"Affine term structure models for the foreign exchange risk premium in Armenian deposit market"

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Outline

- Motivation & Objectives
- Literature Review
- Data & Background Analysis
- Estimation Results
- Conclusions

Motivation & Objectives

Importance of the research

- Foreign Exchange Risks
  - Important source of uncertainty in transition countries
  - Not established foreign exchange derivatives markets
  - Dollarization as a tool for hedging currency risks
- Why Armenia?
  - Floating exchange rate regime

Motivation & Objectives

The case of Armenia

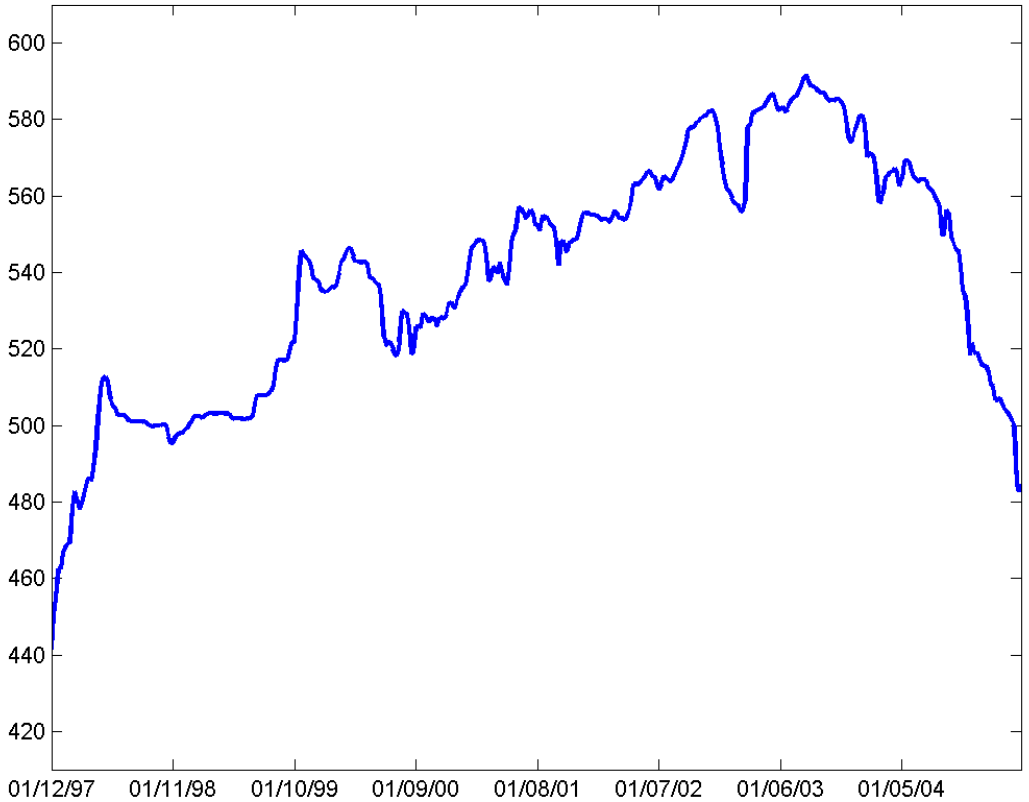

Figure: AMD-USD exchange rate (weekly, 1997-2004)

Motivation & Objectives

Importance of the research

- Foreign Exchange Risks in Transition Countries
  - Important source of uncertainty
  - Not established foreign exchange derivatives markets
  - Dollarization – a tool for hedging currency risks
- Why Armenia?
  - Floating exchange rate regime
  - Active market of foreign exchange denominated financial instruments (dollarization)
  - Liberalized capital accounts

Motivation & Objectives

Research Questions

- To which extent the information from *local* financial markets is sufficient for explaining the exchange rate risks?
- Do standard term structure models imply behavior of the exchange rate risk premium consistent with the data?
- What are the systematic factors driving the exchange rate risk premium?

Literature review

Foreign exchange market efficiency

- Uncovered interest parity (UIP): $E_t[\Delta s_{t+1}] = i_t - i_t^*$
- Workhorse equation for testing UIP (Sarno & Taylor, 2002)

$$\Delta s_{t+1} = \alpha + \beta(i_t - i_t^*) + \varepsilon_{t+1}$$

  - Theoretical predictions: H_0: $\alpha = 0$ and $\beta = 1$
  - Empirical evidence: on average $\beta = -0.88$ (Froot & Thaler, 1990)
  - Markets are not efficient? ("Forward premium" puzzle)
- Explanations
  - Time-varying risk premium (Fama, 1984; Engel, 1996)
  - Rational expectations (Rogoff, 1979; Lewis, 1995)
  - Monetary policy (McCallum, 1994)

Literature review

Stochastic discount factor models

- Risk premium: $i_t - i_t^* - E_t[\Delta s_{t+1}] = \phi_t \lesseqgtr 0$
- CAPM model: tradeoff between expected return and volatility
- Stochastic discount factor models ($E_t[\beta \frac{U'(C_{t+1})}{U'(C_t)} R_{t+1}] = 1$)
  - C–CAPM model (Smith & Wickens, 2002)

    $$E_t[r_{t+1}] - \tfrac{1}{2} Var_t[r_{t+1}] = -Cov_t[m_{t+1}; \Delta r_{t+1}]$$

    where
    - $r_{t+1} = [i_t - i_t^* - \Delta s_{t+1}]$ – the excess return
    - $m_{t+1} = log[\beta \frac{U'(C_{t+1})}{U'(C_t)}]$ – discount factor (pricing kernel)
  - Affine term structure models (Bansal, 1997; Backus, Foresi & Telmer 2001)

    $$i_t - i_t^* - E_t[\Delta s_{t+1}] = \tfrac{1}{2}[\lambda^2(i_t^*) - \lambda^2(i_t)]$$

    where λ is the market price of risk (mean-variance ratio)

Data & Background Analysis

Data

- Household deposit rates (weekly frequency, 1997-2004)
- Term structure (30, 60, 90, 180, 360 days)
- Covers total banking system
- Financial instruments *similar in all characteristics* except currency of denomination

Data & Background Analysis

Descriptive statistics

	Mean	Median	Max	Min	St. Dev.
AMD					
30 days	17.8	16.0	49.7	2.3	10.6
60 days	17.7	14.9	44.0	2.3	10.4
90 days	21.1	20.3	51.8	2.6	11.9
180 days	22.5	21.1	47.4	4.2	12.2
360 days	21.9	21.9	48.0	6.3	10.3
USD					
30 days	12.8	10.7	35.0	1.1	8.9
60 days	13.5	10.8	39.0	1.0	9.6
90 days	15.8	13.7	43.0	1.4	9.2
180 days	15.6	15.3	45.3	2.1	8.6
360 days	15.6	14.6	45.0	4.4	7.8

Data & Background Analysis

UIP relationship

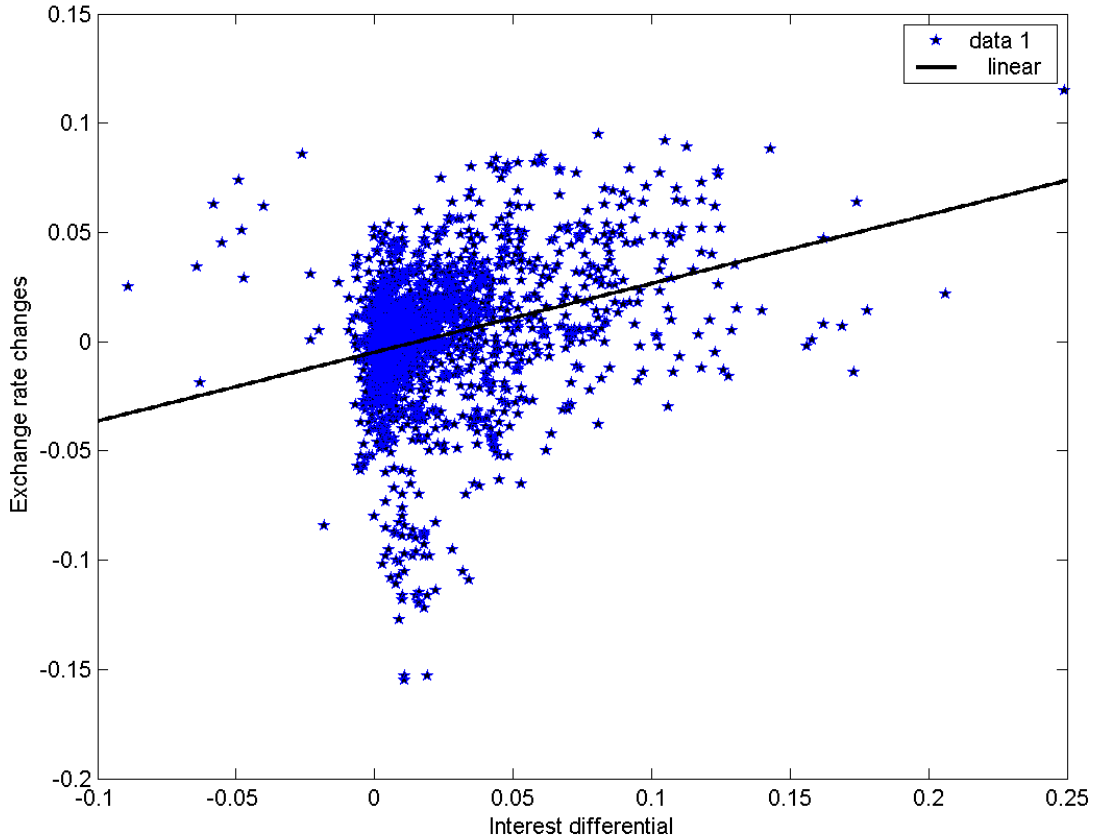

Figure: Plot of interest rate differentials and exchange rate changes

Data & Background Analysis

Deviations from the UIP: $d_t = (i_t - i_t^*) - \Delta s_{t+1}$

	30 days	60 days	90 days	180 days	360 days	Average	TBills rates
USD rates							
Average [*St.Dev.*]	0.011 [0.007]	N/A	0.039* [0.022]	0.084* [0.043]	N/A	0.045* [0.024]	0.263* [0.151]
Prob.	0.1098	N/A	0.0796	0.0513	N/A	0.0676	0.0852
AMD rates							
Average [*St.Dev.*]	0.005 [0.013]	0.007 [0.019]	0.013 [0.023]	0.029 [0.035]	0.046 [0.053]	0.020 [0.021]	N/A
Prob.	0.7228	0.7104	0.5657	0.4034	0.3807	0.3370	N/A
Mean eq. test							
$t-stat$	6.489	N/A	13.734	18.648	N/A	14.461	N/A
Prob.	0.0000	N/A	0.0000	0.0000	N/A	0.0000	N/A

- **UIP fails for a cross-country data**
- **Systematic positive risk premium**

Data & Background Analysis

Deviations from the UIP by years (%): $d_t = [(i_t - i_t^*) - \Delta s_{t+1}] * 100$

	30 days	60 days	90 days	180 days	360 days	Average
1998	0.38	-0.06	1.80	4.84	4.05	2.20
1999	0.43	0.82	1.77	2.24	1.14	1.28
2000	-0.08	0.02	0.09	2.00	7.23	1.85
2001	0.50	0.59	1.40	1.56	1.79	1.17
2002	0.07	0.09	0.06	1.19	4.31	1.15
2003	0.46	1.11	1.30	2.13	3.16	1.64
2004	1.30	2.41	2.98	6.62	10.77	4.82
Average	0.44	0.71	1.34	2.94	4.64	

- **Risk premium is still positive and time-varying**
- **Risk premium increases with investment horizon**

Data & Background Analysis

Maturity Effect (Implicit Risk Premium)

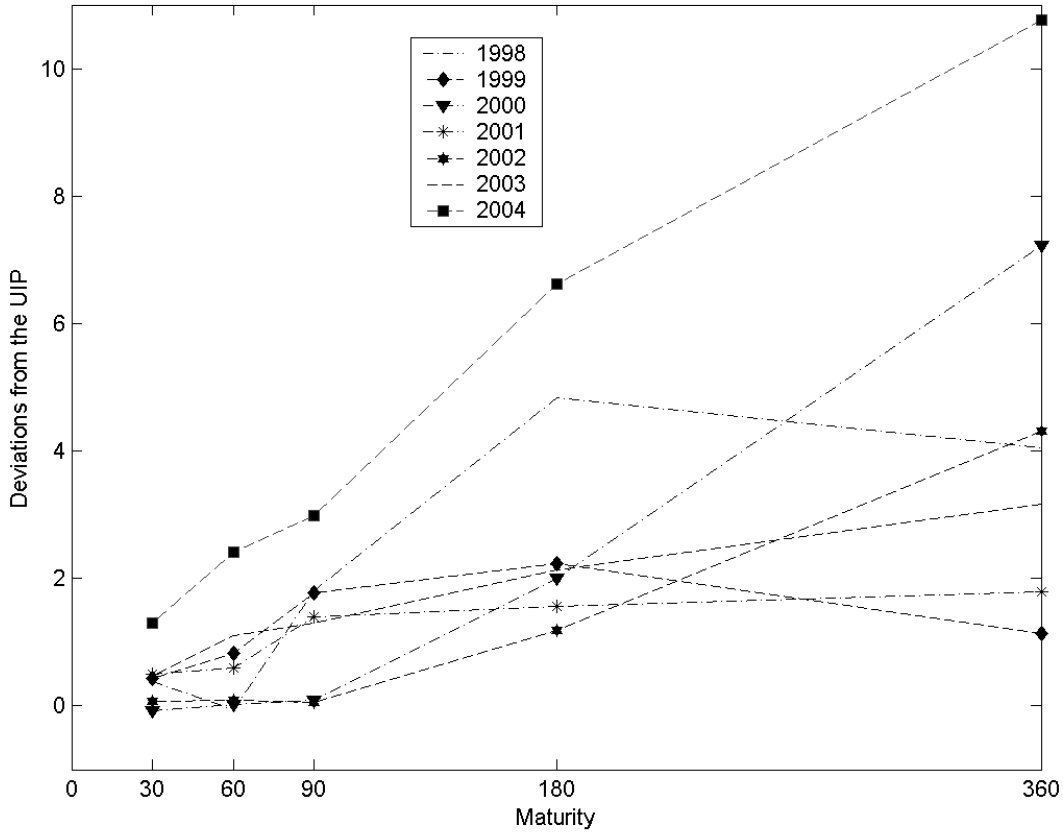

Figure: Maturity Effect

Estimation Results

Single-factor affine term structure models

- Exchange rate risk premium is determined by interest rate risks for two currencies' financial instruments
- Interest rate processes (Chan et al., 1992)

$$dr = (\alpha + \beta r)dt + \sigma r^{\gamma} dZ$$

- Nested interest rate models

Model	α	β	σ^2	γ
Merton		0		0
Vasicek				0
Cox-Ingersoll-Ross, Square Root (CIR-SR)				0.5
Dothan	0	0		1
Geometric Brownian Motion (GBM)	0			1
Brennan-Schwartz (B-S)				1
Cox-Ingersoll-Ross, Variable Return (CIR-VR)	0	0		1.5
Constant Elasticity of Variance (CEV)	0			

Estimation Results

GMM – Test of overidentifying restrictions

- Econometric specification (GMM): $r_{t+1} - r_t = \alpha + \beta r_t + \varepsilon_{t+1}$
- Moment conditions: $E[\varepsilon_{t+1}] = 0$, $E[\varepsilon_{t+1}^2] = \sigma^2 r_t^{2\gamma}$
- Instruments: $[c, r_t]$
- Hansen's (1982) test of overidentifying restrictions

Model	AMD interest rates					USD interest rates					
	30	60	90	180	360	30	60	90	180	360	TB
Merton	R	R	R	R	R	R	R	R	R	R	R
Vasicek	R	R	CR	CR	R	R	R	R	R	R	R
CIR-SR	**CR**	**CR**	**CR**	**CR**	**CR**	**CR**	**CR**	**CR**	**CR**	**R**	**CR**
Dothan	R	R	CR	R	R	R	R	R	R	R	R
GBM	R	R	CR	CR	R	R	R	R	R	R	R
B-S	R	R	CR	CR	CR	R	R	R	CR	CR	R
CIR-VR	R	R	R	R	R	R	R	R	R	R	R
CEV	R	R	R	R	R	R	R	R	R	R	CR

H_0: the model specification is correct.
R – reject H_0, CR – can't reject H_0 at 10% significance level.

Estimation Results

GMM estimates of the CIR model

	α	β	σ^2	γ	χ^2 test	Volume
TBills	.003	-.014	.003*	.5	.015*	
AMD 30	.017*	-.119*	.011*	.5	2.15*	10%
AMD 60	.012*	-.083*	.007*	.5	0.02*	16%
AMD 90	.004*	-.031*	.003*	.5	1.67*	12%
AMD 180	.004*	-.027*	.003*	.5	0.16*	32%
AMD 360	.013*	-.069*	.005*	.5	0.76*	30%
USD 30	.009*	-.097*	.008*	.5	3.13*	8%
USD 60	.006*	-.056*	.005*	.5	1.58*	20%
USD 90	.006*	-.045*	.003*	.5	0.00*	12%
USD 180	.004*	-.026*	.003*	.5	3.65*	35%
USD 360	.019*	-.131*	.007*	.5	6.28	24%

Note: * stands for a 10% significance level.

- Deposit rates are mean reverting (negative β), TBills rates are not
- Conditional volatility is lowest for the most traded deposits (in line with the theory)

Estimation Results

Market price of risk

- Market price of risk in the CIR model: $\lambda(r_t) = \frac{\alpha+\beta r_t}{\sigma r_t^{0.5}}$
- Nonlinear negative relationship between rate and risk

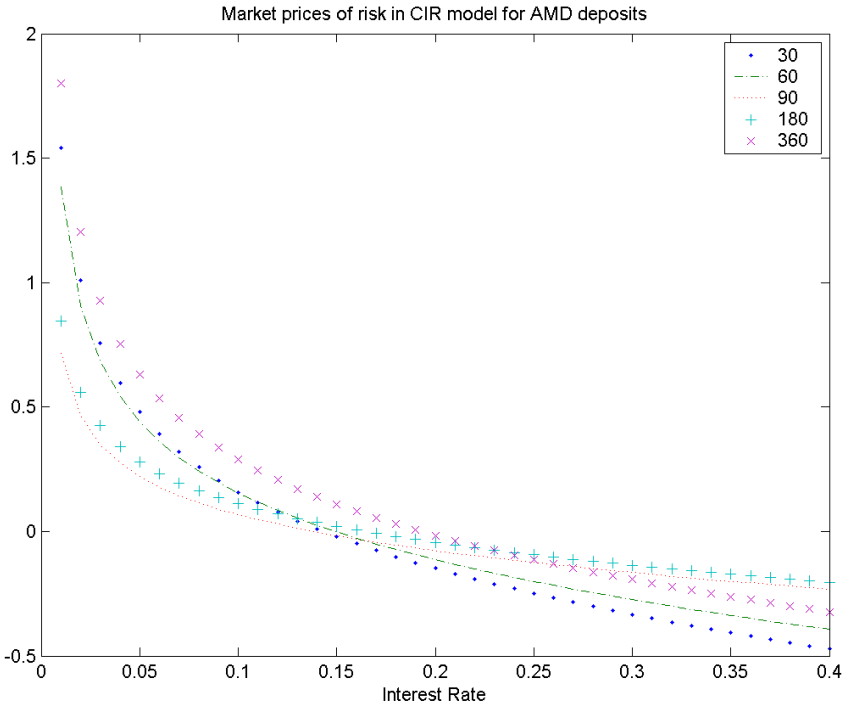

Figure: AMD

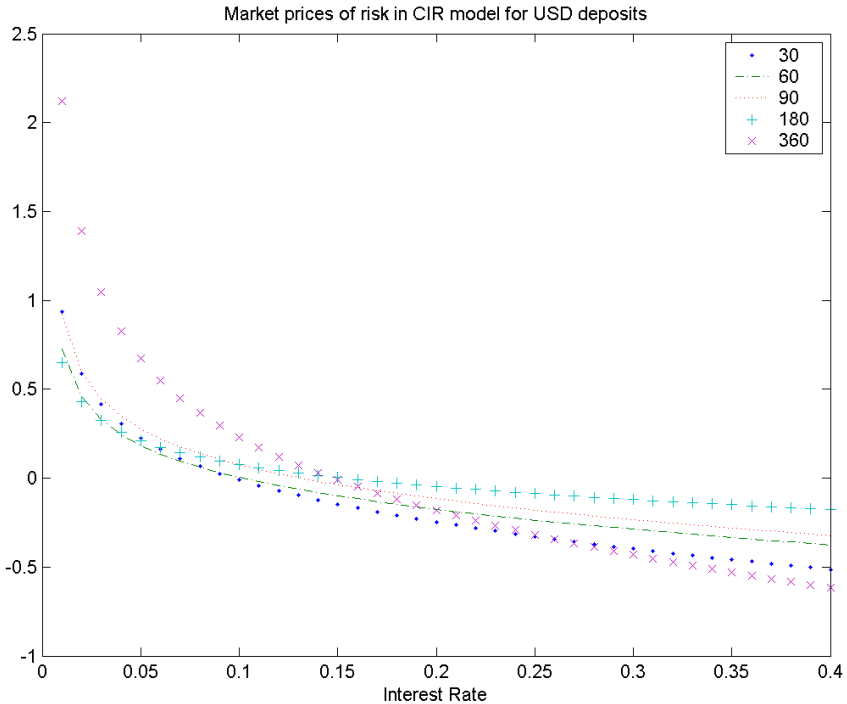

Figure: USD

Conclusions

- Study on the foreign exchange risk premium using the UIP
- Positive correspondence between exchange rate depreciation and interest differential (no "forward discount" puzzle)
- Systematic positive exchange rate risk premium in Armenia
- The risk premium is time-varying and increasing over the investment horizon (in line with the CIR model)
- Domestic currency interest rate risks are priced higher than foreign currency interest rate risks – this partially explains the positive exchange rate risk premium
- Future work - extension to multiple-factor models