Gold Risk, Crash Fear, and Expected Stock Returns

Nima Ebrahimi

University of North Texas

Friday 5th August, 2022

- Inability of models to reconcile asset prices and macroeconomic risk $\Rightarrow$ Many puzzles in macro-finance

- Inability of models to reconcile asset prices and macroeconomic risk $\Rightarrow$ Many puzzles in macro-finance
- Classic example $\Rightarrow$ Equity premium puzzle: averaged stock returns are far too high to be explained by the observed risk in consumption (Mehra and Prescott, 1985)

- Inability of models to reconcile asset prices and macroeconomic risk $\Rightarrow$ Many puzzles in macro-finance
- Classic example $\Rightarrow$ Equity premium puzzle: averaged stock returns are far too high to be explained by the observed risk in consumption (Mehra and Prescott, 1985)
- Potential resolution: We do not observe the risk that agents genuinely care about

- Inability of models to reconcile asset prices and macroeconomic risk $\Rightarrow$ Many puzzles in macro-finance
- Classic example $\Rightarrow$ Equity premium puzzle: averaged stock returns are far too high to be explained by the observed risk in consumption (Mehra and Prescott, 1985)
- Potential resolution: We do not observe the risk that agents genuinely care about
- Rare disaster models (Rietz, 1988; Barro, 2006) $\Rightarrow$ Agents care about infrequent but severe macroeconomic crises

- Inability of models to reconcile asset prices and macroeconomic risk $\Rightarrow$ Many puzzles in macro-finance
- Classic example $\Rightarrow$ Equity premium puzzle: averaged stock returns are far too high to be explained by the observed risk in consumption (Mehra and Prescott, 1985)
- Potential resolution: We do not observe the risk that agents genuinely care about
- Rare disaster models (Rietz, 1988; Barro, 2006) $\Rightarrow$ Agents care about infrequent but severe macroeconomic crises
- Gabaix (2012), Gourio (2012), and Wachter (2013) $\Rightarrow$ Variation in macroeconomic tail risk can rationalize macro-finance puzzles

- Inability of models to reconcile asset prices and macroeconomic risk ⇒ Many puzzles in macro-finance
- Classic example ⇒ Equity premium puzzle: averaged stock returns are far too high to be explained by the observed risk in consumption (Mehra and Prescott, 1985)
- Potential resolution: We do not observe the risk that agents genuinely care about
- Rare disaster models (Rietz, 1988; Barro, 2006) ⇒ Agents care about infrequent but severe macroeconomic crises
- Gabaix (2012), Gourio (2012), and Wachter (2013) ⇒ Variation in macroeconomic tail risk can rationalize macro-finance puzzles
- The success of rare disasters models rely on a seemingly unobserved variable — the time-varying probability of a large macroeconomic crisis

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market
  - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market
  - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents
  - Concentrate on the safe haven demand channel and separating it

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market
  - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents
  - Concentrate on the safe haven demand channel and separating it
  - Consumption $\Rightarrow$ Pre-planned and smoothly growing

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market
  - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents
  - Concentrate on the safe haven demand channel and separating it
  - Consumption $\Rightarrow$ Pre-planned and smoothly growing
  - Safe Haven $\Rightarrow$ Spontaneous and jumpy

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market
  - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents
  - Concentrate on the safe haven demand channel and separating it
  - Consumption $\Rightarrow$ Pre-planned and smoothly growing
  - Safe Haven $\Rightarrow$ Spontaneous and jumpy
  - Jump vs. Diffusion

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
  - How to isolate the safe haven channel in gold market
  - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents
  - Concentrate on the safe haven demand channel and separating it
  - Consumption $\Rightarrow$ Pre-planned and smoothly growing
  - Safe Haven $\Rightarrow$ Spontaneous and jumpy
  - Jump vs. Diffusion
- Options provide an additional dimension (strike)

- **Gold as a three-dimensional macroeconomic player: High tech, Jewelry and Safe Haven**
    - How to isolate the safe haven channel in gold market
    - Classic problem in commodity finance (economics) $\Rightarrow$ Estimating supply, demand and their constituents
    - Concentrate on the safe haven demand channel and separating it
    - Consumption $\Rightarrow$ Pre-planned and smoothly growing
    - Safe Haven $\Rightarrow$ Spontaneous and jumpy
    - Jump vs. Diffusion
- Options provide an additional dimension (strike)
- Building up and option-based index which isolates the safe haven channel of demand in gold market

Bollerslev and Todorov (2011) propose the following methodology to measure the risk-neutral jump tail measures as:

$$RT_t^Q(k) \equiv \frac{1}{T-t}\int_t^T \int_R (e^x - e^k)^+ E_t^Q(\nu_s^Q(dx))ds \approx \frac{e^{r(t,T]}C_t(K)}{(T-t)F_t}$$

$$LT_t^Q(k) \equiv \frac{1}{T-t}\int_t^T \int_R (e^k - e^x)^+ E_t^Q(\nu_s^Q(dx))ds \approx \frac{e^{r(t,T]}P_t(K)}{(T-t)F_t}$$

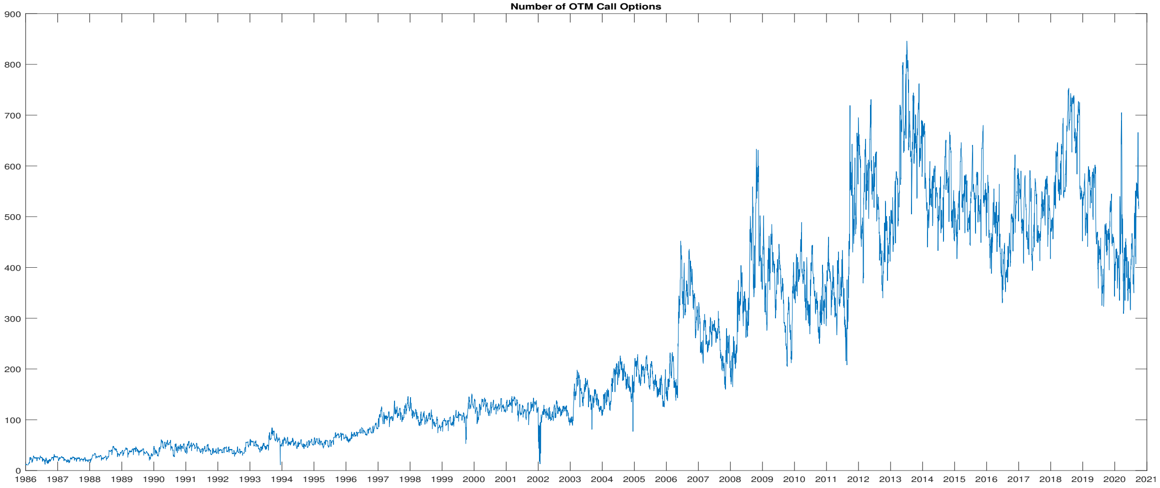
The basic idea is that the deep out-of-the-money options can only be in-the-money in very short term if a jump happens

- The macroeconomic data series are downloaded from Federal Reserve Economic Data (FRED)
- The raw options data (options on gold future contracts) is from the CME (formerly NYMEX) for the period 1986 through 2020
- The historical prices of precious metals are from London Bullion Market(LBM)
- For the stock returns, we use the CRSP value-weighted index returns
- The risk-free rate, and the factor mimicking portfolio returns for size, book-to -market, and momentum factors are downloaded from the online data library of Kenneth R. French

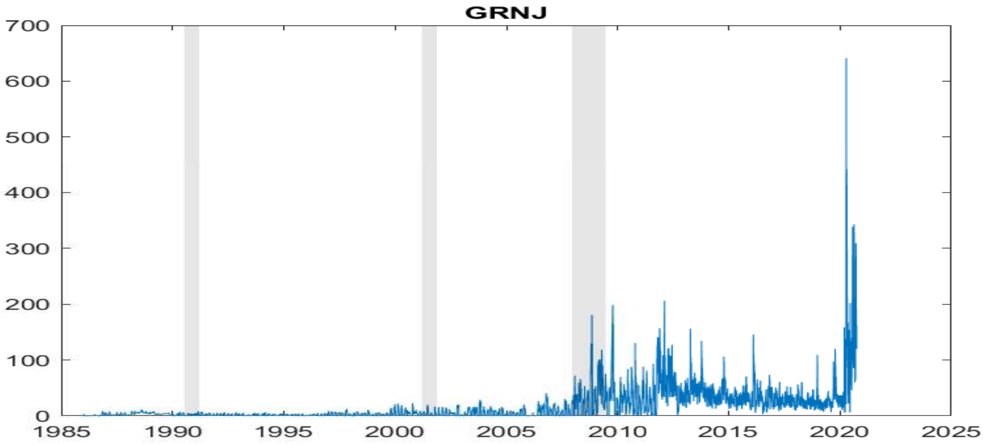
- $\log PD_t$ is the log price-dividend ratio from Robert Shiller's website
- $\log PE_t$ is the cyclically adjusted price-earnings ratio from Robert Shiller's website
- $\log PNY_t$ is the net-payout yield from Michael Robert's website
- CAY_t is the consumption-wealth ratio from Martin Lettau's website
- VRP_t is the variance risk premium, the difference between risk-neutral and physical variance, from Hao Zhou's website

- The problem here $\Rightarrow$ We do not have a continuum of implied volatilities
- Solution $\Rightarrow$ Using linear interpolation to get a continuum of implied volatilities
- The next stage would be to go from continuum of implied volatilities to continuum of prices, using Black (1976)
- **Gold Risk-Neutral Jump (GRNJ) = Integral of call option prices with strike** $X \geq F(t, T_1)e^{4\sigma\sqrt{(T-t)}}$

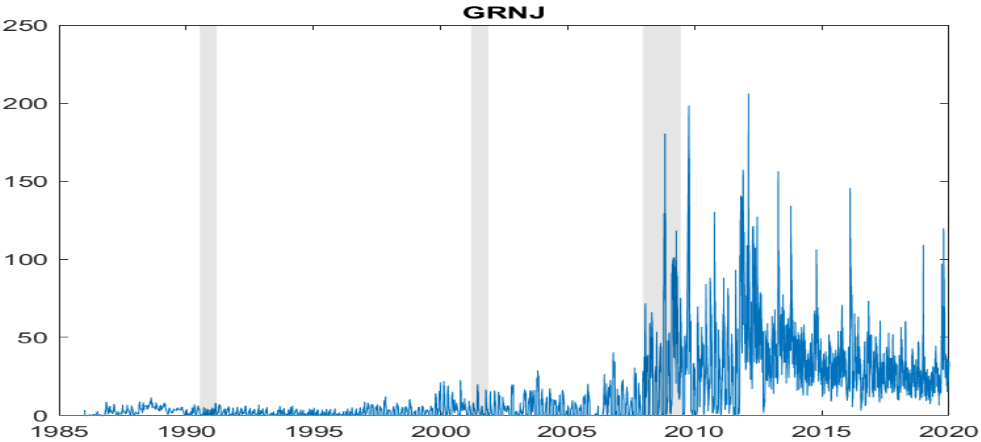
Number of Out-of-the-Money Call Gold Options 1986-2020



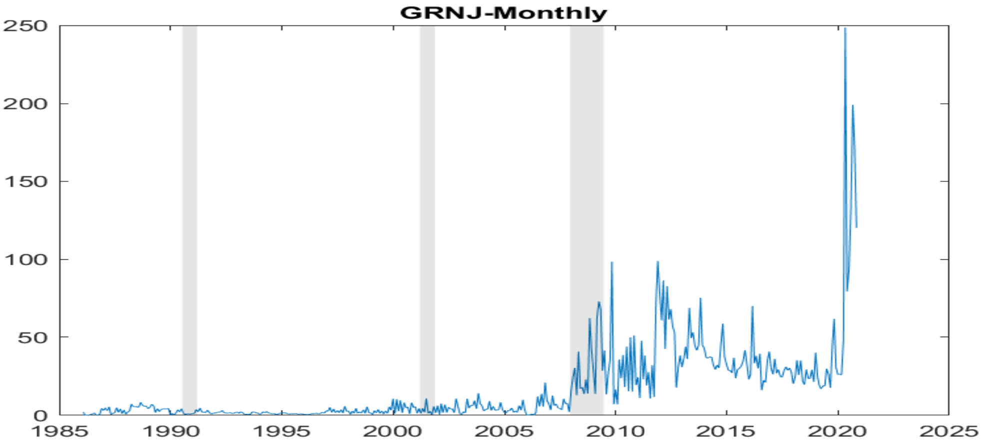
Gold Risk-Neutral Jump 1986-2020 Including COVID Crisis-Daily



Gold Risk-Neutral Jump 1986-2020 Excluding COVID Crisis- Daily



Gold Risk-Neutral Jump 1986-2020 Including COVID Crisis-Monthly



	(1) 1m	(2) 3m	(3) 6m	(4) 1y	(5) 2y	(6) 3y	(7) 4y	(8) 5y
$GRNJ_t$	0.00521**	0.00330***	0.00302**	0.00268**	0.00272***	0.00256**	0.00244***	0.00223***
	(0.00202)	(0.000943)	(0.00116)	(0.00104)	(0.000779)	(0.000847)	(0.000519)	(0.000448)
_cons	-0.0727	-0.0201	-0.0120	-0.00338	-0.00686	-0.00575	-0.00595	-0.0000490
	(0.0801)	(0.0559)	(0.0604)	(0.0577)	(0.0370)	(0.0415)	(0.0238)	(0.0228)
R^2_{adj}	0.045	0.049	0.071	0.113	0.220	0.313	0.382	0.416

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	1m			3m			1y			5y		
	Coef	tstat	$\bar{R}^2$	Coef	tstat	$\bar{R}^2$	Coef	tstat	$\bar{R}^2$	Coef	tstat	$\bar{R}^2$
$GRNJ_t$	0.005	3.219	0.045	0.003	3.651	0.049	0.003	2.932	0.113	0.002	6.642	0.416
$\log GP_t$	0.145	2.090	0.010	0.163	1.932	0.045	0.171	1.889	0.180	0.074	1.276	0.172
$\log PD_t$	−0.190	−0.402	−0.002	−0.235	−0.688	0.007	−0.358	−4.699	0.090	−0.346	−5.517	0.454
$\log PE_t$	−0.276	−1.127	0.005	−0.314	−2.056	0.029	−0.272	−2.147	0.080	−0.283	−5.500	0.470
$\log PNY_t$	0.956	1.086	0.028	0.930	1.078	0.072	0.468	1.445	0.052	−0.106	−0.754	0.009
CAY_t	−13.449	−1.996	0.029	−9.026	−1.647	0.031	−4.336	−1.127	0.020	−4.475	−2.148	0.154
VRP_t	0.623	3.930	0.076	0.430	4.903	0.098	0.093	1.437	0.011	0.065	1.234	0.035
$DFSP_t$	−0.080	−0.525	0.001	−0.026	−0.279	−0.003	0.056	2.372	0.021	0.066	3.859	0.186
$Inflation_t$	3.267	0.262	−0.005	7.398	0.509	0.001	−13.869	−2.180	0.065	−5.367	−3.721	0.050
$TMSP_t$	−0.011	−0.384	−0.005	−0.010	−0.501	−0.004	0.029	1.856	0.037	0.041	4.493	0.418

Bivariate Return Predictability-Short Horizon

	1m					3m				
	$GRNJ_t$	tstat	Coef	tstat	$\bar{R}^2$	$GRNJ_t$	tstat	Coef	tstat	$\bar{R}^2$
log GP_t	0.005	2.375	0.014	0.155	0.040	0.003	1.999	0.068	0.736	0.047
log PD_t	0.006	2.292	0.248	0.412	0.044	0.003	1.884	−0.031	−0.061	0.041
log PE_t	0.006	2.802	0.103	0.281	0.041	0.003	2.632	−0.067	−0.219	0.042
CAY_t	0.005	2.761	−4.765	−1.293	0.055	0.003	2.540	−4.461	−1.305	0.083
VRP_t	0.005	3.206	0.618	4.520	0.120	0.003	3.272	0.422	6.442	0.136
$DFSP_t$	0.006	3.256	−16.056	−1.097	0.063	0.004	3.391	−6.767	−0.504	0.051
$Inflation_t$	0.006	3.284	25.886	1.297	0.067	0.004	3.335	16.789	1.070	0.070
$TMSP_t$	0.006	3.219	−3.986	−1.253	0.048	0.004	3.361	−2.010	−0.720	0.046

Bivariate Return Predictability-Long Horizon

	1y					5y				
	$GRNJ_t$	tstat	Coef	tstat	$\bar{R}^2$	$GRNJ_t$	tstat	Coef	tstat	$\bar{R}^2$
log GP_t	0.001	1.836	0.132	1.801	0.198	0.002	5.868	0.055	2.795	0.511
log PD_t	0.002	2.541	−0.209	−1.626	0.138	0.001	5.636	−0.247	−4.796	0.613
log PE_t	0.002	2.992	−0.149	−1.686	0.137	0.002	4.854	−0.150	−5.033	0.555
CAY_t	0.003	3.854	−1.722	−1.000	0.136	0.002	7.605	−0.995	−2.110	0.494
VRP_t	0.003	3.679	0.084	1.930	0.127	0.002	6.445	0.048	1.833	0.457
$DFSP_t$	0.003	3.277	2.244	0.494	0.118	0.002	5.868	3.706	5.142	0.491
$Inflation_t$	0.002	3.698	−8.610	−1.331	0.140	0.002	6.324	−2.268	−1.641	0.444
$TMSP_t$	0.003	3.874	1.679	1.305	0.127	0.002	4.949	2.649	4.060	0.602

- Goyal and Welch (2008) argue that most of the well-known in-sample return predictors perform poorly out-of-sample

- The out-of-sample R^2 is given by:

$$R^2_{OS} = 1 - \frac{\sum_{k=1}^{T-m} (r^e_{m+k} - \hat{r}^e_{m+k})^2}{\sum_{k=1}^{T-m} (r^e_{m+k} - \bar{r}^e_{m+k})^2}$$

- We consider windows of length 120 months and 180 months to estimate betas
- The p-values are calculated using the adjusted-MSPE statistic of Clark and West (2007) given by:

$$f_{t+1} = (r_{t+1} - \bar{r}_{t+1})^2 - [(r_{t+1} - \hat{r}_{t+1})^2 - (\bar{r}_{t+1} - \hat{r}_{t+1})^2]$$

Which is regressed against a constant and the test is a one-sided test

Out-of-Sample Prediction

	$120m_{\text{exp}}$	pval	$180m_{\text{exp}}$	pval	$120m_{roll}$	pval	$180m_{roll}$	pval
1m	0.070	0.002	0.076	0.013	0.041	0.020	0.059	0.026
3m	0.173	0.000	0.125	0.003	0.085	0.002	0.076	0.012
6m	0.291	0.000	0.188	0.001	0.151	0.000	0.083	0.011
1y	0.453	0.000	0.260	0.000	0.274	0.000	0.128	0.004
2y	0.562	0.000	0.333	0.000	0.393	0.000	0.239	0.000
3y	0.527	0.000	0.267	0.000	0.386	0.000	0.214	0.000
4y	0.460	0.000	0.117	0.002	0.344	0.000	0.148	0.000
5y	0.443	0.000	-0.085	0.008	0.345	0.000	0.072	0.000

Macroeconomic Determinants of GRNJ

	$GRNJ_t$
$NVIX_t$	1.911***
	(0.530)
$NVIX_{SM_t}$	-2.645
	(3.402)
PUI_t	0.00926
	(0.0675)
$TedSpread_t$	-7.495
	(4.110)
ΔIP_t	-312.7
	(309.2)
$DFSP_t$	16.88
	(11.19)
$\Delta IPMAN$	-310.7
	(466.7)
ΔPCE	-214.8
	(332.1)
Constant	-26.67**
	(9.438)
R^2_{adj}	0.396

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Predicting Macroeconomic Variables by the Lags of GRNJ

	(1) $NVIX_t$	(2) $NVIX_{SM_t}$	(3) PUI_t	(4) $Intermediation_t$	(5) ΔIP_t
$GRNJ_{t-1}$	0.104**	0.00165	0.483***	0.00708*	-0.0000361
	(0.0360)	(0.00293)	(0.137)	(0.00325)	(0.0000309)
$GRNJ_{t-2}$	0.00816	0.000853	0.0925	0.00535*	-0.0000145
	(0.0170)	(0.00187)	(0.0853)	(0.00263)	(0.0000379)
$GRNJ_{t-3}$	0.0482*	0.00181	0.168	0.00362	-0.00000308
	(0.0198)	(0.00262)	(0.125)	(0.00408)	(0.0000311)
$GRNJ_{t-4}$	0.0720**	0.00554*	0.341**	0.000986	0.0000368
	(0.0274)	(0.00249)	(0.116)	(0.00414)	(0.0000364)
Constant	19.44***	1.456***	87.98***	1.022**	0.00125
	(2.701)	(0.218)	(10.66)	(0.374)	(0.000999)
R^2_{adj}	0.300	0.049	0.217	0.071	-0.007

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	(1) $Slope_t^{20\Delta}$	(2) $Slope_t^{20\Delta}$	(3) $Slope_t^{30\Delta}$	(4) $Slope_t^{30\Delta}$	(5) $Slope_t^{40\Delta}$	(6) $Slope_t^{40\Delta}$
$GRNJ_t$	0.00181**	0.000614	0.00392**	0.00133*	0.00689**	0.00268*
	(0.000599)	(0.000322)	(0.00132)	(0.000663)	(0.00230)	(0.00105)
σ_{ATM_t}		0.0506***		0.109***		0.177***
		(0.00499)		(0.0107)		(0.0176)
_cons	0.170***	0.0300	0.393***	0.0921*	0.747***	0.257***
	(0.0239)	(0.0194)	(0.0519)	(0.0404)	(0.0890)	(0.0641)
R^2_{adj}	0.132	0.772	0.131	0.760	0.143	0.730

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

- Gold can be used for: Jewelry, Production, and Safe Haven

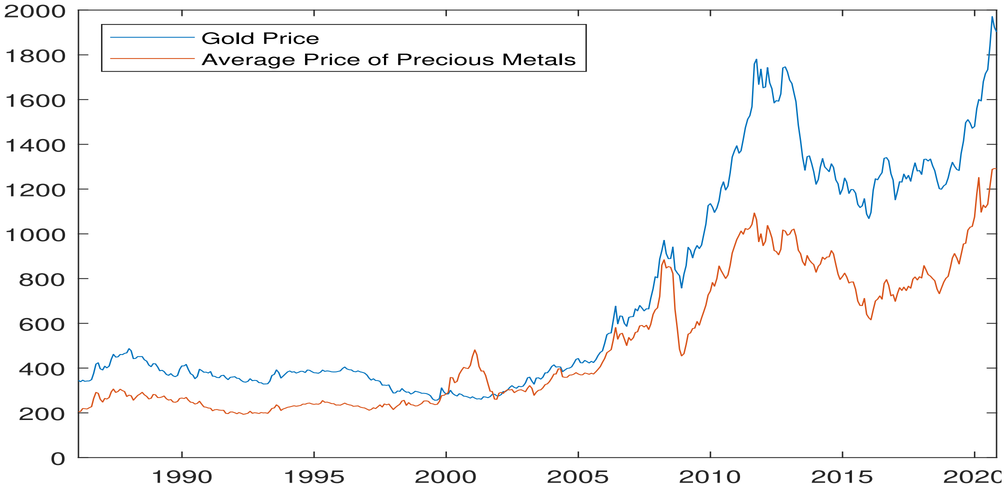
- Gold can be used for: Jewelry, Production, and Safe Haven
- Other precious metals are mainly used for jewelry and production

- Gold can be used for: Jewelry, Production, and Safe Haven
- Other precious metals are mainly used for jewelry and production
- Precious Metals: Gold, Palladium, Platinum, Silver, Rhodium and Iridium
- Huang and Kilic (2019) use the log of gold price over platinum price as a proxy for safe haven channel

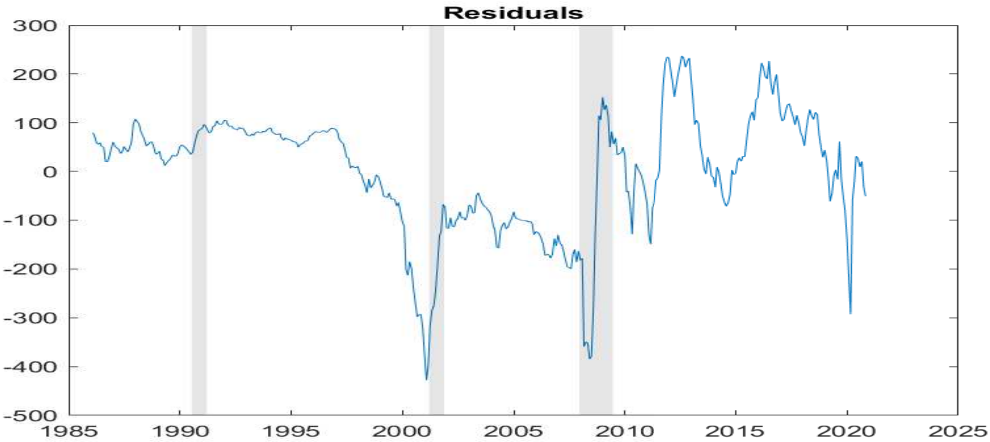
- Gold can be used for: Jewelry, Production, and Safe Haven
- Other precious metals are mainly used for jewelry and production
- Precious Metals: Gold, Palladium, Platinum, Silver, Rhodium and Iridium
- Huang and Kilic (2019) use the log of gold price over platinum price as a proxy for safe haven channel
- **The deviation of gold price from the average price of precious metals $\Rightarrow$ Safe haven channel**

- Gold can be used for: Jewelry, Production, and Safe Haven
- Other precious metals are mainly used for jewelry and production
- Precious Metals: Gold, Palladium, Platinum, Silver, Rhodium and Iridium
- Huang and Kilic (2019) use the log of gold price over platinum price as a proxy for safe haven channel
- **The deviation of gold price from the average price of precious metals $\Rightarrow$ Safe haven channel**
- The data for gold, palladium, silver and platinum is available from 1986 to 2020

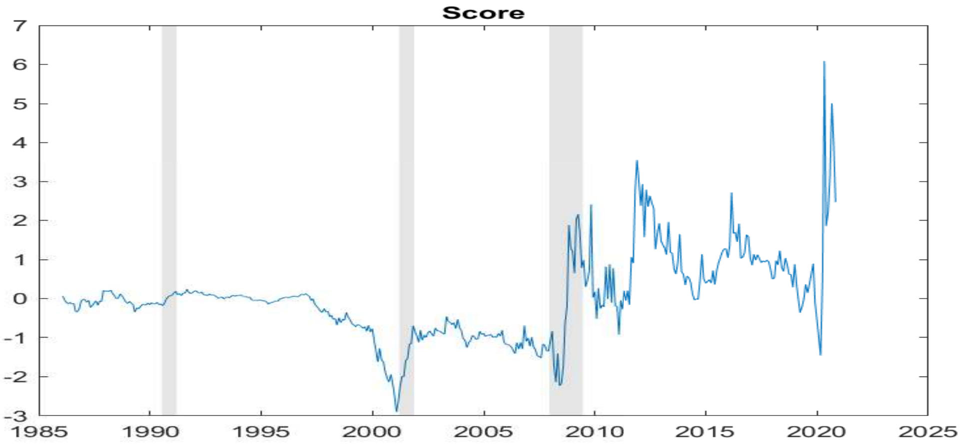
Gold Price and Average Price of Precious Metals 1986-2020



Residuals of the Regression of Gold Price on Average Prices of Precious Metal



The Scores of the First Principal Component of Residuals and GRNJ



Out-of-Sample Prediction

	$120m_{\text{exp}}$	pval	$180m_{\text{exp}}$	pval	$120m_{roll}$	pval	$180m_{roll}$	pval
1m	0.008	0.013	0.027	0.004	-0.008	0.139	0.020	0.010
3m	0.080	0.000	0.087	0.000	0.077	0.000	0.079	0.000
6m	0.193	0.000	0.188	0.000	0.226	0.000	0.174	0.000
1y	0.325	0.000	0.279	0.000	0.383	0.000	0.256	0.000
2y	0.442	0.000	0.308	0.000	0.539	0.000	0.297	0.000
3y	0.420	0.000	0.169	0.000	0.526	0.000	0.291	0.000
4y	0.418	0.000	0.200	0.000	0.499	0.000	0.413	0.000
5y	0.448	0.000	0.314	0.000	0.503	0.000	0.530	0.000

- The option-based gold economic disaster index is a powerful predictor of stock returns during the 2004-2020 period

- The option-based gold economic disaster index is a powerful predictor of stock returns during the 2004-2020 period

- The index keeps its significance in presence of all well-known stock market returns predictors during the 2004-2020 period

- The option-based gold economic disaster index is a powerful predictor of stock returns during the 2004-2020 period
- The index keeps its significance in presence of all well-known stock market returns predictors during the 2004-2020 period
- The index can predict major macroeconomic and economic uncertainty indices during the 2004-2020 period

- The option-based gold economic disaster index is a powerful predictor of stock returns during the 2004-2020 period
- The index keeps its significance in presence of all well-known stock market returns predictors during the 2004-2020 period
- The index can predict major macroeconomic and economic uncertainty indices during the 2004-2020 period
- The Score index is a powerful predictor out-of-sample stock market returns during the 1986-2020 period