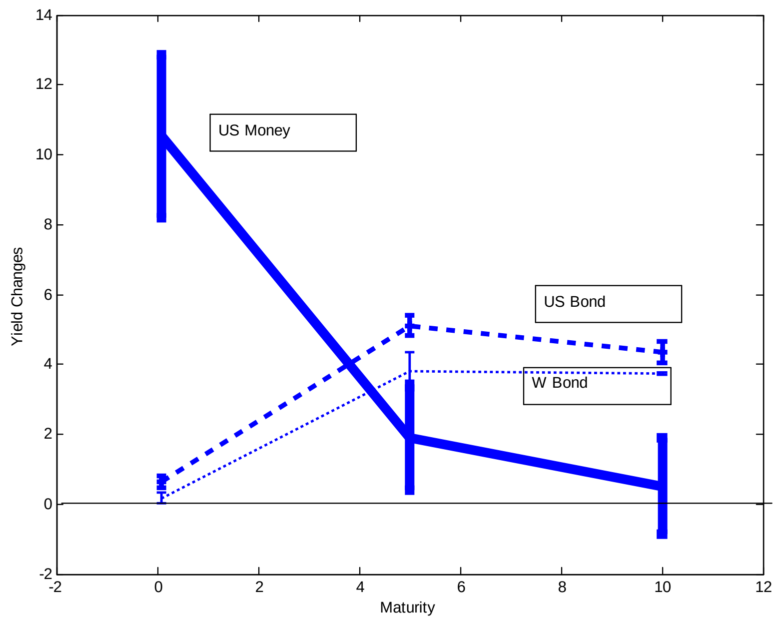

Figure 4: Response of US yields to a one standard deviation surprise in US money (US Money), US bonds (US Bond) and world bonds (W Bond). Parameter estimates based on the parsimonious factor model.

Bond surprises, World and US, twist the long end of the yield curve. Intermediate and long maturity yields increase by 3 to 4 times the one-standard deviation surprise. The one-month Euro$ rate increases by about half the size of the surprise. All the factor loadings on the bond surprises are statistically significant. Bond surprises increase the long end of the yield curve and have virtually no effect on the short end. The Federal Reserve controls the short maturity end of the US yield curve.

Australia Figure 5 represents graphically the response of Australian yields to an Australian money surprise and to Australian and World bond surprises. The error bars give the two standard deviation confidence bands.

The bold solid line labeled AU Money shows the yield curve response to a one standard deviation Australian money surprise[13]. The solid line labeled AU Bond shows the Australian yield response to the Australian bond factors and the thin line labeled W Bond shows the response to the world bond

[13] The point estimates of the Australian yield responses to Australian monetary surprises in the parsimonious model are smaller than in the general model and the standard errors of the coefficients are larger. The response of the Australian 10 year yield to an Australian monetary surprise is insignificant. This result matches the result for US long maturity response to a US monetary surprise.

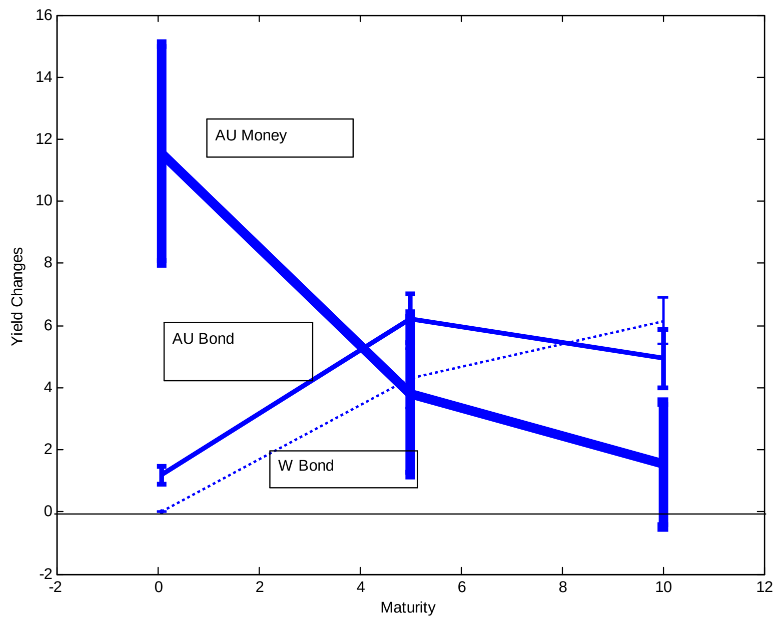

Figure 5: Response of Australia yields to a one standard deviation surprise in Australian money (AU Money), Australian bonds (AU Bond) and world bonds (W Bond). Parameter estimates based on the parsimonious factor model.

factor. The Australian yield responses given in Figure 5 are similar to the US yield curve responses in Figure 4. The bond factors explain more than 75% of the variance of the change in the yield on five year bonds and over 95% of the variance of the change in the ten year yield on Australian monetary event days. The Reserve Bank of Australia controls the short maturity end of the yield curve. The bond factors cannot move the 30-day Euro$ rate very much. Bond surprises move the long maturity end on the yield curve.

4.2.3 Equity Responses

In tightly integrated international equity markets low risk expected profit opportunities force expected risk adjusted equity returns in different countries to stay close to each other. The simple correlation between US and Australian equity index returns over the full sample, is 0.5.

Figure 6 shows the equity return response to the World equity surprise, the US and Australian monetary surprises, and the idiosyncratic equity surprises. The height of the bar shows the (absolute value of) the response to a one standard deviation factor surprise.

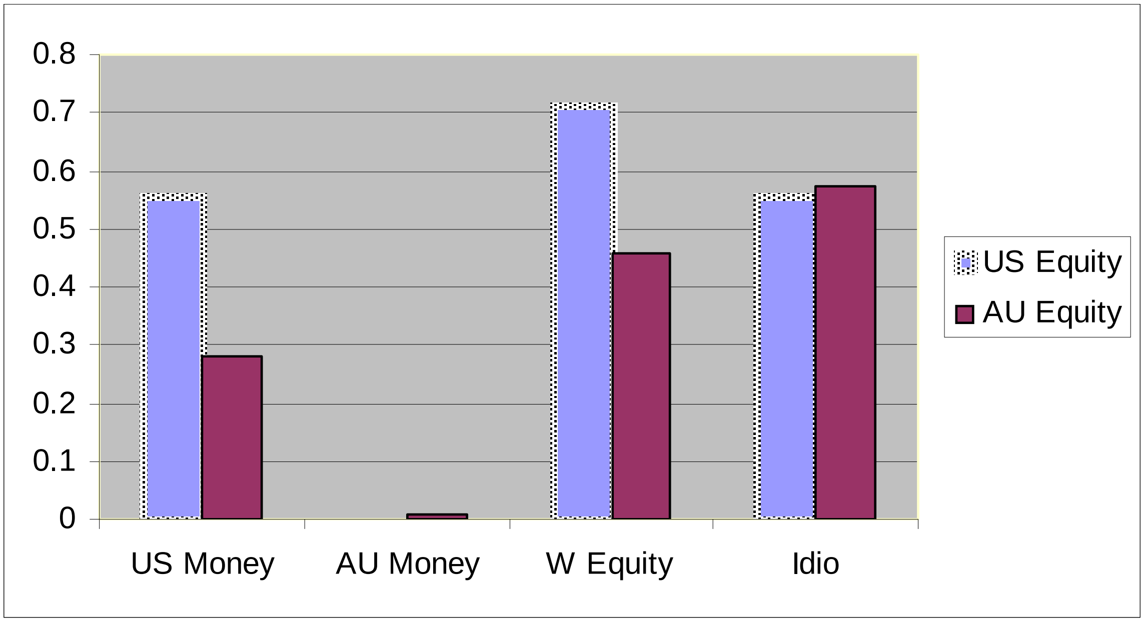

Figure 6: US and Australian equity responses to US money (US Money) and Australian money (AU Money) surprises, and world equity (W Equity) and idiosyncratic (Idio) nonmonetary surprises. Parameter estimates based on parsimonious model estimates.

The world equity factor generates the largest response for US equity returns and the second largest for Australian equity returns. US money surprises, however, have a surprisingly large impact on US[14] and Australian equity returns. A positive one standard deviation US money surprise reduces the daily US equity return by 1/2% and the Australian equity return by 1/4%. Australian money surprises, in contrast, affect neither Australian equity nor US equity returns. Evidently for a domestic monetary surprise to move the domestic equity return the country must be large enough that its money surprise also moves world equity markets.

4.3 Bias in the Event Study Specification

The event model specifies that an observable change in a short maturity rate, the 30-day Euro$ rate for the US or Australia in our study, on monetary policy event days is the monetary policy surprise, m. If the event specification were correct, then the estimate of the response of security j to the monetary surprise, as measured by the change in the short rate, would equal $(\alpha_j/\alpha_{\Delta i})$; see Equation (17).

[14] Bernanke and Kuttner attribute most of the US equity response to a US money surprise to a revision in the expected risk premium.

It turns out that the event study specification is a very good approximation. For US monetary surprises the estimates of the bias for the event study specification are small and insignificant. For Australian monetary policy surprises the estimates of the bias are small but significant.

Table 5 shows the normalized responses ($\alpha_j/\alpha_{\Delta i}$) to a one basis point surprise in the US monetary factor. The second column shows the bias. The GMM standard errors, in parentheses, are below the coefficients.

Only the bias in the estimate of the response of the exchange rate to a US monetary surprise is significant and the bias is very small relative to the estimated response coefficient. Tested jointly the bias estimates have a p value of 0.3, given at the bottom of Table 5.

Table 6 shows the normalized response of security prices to a one basis point surprise in the Australian monetary factor. The GMM standard errors are in parentheses below the coefficient estimates.

The estimates of the bias in the event study specification coefficients for Australian money surprises are significant for the response of the 30day USEuro$ rate and the exchange rate. But the magnitude of the estimated bias relative to the coefficient is very small.

5 Conclusions

This paper estimates the impact of international monetary policy surprise spillovers on yield changes, and equity and exchange rate returns. It is the first to jointly estimate the impact of unobservable monetary and nonmonetary surprises and to estimate the bias in event study estimates of the impact of monetary surprises on security price changes.

Our estimates show that domestic monetary policy surprises twist the domestic yield curve–short rates respond much more than longer maturity yields. The Central Bank controls the short maturity end of the yield curve. Our estimates of the impact of domestic monetary policy surprises on domestic security price changes are similar to previous studies.

The following results are new. International and domestic bond surprises explain most of the variation in the change in longer maturity yields. An equity surprise explains most of the variation

Table 5:

Normalized responses and estimates of the bias in the event study specification for the US monetary factor using the general model estimates in Table 2. GMM standard errors in parentheses.

Asset		Monetary Factor	Implied Event Bias
US 30 day Euro		1.000	n.a.
US 5 yr yield		0.178	-0.012
		(0.109)	(0.015)
US 10 yr yield		0.046	-0.023
		(0.094)	(0.017)
US equity return		-0.056	-0.006
		(0.017)	(0.003)
AU 30 day Euro		0.456	0.038
		(0.122)	(0.023)
AU 5 yr yield		0.400	0.027
		(0.167)	(0.031)
AU 10 yr yield		0.231	0.009
		(0.168)	(0.026)
AU equity return		-0.028	-0.003
		(0.014)	(0.002)
Currency return		-0.035	-0.004
		(0.010)	(0.002)
Joint test of bias:	Stat.		9.479
	DOF		8
	pv		0.304

Table 6:

Normalized responses and event bias estimates of the Australian monetary factor using the general model estimates in Table 2. GMM standard errors in parentheses.

Asset		Monetary Factor	Implied Event Bias
AU 30 day Euro		1.000	n.a.
US 30 day Euro		-0.005	-0.016
		(0.014)	(0.008)
AU 5 yr yield		0.386	0.037
		(0.062)	(0.027)
AU 10 yr yield		0.178	0.003
		(0.058)	(0.018)
AU equity return		-0.005	0.001
		(0.006)	(0.001)
Currency return		0.027	0.006
		(0.003)	(0.002)
Joint test of bias:	Stat.		56.867
	DOF		5
	pv		0.000

in equity returns. There are monetary policy surprise spillovers from the US to Australia. The US monetary surprise is a world surprise—it helps explain variations in US and Australian yields and equity returns. The Australian monetary surprise does not affect US yields and equity returns. The Australian economy is too small to affect world security markets. The biases implied by the general factor model in the event study estimator for US monetary policy surprises are small and insignificant. The biases in the event study estimator for Australian monetary policy surprises are significant but small. The event study specification is a good approximation to estimate the impact of a monetary policy surprise on security prices.

A Variance Decompositions

Table A1:

Variance decompositions of variables in terms of the contribution of the factors on US event days, expressed as a proportion of the total. Based on the parsimonious parameter estimates in Table 3.

Asset	Factor						
	US Money	AU Money	AU Bond	W Bond	W Equity	US Bond	Idio
US 30 day Euro	**0.914**	0.000	0.002	0.000	0.000	0.003	0.081
US 5 yr yield	0.079	0.000	0.037	**0.314**	0.002	**0.567**	0.000
US 10 yr yield	0.007	0.000	0.043	**0.369**	0.000	**0.503**	0.077
US equity return	*0.257*	0.000	0.049	0.018	**0.421**	0.000	0.255
AU 30 day Euro	**0.668**	0.000	0.040	0.000	0.000	0.000	0.291
AU 5 yr yield	0.209	0.000	**0.499**	**0.239**	0.048	0.005	0.000
AU 10 yr yield	0.077	0.000	**0.357**	**0.555**	0.011	0.000	0.000
AU equity return	0.113	0.000	0.103	0.000	**0.304**	0.000	**0.480**
Currency return	0.101	0.000	0.000	0.000	**0.572**	0.000	0.327

Table A2:

Variance decompositions of variables in terms of the contribution of the factors on Australian event days, expressed as a proportion of the total. Based on the parsimonious parameter estimates Table 3.

Asset	Factor						
	US Money	AU Money	AU Bond	W Bond	W Equity	US Bond	Idio
US 30 day Euro	0.000	0.001	0.019	0.003	0.001	0.040	0.936
US 5 yr yield	0.000	0.000	0.040	**0.341**	0.002	**0.616**	0.000
US 10 yr yield	0.000	0.000	0.043	**0.372**	0.000	**0.507**	0.078
US equity return	0.000	0.000	0.066	0.024	**0.567**	0.000	0.343
AU 30 day Euro	0.000	**0.921**	0.010	0.000	0.000	0.000	0.069
AU 5 yr yield	0.000	0.189	**0.511**	**0.245**	0.049	0.005	0.000
AU 10 yr yield	0.000	0.036	**0.373**	**0.580**	0.012	0.000	0.000
AU equity return	0.000	0.000	0.117	0.000	**0.343**	0.000	0.540
Currency return	0.000	0.082	0.000	0.000	**0.584**	0.000	0.333

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