BANCO CENTRAL
DE LA REPÚBLICA ARGENTINA

Strategic Asset Allocation at BCRA: portfolio optimization & hedging against shocks

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CEMLA
XIII Reunión sobre Administración de Reservas Internacionales
Lima, Perú 11-13 Septiembre 2019

In 2017 BCRA developed a new SAA framework based on two pillars

1. *Portfolio's construction based on a macroprudential approach**

BCRA's objective function:

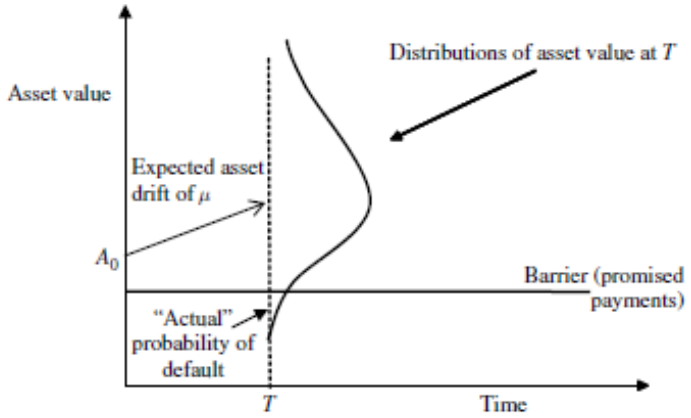
$$min\ Var(r) = \omega^2\sigma^2_{Act.Sint.} + (1-\omega)^2 w^T \Sigma w + 2\omega(1-\omega)\sigma^2_{Act.Sint.} w^T \beta$$

subject to:

$$1^T w = 1$$
$$E(r_i)^T w = \mu$$
$$w_i \geq 0\ \forall w_i$$
$$CVAR_{95\%}(r^T w) < CVAR_{limite\ 95\%}$$

CONTINGENT CLAIMS APPROACH TO MEASURING AND MANAGING SOVEREIGN CREDIT RISK

Dale F. Gray[a], Robert C. Merton[b] and Zvi Bodie[c]



2. *Expected returns&risk based on a factor-risk approach (BIS BAAM)*

BAAM BIS Asset Management Asset Allocation Module

BANK FOR INTERNATIONAL SETTLEMENTS

Central banks hold reserves for a variety of reasons, but mainly as a liquidity insurance to mitigate country exposure and vulnerability to external shocks

Rationale:

Emerging Market Economies (EMEs) tend to have current account deficits to smooth consumption intertemporally

↓

funding of these deficits requires ongoing capital inflows, which can suddenly stop

↓

If a sudden-stop occurs, the country's current consumption capacity is reduced and the marginal value of an extra unit of reserves increases significantly

↓

Prudent economies tend to build large war-chests of international reserves as a self-insurance mechanism

Theoretical framework*:

Central bank's objective function:

$$\max_{R_0,\pi} -\frac{\alpha}{2} E\left[(R_1 - K - 1\{SS\}Z)^2\right]$$

subject to:

$$\left.\begin{aligned} R_0 &= \pi P_0 + B_0 \\ R_1 &= B_1 + \pi P_1 \end{aligned}\right\} \quad R_1 = R_0 + \pi(P_1 - P_0).$$

where: R_1*=reserves level at date 1*
K=reserves target
1{SS}= 1 at sudden stop, 0 otherwise
Z>0 need for funds during SS

First order conditions:

$$R_0 = K + \Pr(SS)Z$$

$$\pi = Z\frac{Cov(1\{SS\}, P_1)}{Var(P_1)}$$

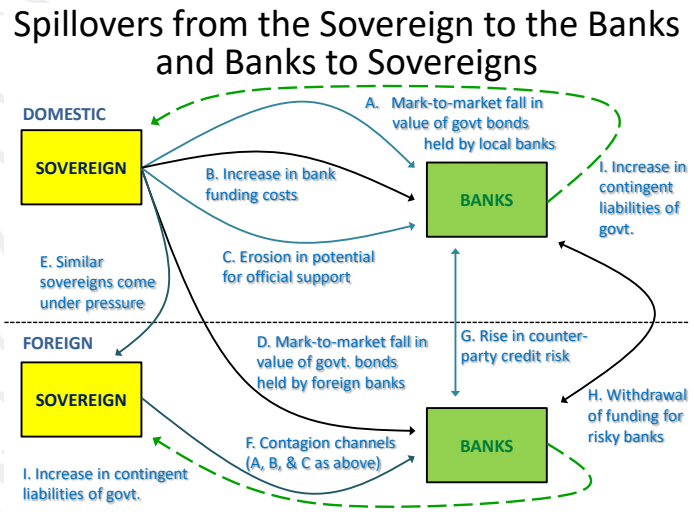
* Caballero&Panageas (2004)

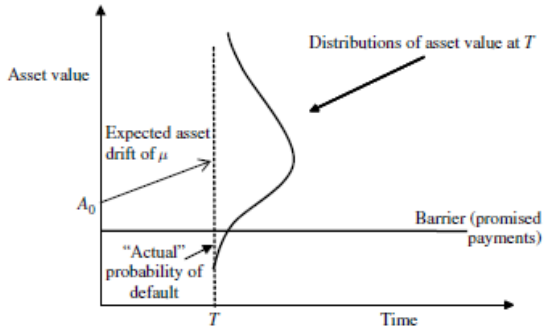
CB's reserves play a central role in ensuring economic stability. CCA balance sheet approach is a powerful tool to model this role.

Public Sector (Government and Monetary Authority)

TOTAL ASSETS	LIABILITIES
Foreign currency (including contingent foreign reserves)	**Financial guarantees** (modeled as put options related to too-important-to-fail financial and other entities)
Net fiscal asset and other public assets	**Foreign currency debt** (default-free value of debt minus put option)
Value of other public sector assets	**Base money and local currency debt** Held outside of the government and monetary authorities (call options on public sector assets)

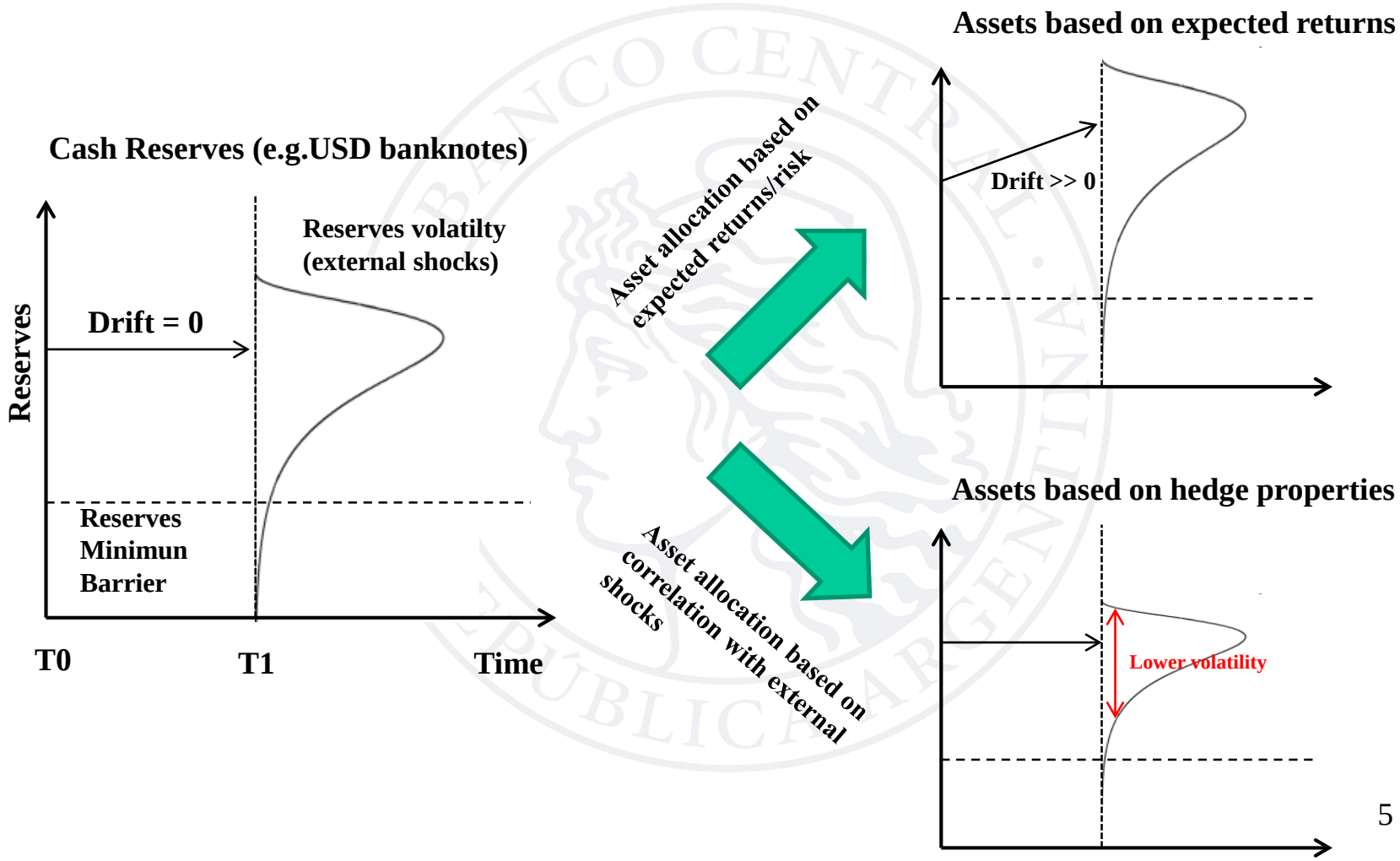
Figure 7.2 Interlinked CCA balance sheets for the economy: the public sector



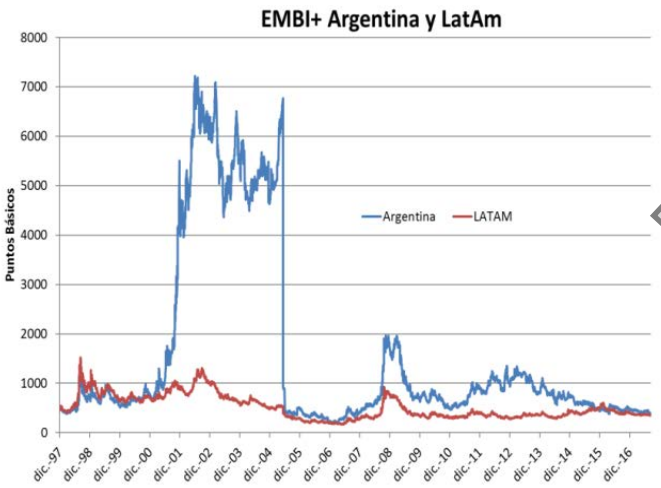


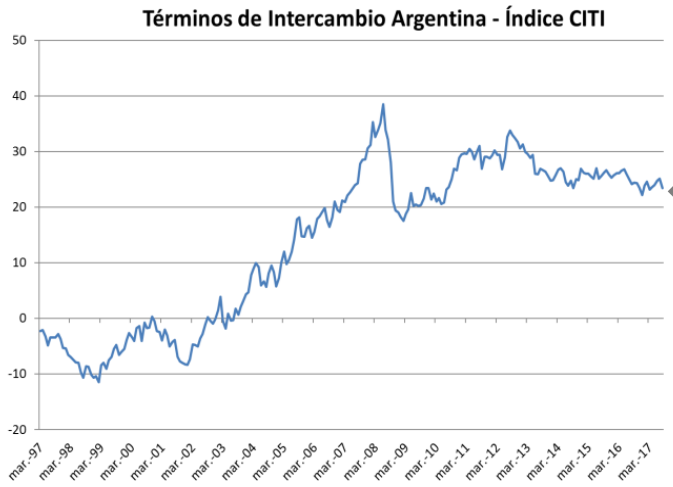
$$\text{Prob}\left(\varepsilon \le -\frac{\ln\left(\frac{A_0}{B_t}\right)+\left(\mu_A-\frac{\sigma_A^2}{2}\right)t}{\sigma_A\sqrt{t}}=-d_{2,\mu}\right)$$

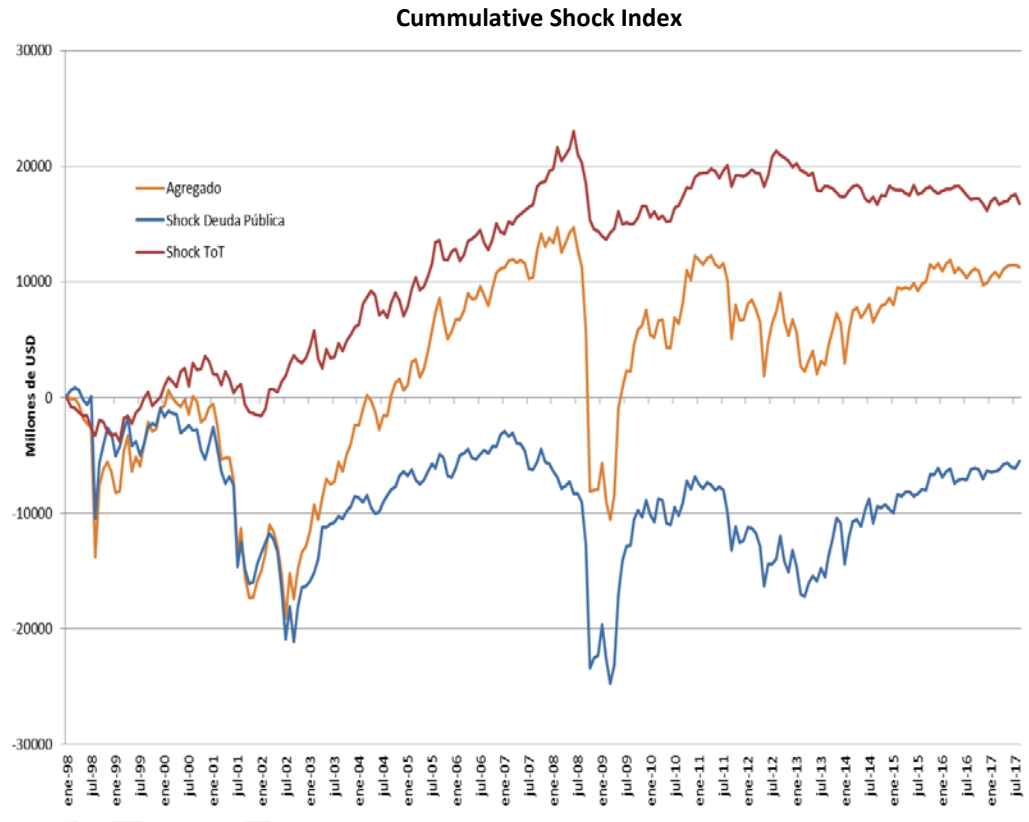
BCRA developed a new framework, where the role of reserves is expanded to include the hedge decision as part of the optimization process



BCRA's framework follows the model proposed in Gintschel&Scherer (2008), with a synthetic asset representing reserves' exposure to external shocks







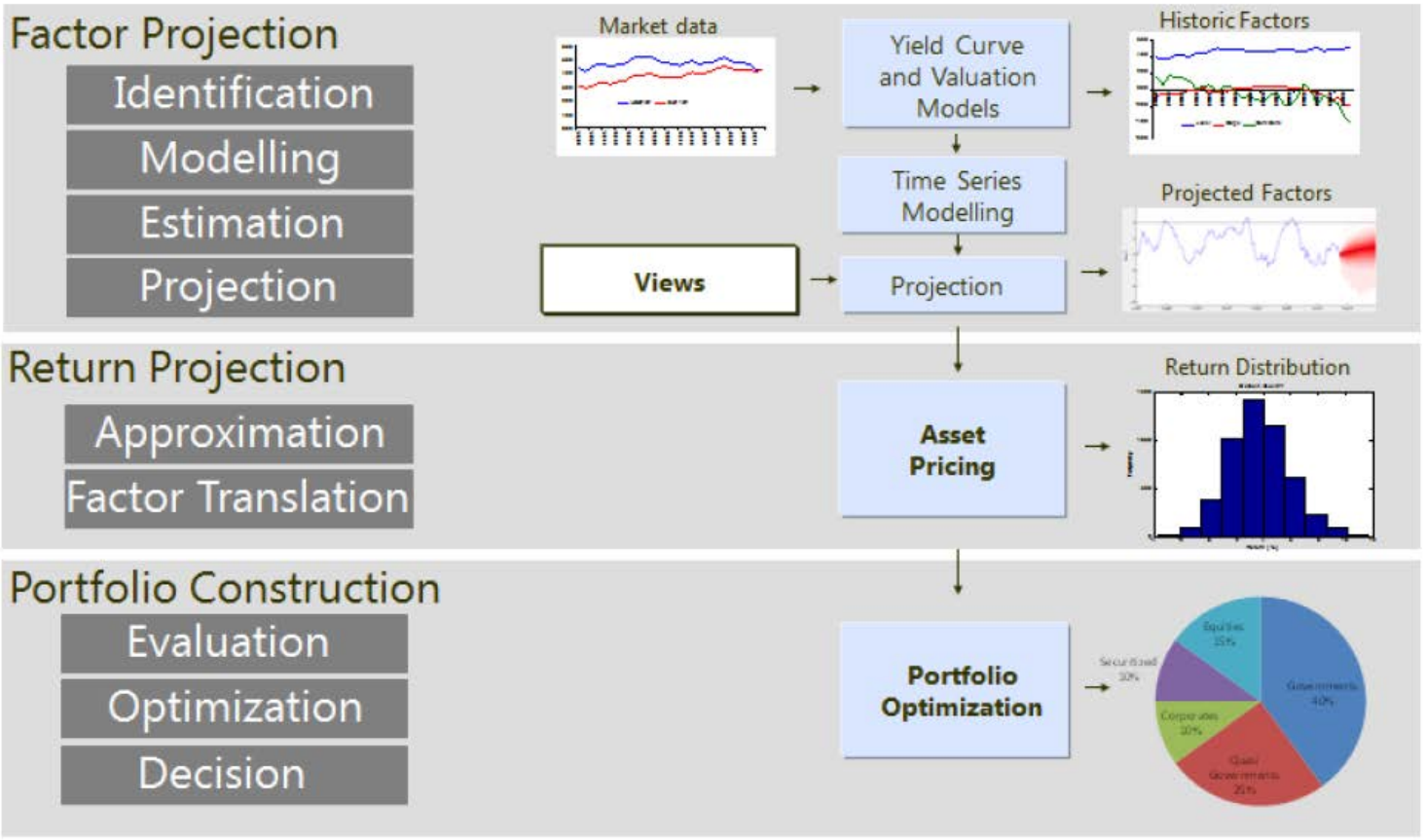
Expected returns and covariances are derived using BAAM

BAAM (BIS Asset Allocation Module)

Step 1

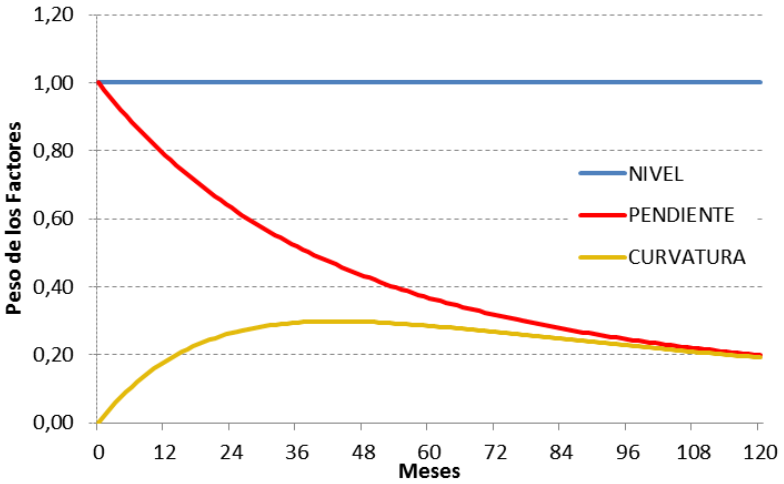
Step 2

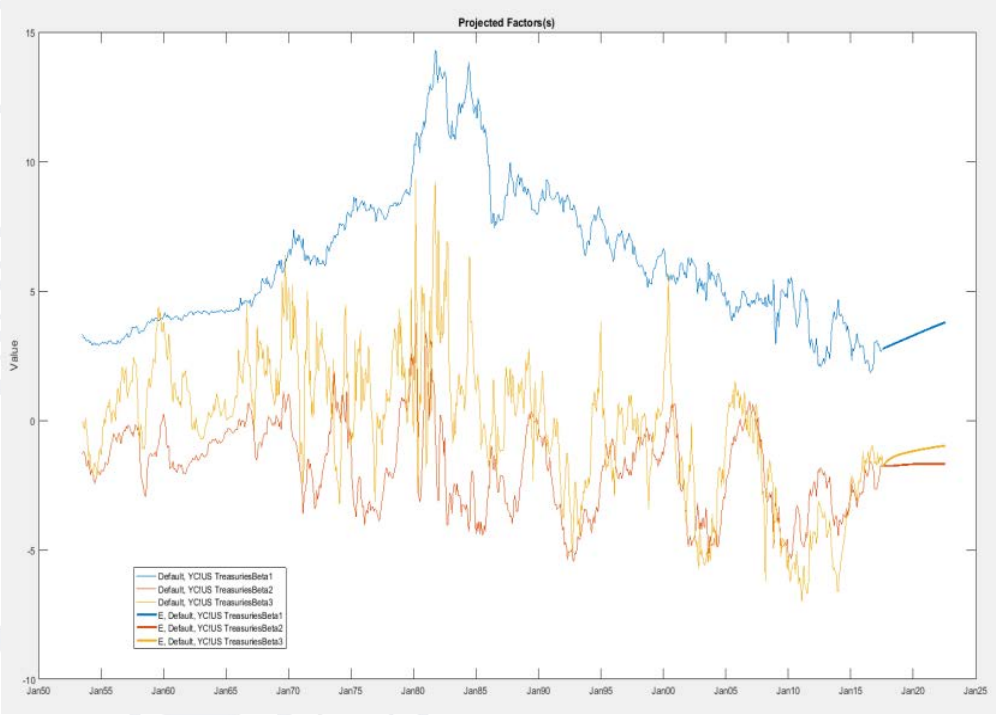
Step 3



Step 1: yield curves are modeled through various alternatives derived from Nelson-Siegel model (with/without shadow rates, rotated)

$$rate(\tau) = Long\ Rate + (-Slope).\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + Curvature.\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right)$$





Rotation
Nyholm (2015)

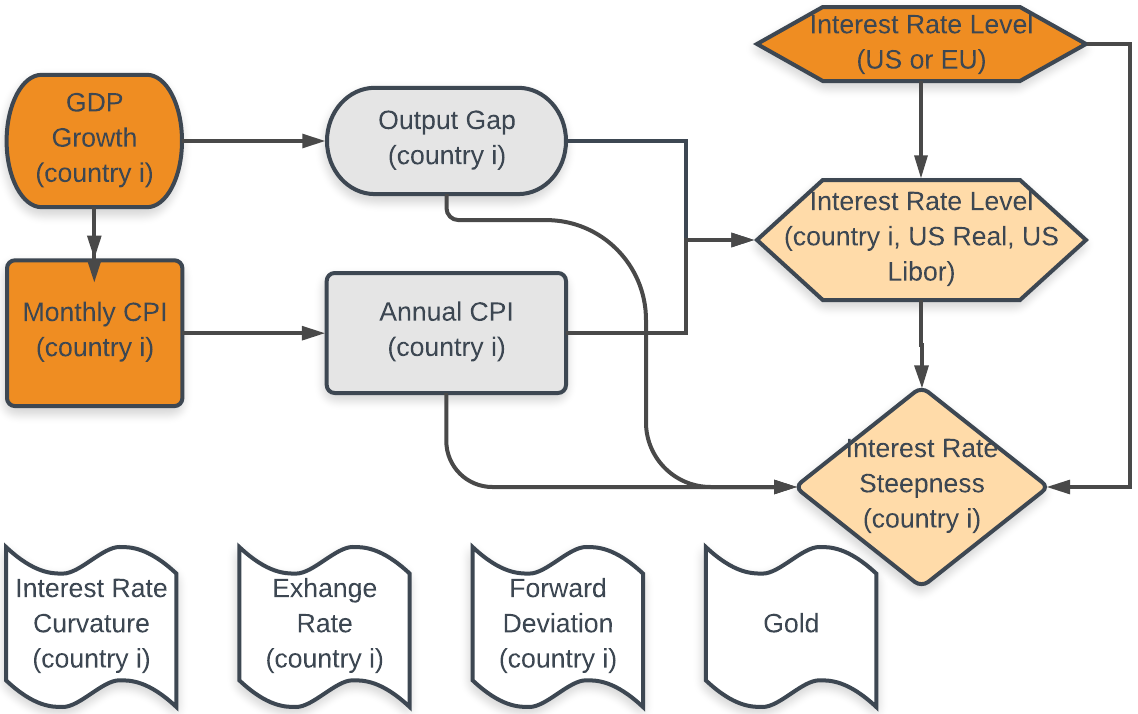
$$\begin{bmatrix} Short\ Rate \\ Slope \\ Curvature \end{bmatrix} = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} Long\ Rate \\ -Slope \\ Curvature \end{bmatrix}$$

Short Rate

$$\gamma_{1,t} = \beta(E_t[\pi_{t+1}] - \pi_*) + \gamma x_t + \epsilon_t$$

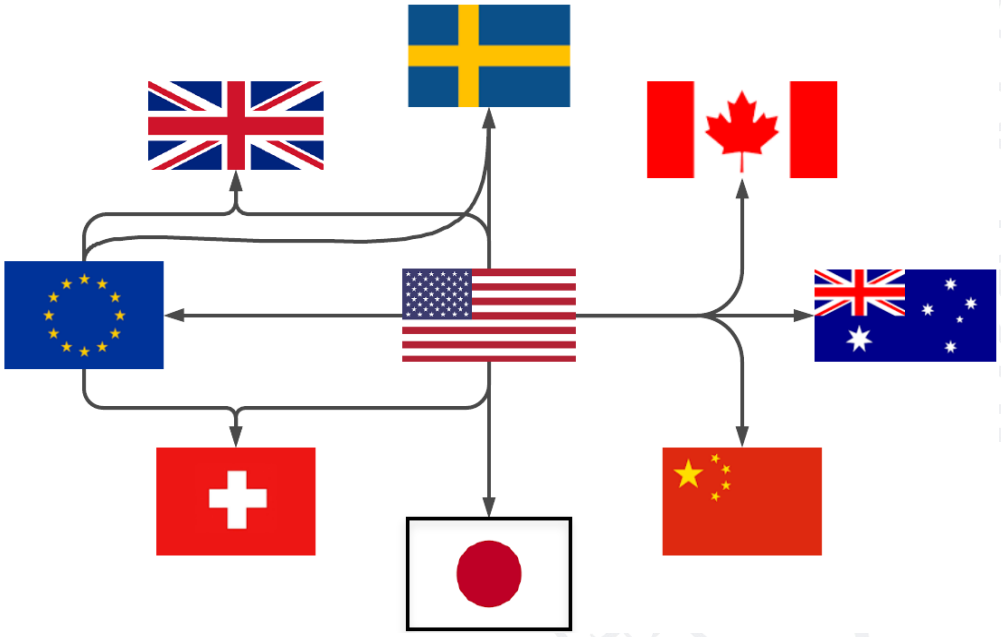
$Et[\pi t+1]$ – Expected Inflation
$\pi*$ - Inflation Target
xt - Output gap

The yield curve is modelled through growth (output gap), inflation and other yield curves linkages

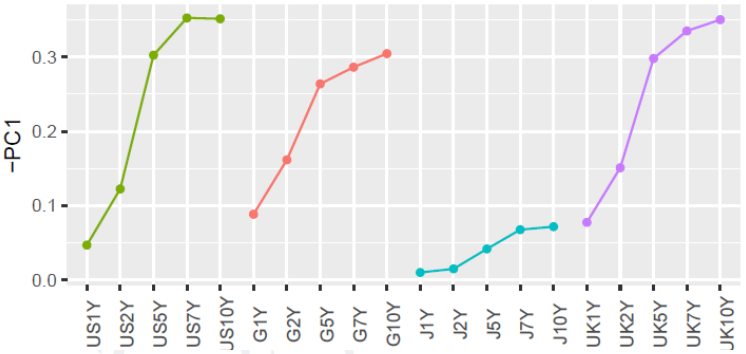


For countries: United States, European Union, United Kingdom, Japan, Canada, Australia, Sweden, China, Switzerland

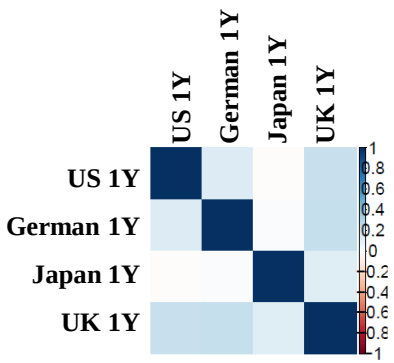
The links between yield curves interregionally were included in the model customized by BCRA

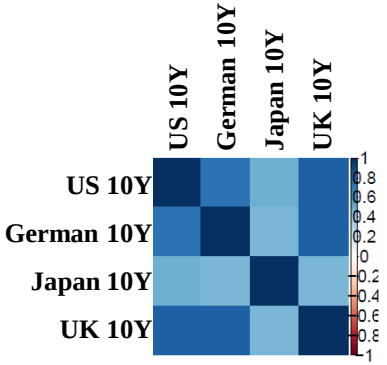


First Principal Component Loadings

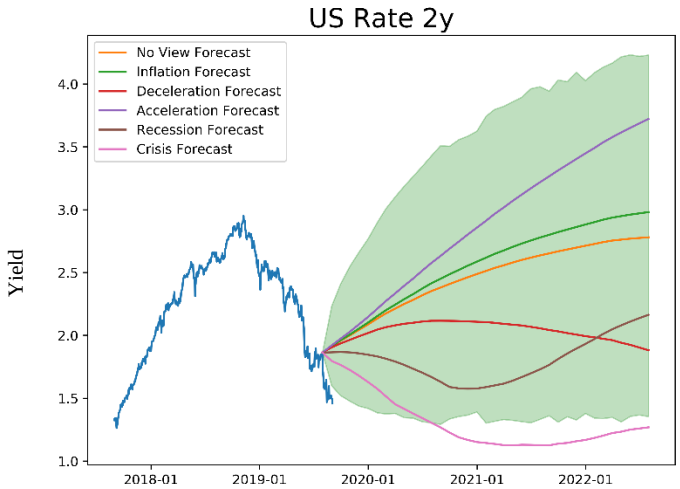


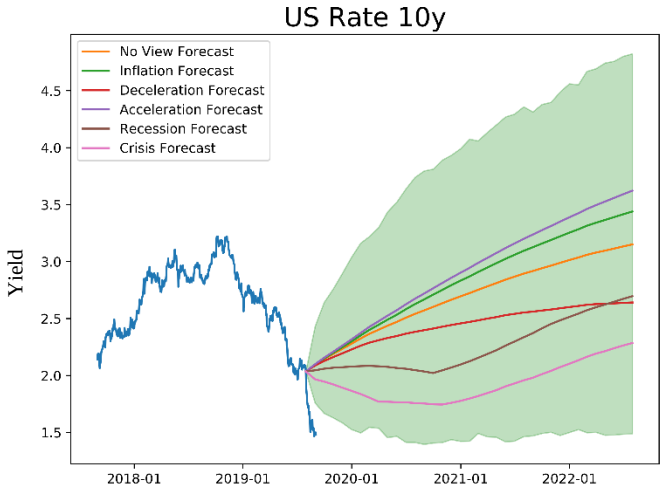
Correlation matrix by maturity

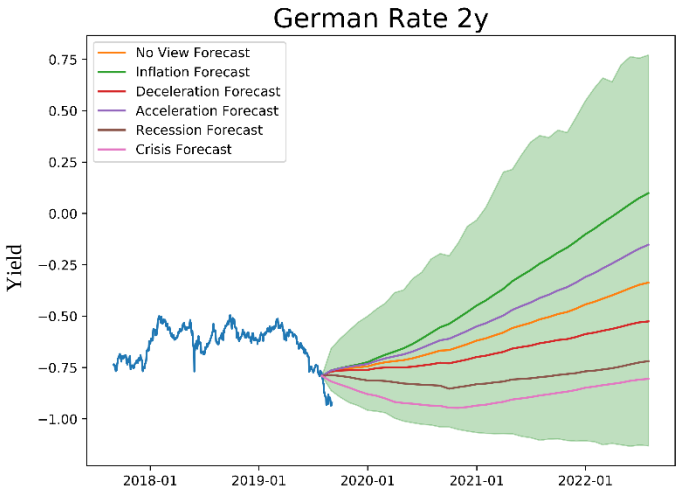


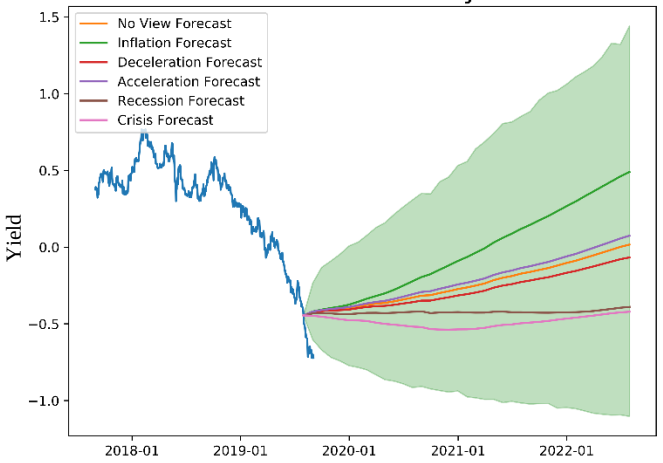


Step 2: expected returns and distributions are projected under different scenarios







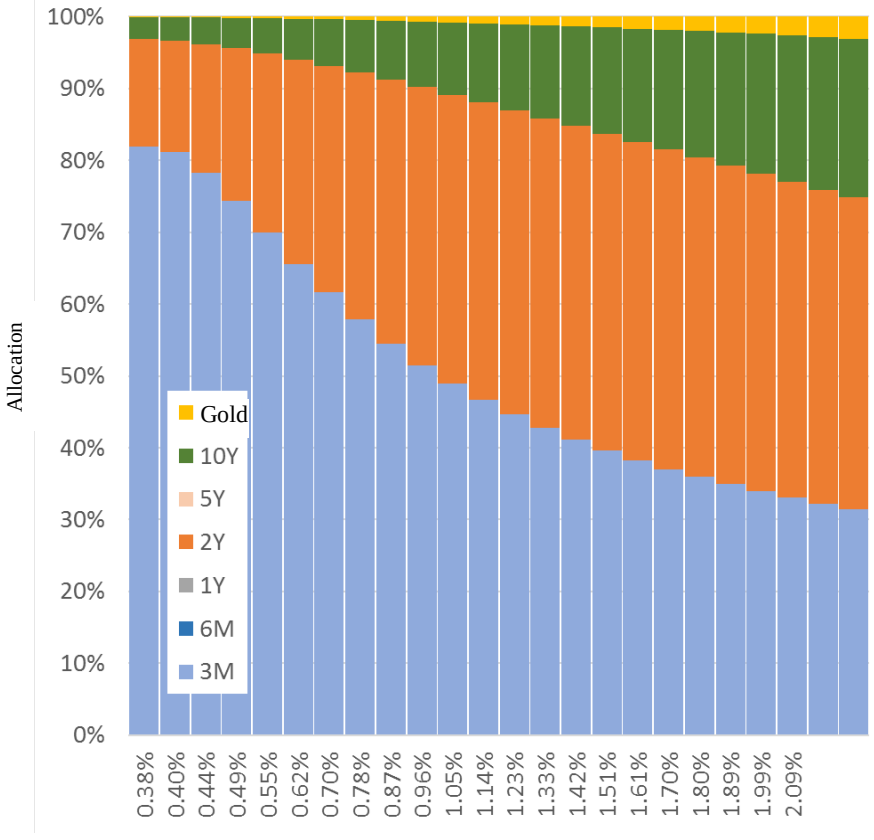


Step 3: the efficient portfolios are constructed considering the hedge provided to external shocks

Efficient Frontiers by duration bucket

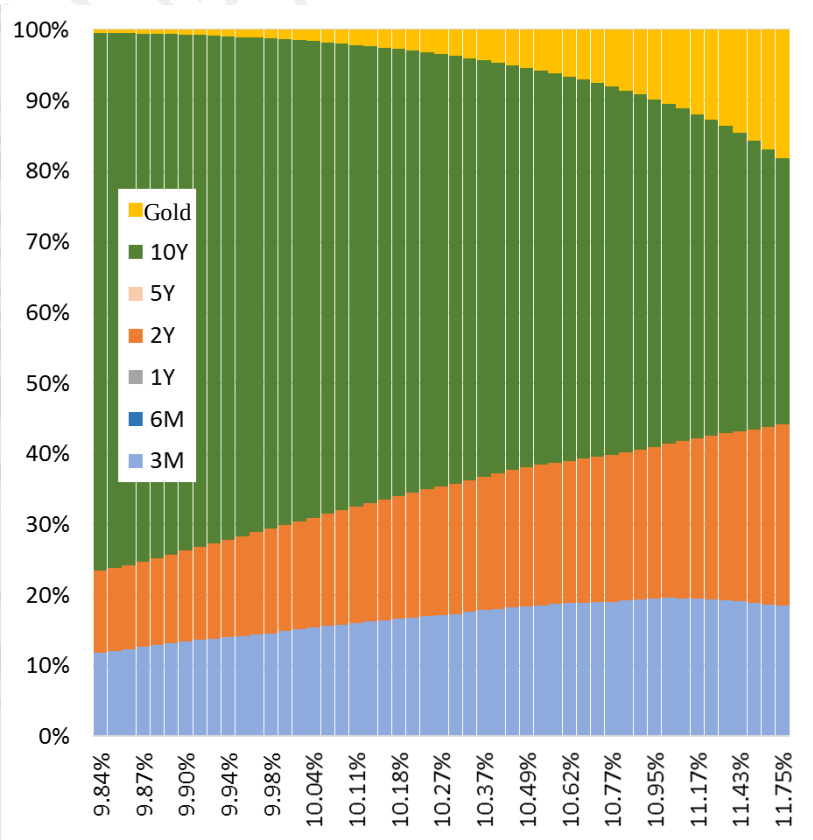
Traditional optimization (without shocks)

$$min\ Var(r) = w^T \Sigma w$$



Optimization with shocks

$$min\ Var(r) = \omega^2 \sigma^2_{Shocks} + (1-\omega)^2 w^T \Sigma w + 2\omega(1-\omega)\sigma^2_{Shocks} w^T \beta$$



Including external shocks allows to have a better understanding about asset classes to prevent procyclical behaviors…

	US Gov 10Y	CA Gov 2Y - Hedged	US Gov 2Y	DE Gov 10Y - Hedged	UK Gov 10Y - Hedged	AU Gov 10Y - Hedged	AU Gov 2Y - Hedged	SE Gov 10Y - Hedged	UK Gov 2Y - Hedged	JP Gov 10Y - Hedged	CA Gov 10Y - Hedged	DE Gov 2Y - Hedged	JP Gov 10Y	CH Gov 3M	UK Gov 10Y	CHF Gov 10Y - Hedged	JP Gov 2Y	JP Gov 3M	CHF Gov 10Y	CHF Gov 2Y	DE Gov 10Y
Correlaciones																					
Asset shock	-0.23	-0.21	-0.20	-0.19	-0.19	-0.15	-0.15	-0.13	-0.12	-0.11	-0.09	-0.07	-0.04	-0.04	-0.04	0.00	0.01	0.01	0.02	0.03	0.04
Terms of Trade	-0.16	-0.19	-0.16	-0.15	-0.14	-0.05	-0.13	-0.03	-0.06	-0.11	-0.01	-0.12	0.00	0.07	-0.08	0.00	0.06	0.07	0.09	0.11	0.06
EMBI+	-0.18	-0.14	-0.12	-0.13	-0.11	-0.16	-0.13	-0.13	-0.09	-0.06	-0.11	-0.03	-0.07	-0.11	0.05	0.01	-0.04	-0.04	0.00	0.01	0.06
Asignaciones																					
No Asset Shock	0.4%	0.6%	1.7%	2.9%	0.1%	1.7%	1.2%	1.0%	0.2%	0.2%	0.8%	26.4%	0.0%	2.2%	0.0%	0.0%	0.2%	0.9%	0.0%	0.2%	0.2%
Asset Shock	6.7%	1.8%	9.1%	3.6%	0.8%	2.8%	1.0%	0.8%	3.2%	3.3%	0.5%	16.9%	0.4%	3.2%	0.1%	0.2%	1.3%	2.0%	0.1%	0.3%	0.2%
Difference	6.3%	1.2%	7.3%	0.7%	0.8%	1.1%	-0.2%	-0.3%	2.9%	3.1%	-0.3%	-9.5%	0.4%	1.0%	0.1%	0.2%	1.1%	1.0%	0.1%	0.1%	0.0%

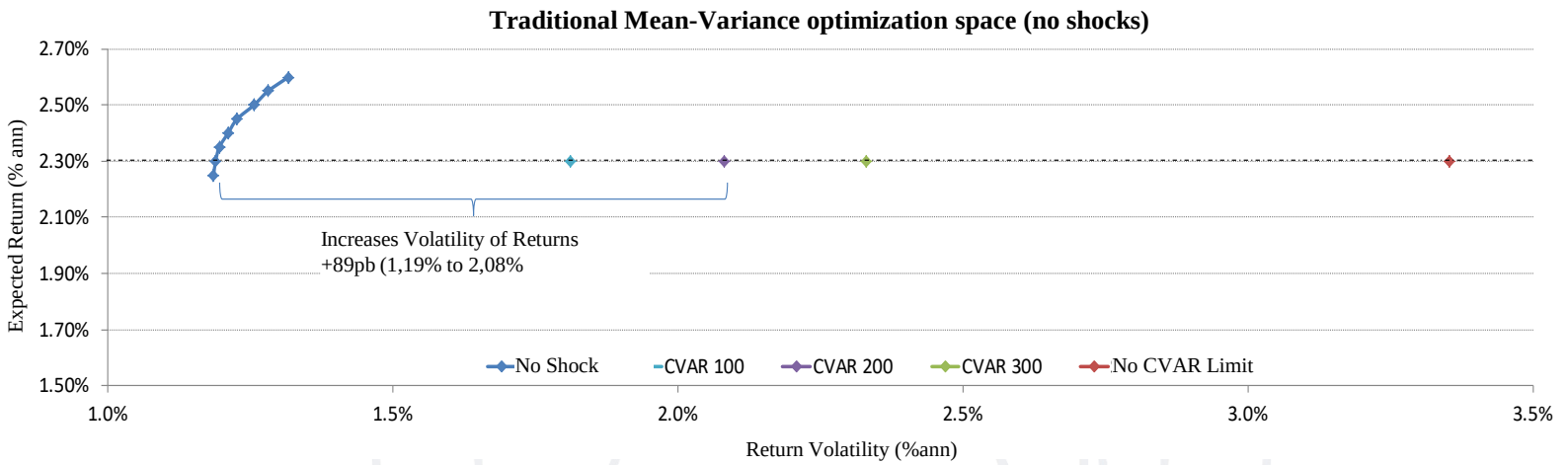
	US Gov IL 10Y	UK Gov 2Y	US Gov IL 5Y	JP Gov 2Y - Hedged	CH Gov 3M - Hedged	UK Gov 3M	SE Gov 2Y - Hedged	CHF Gov 2Y - Hedged	DE Gov 2Y	US Libor 3M	UK Gov 3M - Hedged	US Gov 3M	CA Gov 10Y	DE Gov 3M	JP Gov 3M - Hedged	SE Gov 10Y	DE Gov 3M - Hedged	CA Gov 2Y	SE Gov 2Y	AU Gov 10Y	AU Gov 2Y
Correlaciones																					
Asset shock	0.10	0.10	0.10	0.11	0.13	0.14	0.15	0.16	0.17	0.17	0.17	0.18	0.18	0.19	0.19	0.21	0.21	0.28	0.30	0.38	0.49
Terms of Trade	0.16	0.02	0.14	0.06	0.13	0.04	0.15	0.14	0.16	0.12	0.14	0.11	0.15	0.18	0.15	0.21	0.15	0.17	0.25	0.33	0.38
EMBI+	0.06	0.16	0.08	0.06	0.07	0.18	0.06	0.11	0.15	0.11	0.15	0.13	0.17	0.16	0.12	0.14	0.16	0.29	0.23	0.28	0.39
Asignaciones																					
No Asset Shock	0.2%	0.0%	6.2%	2.1%	3.3%	1.3%	0.0%	0.1%	0.4%	2.8%	5.2%	17.2%	0.4%	0.5%	4.6%	0.3%	12.2%	1.2%	0.0%	0.3%	0.4%
Asset Shock	1.9%	0.4%	7.0%	5.3%	1.7%	2.0%	0.1%	0.2%	0.6%	4.6%	2.2%	7.5%	0.1%	0.8%	2.9%	0.1%	4.1%	0.3%	0.0%	0.0%	0.0%
Difference	1.7%	0.4%	0.8%	3.2%	-1.6%	0.7%	0.1%	0.1%	0.2%	1.8%	-3.0%	-9.7%	-0.3%	0.3%	-1.7%	-0.2%	-8.1%	-0.9%	0.0%	-0.3%	-0.4%

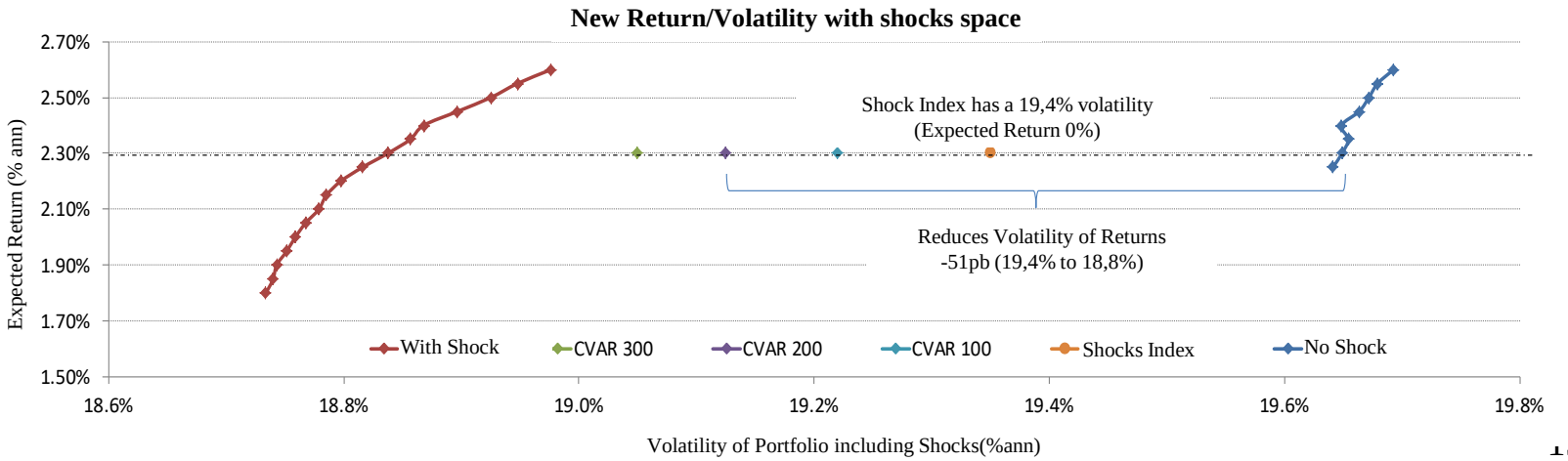
…and help to identify vulnerabilities under stressed scenarios to credit risk, asset classes and other exposures depending on the investment horizon selected

Investment Horizon	1 Year Horizon		3 Year Horizon	
Name / Duration	1-3 Y	3-5 Y	1-3 Y	3-5 Y
ICE BofAML AAA US Corporate Index	0,11	0,12	-0,30	-0,14
ICE BofAML AA US Corporate Index	0,18	0,21	-0,26	-0,09
ICE BofAML Single-A US Corporate Index	0,48	0,41	0,12	0,13
ICE BofAML BBB US Corporate Index	0,53	0,50	0,23	0,21
ICE BofAML AAA US Fixed Rate CMBS Index	0,21	0,38	-0,22	0,04
ICE BofAML AA US Fixed Rate CMBS Index	0,31	0,51	0,01	0,17
ICE BofAML Single-A US Fixed Rate CMBS Index	0,54	0,54	0,15	0,16
ICE BofAML BBB US Fixed Rate CMBS Index	0,53	0,46	0,18	0,16
ICE BofAML US Mortgage Backed Securities Index	-0,01	-0,05	-0,23	-0,09

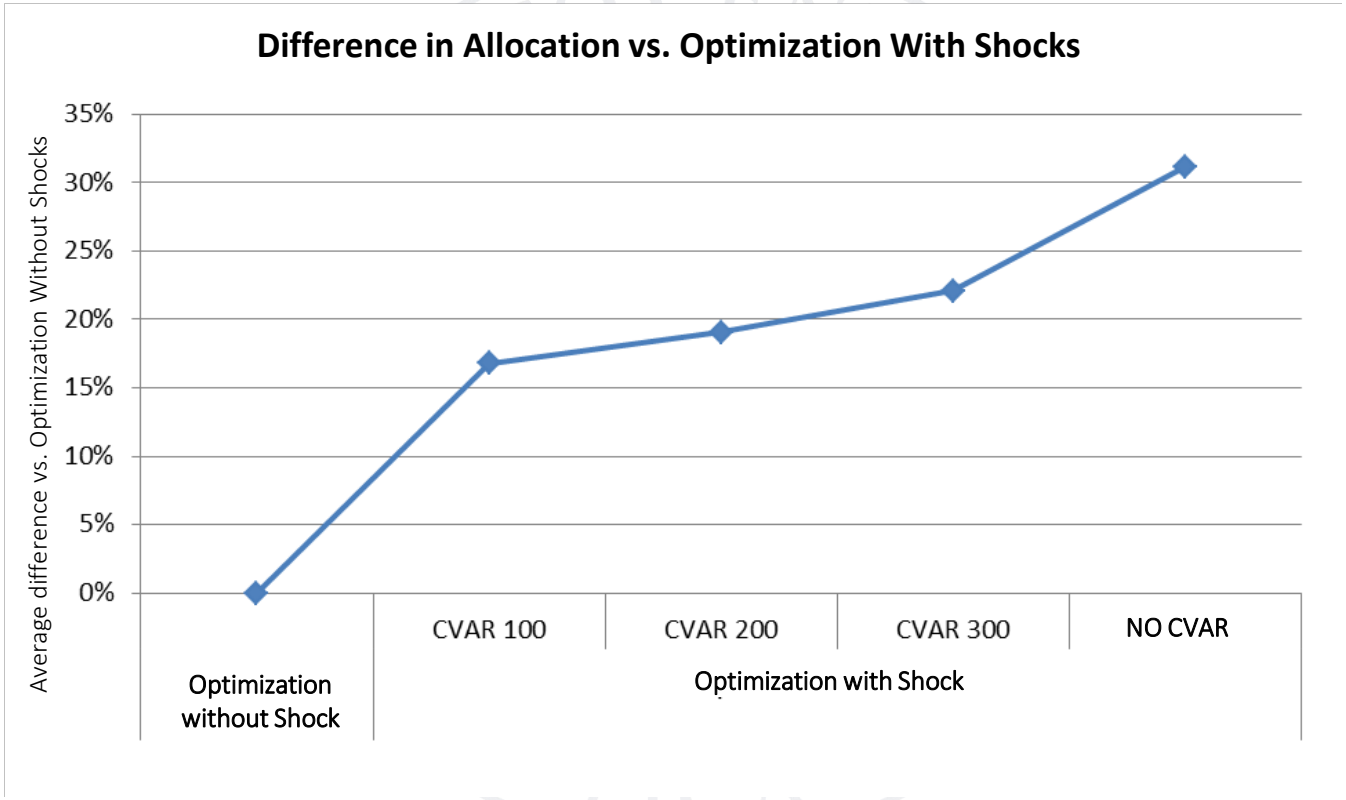
Name	1 Year Horizon	3 Year Horizon
ICE BofAML 0-1 Year US Treasury Index	-0,11	0,09
ICE BofAML 1-3 Year US Treasury Index	-0,35	-0,50
ICE BofAML 3-5 Year US Treasury Index	-0,29	-0,44
ICE BofAML 5-7 Year US Treasury Index	-0,28	-0,34
ICE BofAML 7-10 Year US Treasury Index	-0,26	-0,21

But hedging external shocks is not an easy task: there is a trade-off between immunization and the risk of the financial assets' portfolio

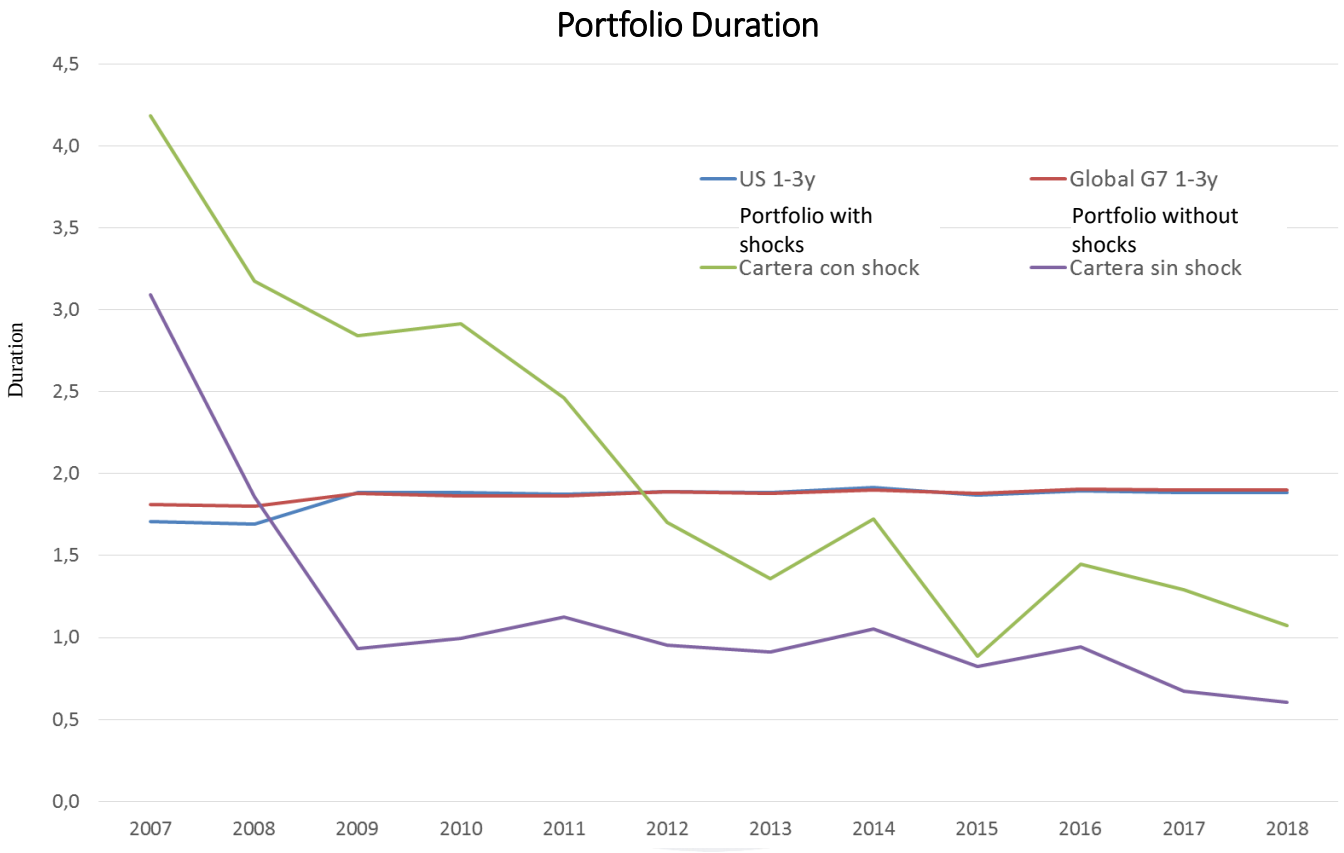




The lower the tolerance for risk in the financial assets' portfolio, the higher the optimization resembles a traditional one



When backtested during the last 10 years, an optimization including shocks would have suggested a higher duration than the one without shocks, allowing a better performance and immunization of the reserves portfolio



Thank you!

References:

•Caballero, R. J., and S. Panageas (2004): “Contingent Reserves Management: An Applied Framework,” NBER Working Papers: 10786.
•Caballero, R. J., and S. Panageas (2005): “A Quantitative Model of Sudden Stops and External Liquidity Management”
•Gintschel, Andreas and Scherer, Bernd (2008): “Optimal asset allocation for sovereign wealth funds” Vol. 9, 3, 215–238 Journal of Asset Management
•Gray, D., Merton, R. and Bodie, Z. (2007): “Contingent Claims approach to measuring and managing sovereign credit risk” Vol. 5, No. 4, pp 5-28 Journal of Investment Management