# For Those Who Want It All... Salience and Behavioral Financial Engineering in the French Financial Retail Market of the Early 2000s

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*This paper presents an in-depth analysis of the BNP Garantie JET 3, a complex retail structured product that was marketed in France in the early 2000s. To understand the risk-return profile of the JET 3 contract, we simulate the distribution of its payoffs. Then we show that the demand for the JET 3 is hard to explain with standard risk-return preferences, since the product is usually dominated by others simpler portfolios. This is no longer the case if we assume that the investor has a "salience bias (Bordalo et al., 2012), i.e. a tendency to overweight salient payoffs. This is due to the fact that the JET 3 has two built-in features that are very attractive for a salient-biased investor: full insurance and very high payoffs in the good states. We show that the JET 3 dominates the relevant alternatives if the salience bias is big enough. We conclude that the JET 3 might be a good instance of behavioral financial engineering, i.e. the design of complex financial products that take advantage of the investors' behavioral biases to shroud risk and high fees.*

## INTRODUCTION

In the late 1990s, the main French commercial banks introduced a new class of financial product : the formula-based funds ("fonds à formule"). The formula-based funds had fancy names (*Doubl'ô*, *JET3*, *Bénéfic*, *Jayanne 4* ...) and very attractive features : a promise of high performance and capital insurance. The formula-based funds were structured products i.e. a combination of a zero coupon bond and an exotic option. These highly sophisticated products were sold to unsophisticated middle class savers (small traders, young pensioners, employees) who were attracted by the high returns of the stock markets, but did not want to take the risk of a capital loss. Alas, the formula-based funds performed badly, as most of the contracts were closed after the 2007 financial crisis. Moreover, many investors discovered that the capital warranty was sometimes partial (30% losses were not uncommon), others got back their investment *minus* subscription and management fees (up to 10% of the initial investment). Three of the biggest French commercial banks were later sued by the investors for "misleading commercial practices".[1]

The story of the French formula-based funds is far from being unique, and many financial institutions have been sued for similar reasons throughout the world in the late 2000s. Yet, the motive of the lawsuits (the unfulfilled capital warranty) is somewhat misleading as it leaves out other relevant issues such as fees or the poor returns of the contracts. A more fundamental issue might be why do banks sell such highly complex and speculative products to small investors, and, as a corollary, why do small investors buy them?

Financial complexity can be seen as an innocuous byproduct of financial innovation. New financial products are developed to improve risk sharing and allow a better match between issuers and investors (Allen and Gale, 1994). Their complexity is a natural consequence of the investors' increased sophistication. Yet this argument is not very convincing in retail financial markets, given the low level of financial literacy of the average small investor (Lusardi and Mitchell, 2014). A growing theoretical literature provides other, darker, rationales for the increased complexity of the financial retail products. Gabaix and Laibson (2006) show how competitive firms may use add-on pricing to shroud the true price of their product. This applies to markets where customers have a limited understanding of the full characteristics of the product such as retail banking. Banks compete by providing the basic service (the account) free of charge, and then take advantage of the "naiveté" of their customers by levying high fees for the add-ons (ATM usage fees, bounced check fees, minimum balance fees ...). Carlin (2009) and Ellison and Wolitzky (2012) take this logic one step further, by showing that price complexity is also a strategic variable that can be used to extract rents from customers. Both models are based on the insights of Diamond (1971). Customers that face high search cost have few incentives to search for a better price if they expect firms to charge high prices, and firms that charge high prices have few incentives to cut prices when customers do not search. Obfuscation (increasing the complexity of the pricing structure) increases the search costs, by reducing the comparability of the products. This generates an equilibrium where obfuscation is used by the firms to increase their market power.

However this line of explanation has a major weakness : why do consumers put up with complexity? Other things being equal, customers should favor simple financial products, which are easier to understand and compare. This implies that complex products must pay some kind of complexity premium to be competitive. Furthermore the supply-side complexity theory does not say anything on the nature of complexity. Firms sell complex products, with complex pricing structures to maintain customer's confusion. This implies that any kind of complexity will do. So why use structured products, when simpler products might be enough to confuse financially illiterate customers ?

Several recent papers, both theoretical and empirical, give us valuable insights on these issues. Célérier and Vallée (2017) investigate the rationale for issuing complex securities to retail investors, using a large data set on European structured products[2]. They show that structured products with complex payoff formulas offer higher headline rates, but also expose investors to higher risks. High headline-rates and more complex products are also more profitable to the banks, since they pay higher fees. They conclude that banks use complexity to cater to yield-seeking households, by making returns more salient and by shrouding risk. [3]

Bordalo et al. (2012, 2013) present a framework that gives strong theoretical foundation to the concept of salience, and show how salience may be a major determinant of the demand of financial assets. The salience hypothesis postulates that individuals overweight salient payoffs when they compare lotteries. This implies that risk attitudes are context dependent. Individuals are risk seeking when the lottery upside is salient, and risk averse when the downside is salient. It follows that securities with large salient upsides will tend to be overvalued, which gives strong incentives to financial institutions to select or design such securities.

The salience hypothesis may explain the banks's fondness for structured products. Thanks to their extraordinary flexibility, structured products can be tailored in a way that showcases some attractive features (insurance, the possibility of earning a big payoff...) while hiding the unwanted ones (risk, poor average performance...).

This paper intends to investigate this conjecture within the framework of the Bordalo et al. (2012, 2013) model. To this end we focus on the *Altiplano* funds, which were a successful family of French formula funds in the late 1990s and early 2000s. The paper is structured around two questions. First, we ask whether investing in an *Altiplano* fund can be justified for individuals with standard preferences (CRRA). Then we do the same within the salience model of Bordalo et al. (2012, 2013).

The first question is motivated by the peculiar risk-return mix of the *Altiplano* funds, which can be characterized as full insurance plus a highly speculative bet. One may assume that full insurance should be appealing for risk-adverse middle-class individuals. But those same individuals should also shun exotic options with a high probability of poor returns. Conversely, risk-seeking individuals should appreciate the spectacular returns of the *Altiplano* option in the good states, and loath the loss of opportunities caused by the full insurance feature.

To find the risk-return preferences that justify the choice of an *Altiplano* contract, we simulate the distribution of its payoffs, as well as several alternative portfolios (based upon the option's underlying asset). Then we compute the utility that arise from those payoff distributions, using different CRRA utility functions. This enables us to rank the portfolios using a vast number of risk-return combinations. Our main result is that the *Altiplano* fund is never the first choice of a rational individual with standard CRRA preferences.

Then we rank those same portfolios using the salience approach of Bordalo et al. (2012, 2013). We show that the *Altiplano* fund dominates the other portfolios if the salience distorsion is big enough. This result is robust, since it holds for a vast range of risk-return preferences. The paper is organized as follows.

Section 2 gives a short presentation of Bordalo et al. (2012, 2013) model, and explains how assets can be selected (or tailored) to take advantage of the salience bias.

Section 3 gives a detailed presentation of the general structure of the *Altiplano* formula funds, and the specifics of the contract that we will simulate : the *BNP Garantie JET3*, which was marketed by the BNP in 2001. This section also gives an estimate of the fair price of the *Altiplano* options, as well as the fees levied on the *JET3* contract, using a Monte Carlo Simulation.

Section 4 presents the simulation method and the ranking of the alternative portfolios using standard preferences. It shall be noted that the Bordalo et al. (2012, 2013) model works with discrete probability distributions, which rules out the use of probability distributions generated through a classic Monte Carlo process. To get around this difficulty, we use a variant of the method of Cox et al. (1979) to create a recombinant binomial tree with $n$ branches. Then we use this highly stylized framework to price the options, and to simulate the expected distributions of the payoffs of the alternative portfolios.

Section 5 presents the estimation of the impact of salience on the valuation of the alternative portfolios, and evaluates the robustness of the result. We also address the issue of behavioral pricing (was the fee strategy devised to exploit the salience bias?)

Section 6 concludes.

## SALIENCE AND BEHAVIORAL FINANCIAL ENGINEERING

Bordalo et al. (2013) present a theory of choice under uncertainty based upon salience. Their main assumption is that, in comparisons of risky lotteries, individuals overweight salient payoffs (those payoffs that are much bigger or much smaller than the average) relative to their objective probability. This implies that risk attitudes are context dependent. Individuals are risk seeking when the lottery upside is salient and risk averse when the downside is salient.

Bordalo et al. (2013) use the salience theory to analyse the demand for risky assets. They show that the salience hypothesis can explain several well known puzzles such as the growth-value puzzle. Salience implies that the investors put more weight on the payoffs that stand out. Growth stocks are overpriced because they have a large upside (with a low probability), value stocks are underpriced because their downside (bankrupcy) is salient (in spite of his low probability). Note that the salience hypothesis also gives a simple and elegant explanation of the equity premium.

Another interesting implication is that financial intermediaries have an incentive to select (or design) assets that have large upsides, in order to hide high fees. The next two subsections explain how. First we give a short presentation of the Bordalo et al. (2013) framework to show how salient thinking distorts the valuation of a financial asset. Then we show how to use salience to select (or design) an overvalued asset.

**The Salience Model of Bordalo et al. (2013)**

Let us assume that there are $S$ states of nature $s = 1,..,S$, each occurring with probability $\pi_s$, with $\sum_{s=1}^{S} \pi_s = 1$. The asset pays $x_s$ in state $s$. The salience of payoff $x_s$ depends on how it compares with the average market payoff $\bar{x}_s$.

Following Bordalo et al. (2013) we assume that the salience function is :

$$\Gamma(x_s, \bar{x}_s) = \frac{|x_s - \bar{x}_s|}{x_s + \bar{x}_s + \theta} \quad (1)$$

with $\theta \geq 0$. This implies that salience is an increasing function of the percentage difference between $x_s$ and the market payoff $\bar{x}_s$, with $\Gamma(x_s, \bar{x}_s) \leq 1$. The parameter $\theta$ reduces the salience of a zero payoff, which is equal to one (the maximum) otherwise, since $\Gamma(0, \bar{x}_s) = 1/(1+\theta)$. [4]

States are ranked by salience (state $s$ is more salient than state $s'$ if $\Gamma(x_s, \bar{x}_s) > \Gamma(x_{s'}, \bar{x}_{s'})$). Let $m_s \in \{1,2,..,S\}$ be the rank of the state $s$ payoff (a lower $m_s$ indicates higher salience) [5]. Salient states are given a higher subjective probability. If, for instance, states $s$ and $s'$ have respective ranks $m_s < m_{s'}$, salient thinking distorts the objective relative odds $\pi_s/\pi_{s'}$ into $\tilde{\pi}_s/\tilde{\pi}_{s'}$, where :

$$\frac{\tilde{\pi}_s}{\tilde{\pi}_{s'}} = \left(\frac{1}{\delta}\right)^{m_{s'} - m_s} \frac{\pi_s}{\pi_{s'}} > \frac{\pi_s}{\pi_{s'}} \quad (2)$$

with $\delta < 1$ and $\sum_{s=1}^{S} \tilde{\pi} = 1$. The distorted (subjective) probability of state $s$ therefore writes :

$$\tilde{\pi}_s = \omega_s \pi_s \quad (3)$$

where $\omega_s = \delta^{m_s} / \sum_{s'=1}^{S} \delta^{m_{s'}} \pi_{s'}$. The discount factor $\delta$ parametrizes the impact of salience on the weighting of the relative odds. $\omega_s$ measures the decision weight attached by the individual to state $s$. State $s$ is overweighted (underweighted) if $\omega_s > 1$ ($\omega_s < 1$). Overweighting occurs when the state $s$ is sufficiently salient to be less discounted than the average ($\delta^{m_s} > \sum_{s'=1}^{S} \delta^{m_{s'}} \pi_{s'}$).

The distorted value of the asset is therefore : [6]

$$\tilde{V} = \sum_{s=1}^{S} \omega_s \pi_s x_s \quad (4)$$

which may be greater or smaller than the real value $V = \sum_{s=1}^{S} \pi_s x_s$.

**Tayloring Assets to Increase their Perceived Value**

Salience theory implies that the investor's willingness to pay is context dependent. Assets that have large salient upsides will tend to be overvalued, whereas assets with salient downsides will be shunned by investors. This implies that financial intermediaries have strong incentives to select (or design) assets with large salient upsides. This section explains how this can be done.

Assume that the market has three equiprobable states : *good*, *average* and *bad*. Gross returns are, respectively, $R_M + \Delta$, $R_M$ and $R_M - \Delta$. The market gross return is, therefore, $R_M$, with standard deviation $\sigma_M = \Delta\sqrt{2/3}$. It will prove convenient to have some specific numbers. We therefore assume that $R_M = 1.25$ and $\Delta = .5$, for a three year investment (which corresponds to an annual net return $\approx$ 8.26%, with an annual standard deviation $\approx$ 23,57%).

We now turn to the asset. To increase the salience of the upside, we must transfer towards the *good* state, some of the payoffs of the two other states (for the sake of simplicity, we will restrict our demonstration to assets that yield the market expected return $R_M$). We therefore assume that the asset yields $R_M + \gamma\Delta$ in the *good* state, $R_M - \alpha\gamma\Delta$ in the *average* state, and $R_M - (1-\alpha)\gamma\Delta$ in the *bad* state, with $\alpha \in ]0,1[$ and $\gamma > 1/(1-\alpha)$. By (1), the salience of the *good*, *average* and *bad* states (respectively $\Gamma_G$, $\Gamma_A$ and $\Gamma_B$) are :

$$\Gamma_G = \frac{(\gamma-1)\Delta}{2R_M+(1+\gamma)\Delta+\theta} \tag{5}$$

$$\Gamma_A = \frac{\alpha\gamma\Delta}{2R_M-\alpha\gamma\Delta+\theta} \tag{6}$$

$$\Gamma_B = \frac{((1-\alpha)\gamma-1)\Delta}{2R_M-(1+\gamma(1-\alpha))\Delta+\theta} \tag{7}$$

To increase the expected (distorted) value, we must choose values of $\alpha$ and $\gamma$ that ensure:

$$\Gamma_G \geq \Gamma_A > \Gamma_B \tag{8}$$

Then, by (2), the expected distorted gross return of the asset is : [7]

$$\tilde{R} = \frac{\frac{1}{3}\delta(R_M+\gamma\Delta)+\frac{1}{3}\delta^2(R_M-\alpha\gamma\Delta)+\frac{1}{3}\delta^3(R_M-(1-\alpha)\gamma\Delta)}{\frac{1}{3}\delta+\frac{1}{3}\delta^2+\frac{1}{3}\delta^3} \tag{9}$$

$$= R_M + \left(\frac{1-\delta(\alpha+(1-\alpha)\delta)}{1+\delta+\delta^2}\right)\gamma\Delta \tag{10}$$

which is greater than $R_M$ since $\alpha < 1$ and $\delta < 1$.

Now let us return to the choice of $\alpha$ and $\gamma$. Equation (8) yield the two following conditions :

$$(\gamma(1-\alpha)-1)[2R_M+\theta] \geq 2\alpha\gamma^2\Delta \tag{11}$$

$$\alpha\gamma[2R_M+\theta]+2(1-\gamma^2(1-\alpha))\Delta > 0 \tag{12}$$

Solving this system is beyond the scope of the paper. Yet, it is easy to show that plausible solutions can be found if $\theta$ is big enough. For instance, conditions (11) and (12) are satisfied if we choose $\gamma = 2$ and $\delta = 1/3$, as long as $\theta \geq 3/2$. With those parameters, the security yields, 2.25 (a 125% gain) in the good state, .917 (a 8.33% loss) in the average state and 0.583 (a whopping 41.67% loss) in the bad state [8]. The average return is the same, but the standard deviation is much bigger ($\sigma = \Delta\gamma\sqrt{(1+\alpha^2+(1-\alpha)^2)/3}$, which is $\approx 41.57\%$ in annualized terms). Yet (for $\theta > 3/2$ and $\delta = .9$), the investor expects, by equation (7), a gross return equal to 1.309 or $\approx 9.39\%$ in annual terms, which is one point higher than the objective return (8.26%).

**The Strategic Use of Structured Products**

A structured products is a pre-packaged investment strategy based on derivatives. The basic strategy, introduced by Leland and Rubinstein (1970), is to combine a zero coupon bond and a call option on a market index. The zero bond is used to insure the investment, whereas the call option is used to make a bet on the market. For instance, assume that the investor wants to invest 100, with an horizon $T$, and let us denote $r$ the (constant) interest rate. The basic strategy is the following : (i) buy $100e^{-rT}$ zero coupon bonds of maturity $T$ ; (ii) use the rest to buy call options on the market index. The exercise price $K$ is chosen so as to balance risk and return (choosing a higher strike price decreases the price of the option, which increases the expected return, and the risk of earning zero net returns).

Note that this kind of structured product has two features that are naturally salient : full insurance and the opportunity to beat the market in the good states. Salience will lead the investor to overweight the probability of earning a high payoff and the benefits of insuring against the small probability of big losses. He will also tend to overlook the poor payoffs of the contract in the (highly probable) intermediate states.

This implies that tailoring a structured product to increase the salience of its attractive features may be much easier than doing the same with plain (non derivative) securities. Next section will illustrate our hypothesis with a family of structured products introduced by a Parisian bank in the end of the 90s : the *Altiplano* options.

## THE ALTIPLANO FORMULA FUNDS

The *Altiplano* formula funds were introduced by the Société Générale in 1999. They were part of the *Mountain Range* family, a series of path-dependent options linked to a basket of underlying assets (Bouzoubaa and Osseiran, 2010) [9]. The *Altiplano* formula funds were very successful. Several major Parisian banks sold retail financial products based on them in the early 2000s (the Caisse d'épargne marketed *Doubl'ô*, BNP Paribas sold *JET3*, ...). The buyers were unsophisticated middle class savers (small traders, young pensioners, employees...), who were drawn by a promise of high performance with no risk (the contract stated that the capital was perfectly insured). The story of the "fonds à promesse" (the promise funds, as they were latter dubbed) ended badly. Their returns were consistently equal to ... zero. Moreover considerable fees were deducted from the capital returned to the investors (up to 10%). BNP Paribas and Caisse d'épargne were later sued for "misleading commercial practices". [10]

This section will focus on the *BNP Garantie JET 3* contract, which was marketed by BNP Paribas in 2001.

### The *BNP Garantie JET 3* Contract

The *BNP Garantie JET 3* was an investment fund marketed by BNP Paribas in the first month of 2001. The capital was to be invested for ten years (from july 2001 to july 2011). The payoff depended on the performance of a basket of 12 blue chip stocks [11] from the main four stock exchanges (Paris, London, New York and Tokyo). The contract stated that the objective was to triplicate the investor's capital – a 11.62% annual return. This "promise" was guaranteed if all the stocks stayed above 60% of their initial level in the last five years of the contract. Otherwise, the investor's was to receive a final payoff equal to his initial capital plus 90% of the average performance of the 12 stocks [12]. In addition, the contract stated that the investor's capital was fully guaranteed at maturity.

It should be noted that the contract did not give any meaningful information on the fund's investment strategy (the fund was allowed to buy stocks, bonds, derivatives ... and "any financial instrument required to protect the investor's capital against market risk"). Moreover, the presentation of the fees was very imprecise. There were two kind of fees : subscription fees that could not exceed 8% of the capital invested and annual management fees (up to 2.5% per year). The rule used to compute the management fees was not specified. Note also, that the subscription fees were levied at the date of the signature of the contract, which means that the capital was guaranteed, *minus subscription fees* (the same rule was applied to compute all the payoffs, which reduced the maximum payoff to 2.72 times the capital instead of 3 - assuming an 8% subscription fee.).

### The Underlying Structure of the *BNP Garantie JET 3*

As noted above *BNP Garantie JET 3* was a structured product that combines a zero coupon bond (to provide insurance) and an *Altiplano* option (to provide an attractive yield). [13]

The *Altiplano*'s payoff is based on the returns of an underlying basket of $n$ stocks (12 in case of the *JET3*). It entitles the holder to receive a large fixed coupon $C$ at maturity $T$, as long as none of the $n$ stocks falls below a predetermined barrier $L$, during a given time period. In the case of the JET 3, the coupon (equal to two times the investor's capital) is paid if the price of all the twelve assets stay above 60% of their initial value in the observation period (20 quarterly dates over the last five years of the contract). If, however, one of the stocks crosses the barrier, then the holder receives the payoff of an Asian call option (multiplied by a constant scaling factor) [14]. The *Altiplano* is therefore an exotic option that starts as a binary no touch option (an option that pays a coupon provided that the underlying doesn't cross a predetermined barrier), and transforms into an Asian call if the barrier is crossed.

Let us write the precise formula for the *JET3*, assuming that the investor's start with 100, and without taking into account the fees. Let us denote $S_1(t), S_2(t), .., S_n(t)$ the prices of the 12 stocks, and $OD$ the set of the 20 quarterly observation dates (from july 2006 to july 2011). The payoff of the Asian call is computed over those same 20 observation dates, with a strike price equal to the initial value of the portfolio. The payoff of the *Altiplano* is therefore :

$$A_{payoff} = \begin{cases} C = 200 & if \quad \frac{S_i(t)}{S_i(0)} \geq 60\% \quad \forall i, \forall t \in OD \\ 0.9 \times ASIAN & otherwise \end{cases} \tag{13}$$

where $ASIAN = 100 \times \max\{0, PERF - 1\}$ is the payoff of the asian call. $PERF$ is the average of the stocks rate of returns over the 20 quarterly observation dates :

$$PERF = \frac{1}{20}\frac{1}{12}\sum_{i=1}^{12}\sum_{t \in OD}\frac{S_i(t)}{S_i(0)} \tag{14}$$

**Pricing the JET3 Altiplano Option with a Monte Carlo Simulation**

This section gives an estimation of the fair price of the JET3 Altiplano Option, based on a Monte Carlo simulation (Hull, 2014). For the sake of comparison, we also evaluate the price of several other options with the same underlying assets.

As said before, the Altiplano's payoff is based on an underlying basket of 12 shares. We assume that the twelve underlying shares follow correlated geometric brownian processes. The life of the derivative is subdivided in subintervals of length $\Delta t$. Denoting $S_i(t)$ the price of share $i$, $r + \mu$ the expected growth rate, and $\sigma_i$ the volatility, the processes are described by the following equations :

$$S_i(t + \Delta t) - S_i(t) = (r + \mu_i)S_i(t)\Delta t + \sigma_i S_i(t)\varepsilon_i\sqrt{\Delta t} \qquad i = 1,2,..,12 \tag{15}$$

where the $\varepsilon_i$ are random sample from normal correlated distributions. For the sake of simplicity, we assume that the expected yield and volatility of the twelve shares are the same, so that $\sigma_i = \sigma$ and $\mu_i = \mu$. We also assume a constant correlation between the Wiener processes driving the twelve shares, so that $\mathrm{Cov}(\varepsilon_i, \varepsilon_j) = \rho\sigma^2, \forall i \neq j$ and $\mathrm{Var}(\varepsilon_i) = 1, \forall i$.

To price the options, we must move to the risk-neutral world, where the shares follow a geometric brownian process with the same covariance matrix and an expected growth rate equal to the risk-free interest rate :

$$S_i(t + \Delta t) - S_i(t) = rS_i(t)\Delta t + \sigma S_i(t)\varepsilon_i\sqrt{\Delta t} \qquad i = 1,2,..,12 \tag{16}$$

Then we generate $N$ random trajectories for each share of the basket, and compute the payoff of the derivative for each trajectory. Note that this payoff is path dependent (we must check whether the deactivation barrier is crossed on one of the 20 observation dates, and if so, compute the average value of the basket over those 20 dates). The trajectories are simulated over 10 years, with monthly draws (this implies 120 draws for each share). We simulate $N = 2.10^6$ trajectories. The parameters take the following values : $r = 5\%$, $\sigma = 34.94\%$, $q = 2.1\%$, and $\rho = 23.93\%$. The coupon is equal to twice the value of the initial basket ($C = 200$). The choice of the parameters is explained in appendix 7.[15]

Besides the Altiplano, we also compute the value of the following options, based upon the same basket of shares : an European call (whose strike price is the initial price of the underlying basket), an Asian call (with the same strike price and a payoff computed using the same 20 observation dates), and a binary option that pays the same coupon as the Altiplano, if none of the shares falls below the 60% threshold on one of the 20 observation dates, and zero otherwise.

The results are presented in table 1 (we assume that the initial price of the underlying basket is 100).

**TABLE 1**
**RESULTS OF THE MONTE CARLO SIMULATION**

| *Option* | *European Call* | *Asian Call* | *Altiplano* | *Binary* |
|---|---|---|---|---|
| *Price* | 29.599 | 22.697 | 20.308 | 0.659 |

The Monte Carlo simulation also gives an estimation of the probability of hitting the knockout barrier (in the risk-neutral world), which is very high : $p = 99.457\%$. In other words the big payoff (the coupon) is paid in less than 0.5% of the trajectories.

### An Estimation of the Fees Levied on the JET3 Contract

The fee policy of the BNP was far from clear. The information booklet specified two kind of fees : a subscription fee (up to 8% of the invested capital) and a management fee (up to 2.5% per year). The contract also indicated that the payoff formula (the capital guarantee and the conditional promise to triplicate the capital) applied to the invested capital *minus subscription fees*. And that was all.

This formulation is troublesome for two reasons. First the bank is free to vary the management fee during the contract as she see fits (up to 2.5% per year). Second the fee rule is not entirely consistent with the other terms of the contract. This results from the fact that management fees can't be levied on the zero coupon or the Altiplano option (doing otherwise would prevent the bank from honoring the contract).

This means that a fraction of the initial capital must be saved to pay for the management fees. Given the terms of the contract, we can assume that the investor's portfolio breaks down as follows at the beginning of the contract :

$$V_0^{SA} = 100 = (1 - \tau_s)(A_0 + Z_0) + F_S + F_M \tag{17}$$

where $F_S = \tau_S V_0^{SA}$ denotes the subscription fees and $F_M = \tau_M V_0^{SA}$ the amount set up to pay the management fees. $A_0$ and $Z_0$ are the value of the Altiplano and the zero coupon at time $t = 0$. In other words, we assume that the bank invests $(1 - \tau_s)(A_0 + Z_0)$ and puts aside the rest to pay the subscription and management fees [16]. This allows us to give a rough estimate of the total fees as a percentage of the investment.

$$\tau = \tau_S + \tau_M = 1 - (1 - \tau_s)\frac{A_0 + Z_0}{100} \tag{18}$$

Note that the total fee rate $\tau$ is a function of the subscription rate $\tau_s$, which was negotiated between the two parties before the signing of the contract [17]. This implies that the fee rate varies from 19.04% (for $\tau_s = 0$) to 25.52% (for $\tau_s = 8\%$) [18]. For the sake of simplicity we will work with the middle value in the following sections ($\tau \approx 22\%$ with a 4% subscription fee). Note that the total implied management fee $\tau_M \approx 18\%$ is equivalent to a 1.96% annual fee.

## AN ASSESSMENT OF THE BNP GARANTIE JET3 AND ITS ALTERNATIVES

Was the *JET3* an inferior financial product ? Did the bank market knowingly an expensive and risky financial product to unsophisticated small investors who thought that they could get simultaneously high returns and absolute security ? The answer to this question depends on the risk-return profiles of the alternative investment strategies. Our method is to simulate the expected payoffs of the *JET3* and several alternative investment strategies and then compute the expected utility to rank the portfolios.

To simplify the problem, all the portfolios are based upon the 12 underlying stocks of the *JET3* and the zero coupon. The portfolios can be grouped in three broad families : "classical" portfolios that mix bonds and stocks, speculative portfolios based on options and structured products that combine an option and a zero coupon bond. We also assume that the total fee rate is the same for all the portfolios, i.e. the $\approx 22\%$ levied on the *JET3*.

We don't know the degree of risk aversion of the small investors. To get around this difficulty we proceed as follows. We choose a simple utility function (a CRRA), knowing that the value of the key parameter (the coefficient of relative risk aversion $\gamma$) is unknown. We start our ranking exercise with $\gamma = 0$, an then we increase gradually $\gamma$ to 20. This gives us the optimal choices for a vast range of individuals, from the risk-seeking ones to the very risk averse.

Section 4.1 presents the framework of the simulation (a recombinant binomial tree). Section 4.2 and 4.3 present the results of the simulation.

**The Framework : A Recombinant Binomial Tree**

The Bordalo et al. (2012, 2013) framework works with discrete probabilities, which rules out the use of a Monte Carlo simulation method. To get around this difficulty, we use a variant of the option pricing method of Cox et al. (1979).

We assume that investors live in a very simplified world where the economy can be in two states : good or bad (both states are equiprobable). In the good state, the price of share $i$ ($i = 1,2,..12$) is multiplied by a factor $u$, with probability $\pi > 1/2$ or by factor $v < u$ with probability $1 - \pi$. In the bad state, the price of the same share is multiplied by $u$ with probability $1 - \pi$ or by $v$ with probability $\pi$. Following Following Cox et al. (1979), we choose :

$$u = e^{\left(r-q-\frac{\sigma^2}{2}\right)\Delta t+\sigma\sqrt{\Delta t}} \tag{19}$$

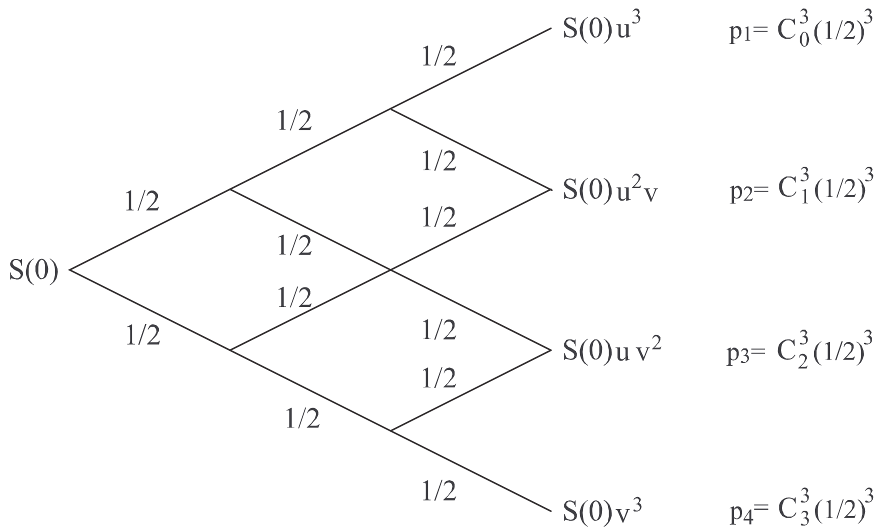
$$v = e^{\left(r-q-\frac{\sigma^2}{2}\right)\Delta t-\sigma\sqrt{\Delta t}} \tag{20}$$

where $\Delta t$ is the time interval between two periods. Note that our set of assumptions imply that the (conditional) covariance between share $i$ and $j$ is : [19]

$$\text{Cov}\left(\frac{S_i(t+\Delta t)}{S_i(t)}, \frac{S_j(t+\Delta t)}{S_j(t)}\right) = (1 - 4\pi(1-\pi))\frac{(u-v)^2}{4} \tag{21}$$

Chosing $\pi = (1 + \sqrt{\rho})/2$ ensures that the correlation coefficient between two shares is $\rho$. [20] The process is repeated at each period (the shocks are independent). Repeating this process $n$ times generates a recombinant tree for each share (see figure 1). The tree has $n + 1$ final states, and the probability of state $k \in \{0,1,..,n\}$ ($n - k$ good shocks, $k$ bad shocks), where share $i$ reaches the value $S_i(T) = S(0)u^{n-k}v^k$, is $C_k^n(1/2)^n$. Choosing $n$ big enough generates, for each share, a good approximation of a log normal distribution with a mean equal to $r - q$ and a standard deviation equal to $\sigma$ (see Hull (2014, p. 465).

**FIGURE 1**
**A 3-STEP RECOMBINANT BINOMIAL TREE**




Pricing a call option within this framework is very easy, since the value of the option is the average of the final values ($\max\{S_i(T) - K, 0\}$) times the discount factor $e^{-rT}$. Pricing the other options is trickier since their final value is path dependent (recall that the big payoff is deactivated if any of the twelve shares of the portfolio loses 40% of more of its value during the observation period, and that the value of the Asian option depends on the price of the shares in the 20 observation dates). Exploring all the possible paths is unfeasible if the number of steps is greater than two dozens (there are $2^n$ paths!). The solution is to sample $N$ paths of the $2^n$ possible paths. Taking $N$ big enough gives a reasonable approximation of the value of the options (see Hull (2014)).

We compute the price of the same options than before (an European call, an Asian call, a binary option and an altiplano option). The parameters are the same : $r = 5\%$, $\sigma = 34.94\%$, $\rho = 23.93\%$ (which implies $\pi = 74.46\%$) and $C = 200$. We assume, as before, monthly shocks over a ten year period, so that: $n = 120$ and $\Delta t = T/n = 1/12$. We simulate $N = 10^7$ paths in the recombinant tree. The results are presented in table 2 :

**TABLE 2**
**RESULTS OF THE BINOMIAL TREE SIMULATION**

| *Option* | *European Call* | *Asian Call* | *Altiplano* | *Binary* |
|---|---|---|---|---|
| *Price* | 29.514 | 22.645 | 20.267 | 0.642 |

Comparing table 1 and table 2 shows that the two simulation methods yield very close results. Moreover, the probability of hitting the knockout barrier (in the risk-neutral space) is now $p = 99.47\%$, which is also very close to the value obtained with the Monte Carlo simulation.

Note that we must revise slightly our estimation of the total fee rate. Using the method of section 3.4, the fee rate is now $\tau = 22.32\%$ (assuming a 4% subscription fee).

**A Simulation of the Payoffs of the JET3 and its Alternatives**

We now use the highly stylized framework described in the last subsection to simulate the expected payoffs of the *JET3* contract as well as several other alternative portfolios. Simulating the expected payoffs entails switching from the risk-neutral world to the “real" world. The asset’s law of motion are similar in both worlds, but the parameters $u$ and $v$ must be replaced by :

$$u_R = e^{\left(r+\mu-q-\frac{\sigma^2}{2}\right)\Delta t+\sigma\sqrt{\Delta t}} \tag{22}$$

$$v_R = e^{\left(r+\mu-q-\frac{\sigma^2}{2}\right)\Delta t-\sigma\sqrt{\Delta t}} \tag{23}$$

where $\mu$ is the expected risk premium. We assume that $\mu = 6\%$, which implies an expected nominal log-return of 11%. [21]

We consider 11 investment strategies, which can be grouped in 3 families. First we have the classic portfolios combining bonds and a basket of the twelve shares. We label those strategies *ZERO*, *ETF*, *75/25*, *50/50* and *25/75*. The *ZERO* portfolio is entirely made of ten years zero coupon bonds. *ETF* (for exchange-traded fund) is a 100% share portfolio (with reinvested dividends), composed by the twelve shares. *75/25*, *50/50* and *25/75* are stocks and bonds portfolios - the *75/25* portfolio is made of 75% stocks (the 12 share *ETF*) and 25% bonds (the zero coupon), and so on. We assume that each of these portfolios is subject to the same total fees than the *JET3*, i.e. an initial fee of 22.32% of the investment (equivalent to a 2.494% annual fee). Note that the *25/75* portfolio offers the same level of capital insurance as the *JET3* contract (with 4% subscription fees) [22].

Next we have three speculative portfolios : *EURO*, *ASIAN* and *ALTIP*. The *EURO* portfolio is entirely made of European call options (whose strike price is the initial price). Similarly, the *ASIAN* and *ALTIP* portfolios are composed, respectively, of asian call options (with the same strike price) and Altiplano options. The fee policy is the same as before.

The third group is composed three structured products : *S-EURO*, *S-ASIAN*, and *S-ALTIP*. All the structured products have the same structure than the *JET3* contract. The *S-EURO*, for instance, is made of zero coupon bonds and European call options. For the sake of comparability, the fee policy must be similar to the one used for the *JET3*. We proceed as follows. The share of the zero coupon is set at a level that ensures the initial capital minus the subscription fees. Then, the number of european call options $n_c$ is chosen to ensure a total fee rate equal to 22.32%. Denoting $p_c$ the price of the european call option and $\tau$ the total fee rate, the initial portfolio breaks as follows :

$$100 = (1-\tau_s)e^{-rT} + n_c p_c + \tau 100 = 58.23 + n_c \times 29.51 + 22.32 \tag{24}$$

which yields the number of European calls ($n_c = 0.6591$, assuming a 4% subscription rate). The same logic applies to *S-ASIAN* (which uses asian call options). *S-ALTIP* is the *JET3* contract. Table 3 gives the expected (yearly) log-returns of the different portfolios.

**TABLE 3**
**EXPECTED YEARLY LOG-RETURNS**

| Portfolio | Annual Return |
|---|---|
| *ZERO* | 2.47 % |
| *ETF* | 8.46 % |
| *75/25* | 7.27% |
| *50/50* | 5.91 % |
| *25/75* | 4.34 % |
| *EURO* | 13.51 % |
| *ASIAN* | 12.50 % |
| *ALTIP* | 12.15 % |
| *S-EURO* | 6.56 % |
| *S-ASIAN* | 6.06 % |
| ***S-ALTIP*** | **5.90 %** |

### Ranking the Portfolios

The ranking of the different portfolios depends on the risk-return preferences of the investor. We must specify the utility function and the set of spaces. To simplify matters we assume that : (i) the investor has standard CRRA preferences ; (ii) the set of spaces is made of the $n+1=121$ endpoints of the $n=120$ steps binomial tree that results from the good/bad binary shock that affect the economy over the life of the contract ; (iii) for each state, the utility is computed over the expected cumulative return of the portfolio. This is, of course, a gross simplification, since there are, in fact, twelve independent binomial trees (one for each share), and the value of the Asian and Altiplano options is path-dependent (which increases considerably the real number of states).

Using those two assumptions, the expected utility of an individual who chooses portfolio $k$ is :

$$V^k = \sum_{s=1}^{121} \pi_s u(ER_s^k S_0) = \sum_{s=1}^{121} \pi_s \frac{(W_0 + ER_s^k S_0)^{1-\gamma} - 1}{1-\gamma} \qquad (25)$$

where $\pi_s$ is the probability of state $s$, $R_s^k = ES_{s,T}^k / S_0$ is the expected cumulative return of portfolio $k$ in state $s$ [23], $W_0$ a measure of the others assets of the individual, and $\gamma$ the constant coefficient of relative risk aversion. We assume that the ratio between the other assets and the financial investment is constant, so that $W_0 = \alpha S_0$, with $\alpha = .5$ [24], and without loss of generality set $S_0 = 1$. The $(\pi_s, ER_s^k)$ pairs are derived from the simulation.

The key parameter is of course $\gamma$. To take account of the diversity of risk-preferences, we have chosen to compute the expected utility of the portfolios for $\gamma \in [\underline{\gamma}, \overline{\gamma}]$, and use these numbers (which per se mean nothing) to rank the portfolios. More specifically, we rank the portfolios for $\gamma \in [0,20]$, with increments of .05 (increasing the interval does not bring any meaningful change). The complete table of results is given in appendix 8.

The main results can be seen in table 4, which shows the first and second ranked portfolios, as well as the rank of the JET3.

**TABLE 4**
**A SUMMARY OF THE RANKING OF THE PORTFOLIOS (CRRA UTILITY)**

| $\gamma$ | First Ranked | Second Ranked | JET3 Rank |
|---|---|---|---|
| 0 to 0.35 | *EURO* | *ASIA* | 9 |
| 0.4 to 1.3 | *EURO* | *ASIA* | 8 |
| 1.35 | *ASIA* | *EURO* | 8 |
| 1.4 to 1.65 | *ASIA* | *ALTIP* | 8 |
| 1.7 to 1.75 | *ASIA* | *ALTIP* | 9 |
| 1.8 to 1.85 | *ALTIP* | *ASIA* | 9 |
| 1.9 to 2.05 | *ETF* | *ALTIP* | 9 |
| 2.1 to 2.25 | *ETF* | *75/25* | 8 |
| 2.3 to 3.3 | *ETF* | *75/25* | 6 |
| 3.35 to 3.8 | *75/25* | *ETF* | 6 |
| 3.85 to 3.9 | *75/25* | *50/50* | 5 |
| 3.95 to 4.55 | *75/25* | *50/50* | 3 |
| 4.6 to 4.85 | *50/50* | *75/25* | 3 |
| **4.9 to 6.8** | ***50/50*** | ***S-ALTIP*** | **2** |
| 6.85 to 7.45 | *50/50* | *25/75* | 3 |
| 7.5 to 12.75 | *25/75* | *50/50* | 3 |
| 12.8 to 12.85 | *25/75* | *50/50* | 4 |
| 12.9 to 13.3 | *25/75* | *ZERO* | 4 |
| 13.35 to 20 | *25/75* | *ZERO* | 3 |

As expected, risk-seekers prefer the 100% options portfolios (*EURO* is ranked first for $\gamma < 1.3$, the slightly less risky *ASIA* is preferred for $\gamma \in [1.35,1.75]$), and the 100% Altiplano options for $\gamma \in [1.8,1.85]$ More risk averse individuals choose the 100% share portfolio (for $\gamma \in [1.9,3.3]$), and for $\gamma \geq 3.35$ the investor chooses a bond-share mix (from *75/25* to *25/75*). Looking at the second choice gives us a more complete picture. Risk-seeker's 2nd choice is a 100% options portfolio for all $\gamma < 2.05$. Others bond-share mixes are a good second choice for most risk averse individuals, and the 100% zero-coupon is the 2nd choice for the more risk-averse. Note that the *S-ALTIP* is the second choice for $\gamma \in [4.9,6.8]$

It is by now clear that the structured altiplano is never the first choice. *S-ALTIP* has some appeal for risk-adverse individuals (those whose $\gamma \geq 3.95$). But it is always dominated by a simple bond share-mix. Note, for instance that the *50/50* portfolio is better ranked than the *S-ALTIP* for $\gamma \in [1.7,13.3]$ (see appendix 8)

Furthermore, we have assumed that the total fee rate is the same for all the portfolios. Yet, it is a fact that the fee rate is positively related to the complexity of the portfolio (Célérier & Vallée, 2017). Therefore bond-share portfolios should have smaller fees, which, of course, improves their risk-return profile. Our simulations show that, assuming that the total fee rate is 1/5 lower, *all* the usual bond-share combinations (those with a bond share between 40% and 60%) are better ranked than the *S-ALTIP* for all $\gamma \leq 13.8$ (see appendix 8)

## THE IMPACT OF SALIENCE ON THE EVALUATION OF THE JET3 PROSPECTS

This section shows how the Bordalo et al. (2012, 2013) can be used to explain the success of the Altiplano structured products.

**Our Version of the Bordalo et al. (2012, 2013) Model**

The Bordalo et al. (2012, 2013) framework postulates that the investors value the portfolios using subjective probabilities that are distorted by a salience factor. Salience is computed using a salience function that compares the payoff of the asset in state $s$ with the market payoff. Denoting $\overline{R}_s S_0$ the market payoff in state $s$, and replacing the parameter $\theta$ with $\theta S_0$, we write the salience function of portfolio $k$ as:

$$\Gamma(ER_s^k S_0, \overline{R}_s S_0) = \frac{|ER_s^k S_0 - \overline{R}_s S_0|}{ER_s^k S_0 + \overline{R}_s S_0 + \theta S_0} = \frac{|ER_s^k - \overline{R}_s|}{ER_s^k + \overline{R}_s + \theta} = \Gamma(ER_s^k, \overline{R}_s) \quad (26)$$

The definition of the market payoff is of foremost importance. Bordalo et al. (2012, 2013) recommend to use an average of all the assets as the benchmark. This is straightforward in a world with few assets, but quite impractical in a world with tens of thousands of assets. One might also ask whether the derivatives should be part of the benchmark, which would be even more unpractical...

It seems more natural to assume that the market payoff is computed using a limited set of assets. This is why we add the following assumptions to Bordalo et al. (2012, 2013) : (i) the market payoff is computed using the assets that are mentioned in the contract ; (ii) derivatives are not taken into account. This implies that the market payoff should be computed as the average payoff of the twelve shares and the payoff of the 10 year zero coupon, i.e. :

$$\overline{R}_s = \frac{1}{13}\left(\sum^{12}{}_{j=1} R_s{}^j + e^{\,rT}\right) = \beta\, R\,{}_s{}^{ETF} + (\,1 - \beta\,)\, e^{\,rT} \quad (27)$$

which is also a weighted average of the payoffs of the basket of the twelve shares (the *ETF*) and the zero coupon (using $\beta = 12/13$ as the weight of the basket of shares).

The salience function is used to rank the states by salience. The subjective (distorted) probabilities are computed using a "discounting" rule based on the rank of the state (the lower the rank, the higher the discount). If, for instance, states $s$ and $s'$ have respective ranks $m_s$ and $m_{s'}$, salient thinking distorts the objective relative probabilities $\pi_s/\pi_{s'}$ into $\tilde{\pi}_s/\tilde{\pi}_{s'} = \delta^{m_s - m_{s'}}\pi_s/\pi_{s'}$. The strength of salience is therefore a decreasing function of the coefficient of distortion $\delta < 1$.

**A Measure of the Impact of Salience**

To proceed with the simulation, we must choose a values for the salience parameter $\delta$. The results presented in this section were computed using the following values : $\delta = .75$. Section 5.3 will show what happens when we modify those values.

The main results are presented in tables 5, 6 and 7. Table 5 summarizes the impact of salience on the expected yearly log-returns. The distorted returns are lower for all the portfolios, except the Structured Altiplano (whose return increases from 5.91% to a whopping 12.12%) and the *25/75* portfolio (whose expected returns rises to 8.90%) . The uninsured portfolios are the most affected by the salience distorsion. The perspective of capital loss reduces the expected return of the *ETF* from 8.43% to -5.84%, whereas the *75/25* expected return falls to -2.77%. The impact on the 100% options portfolios is even worse : the subjective expected return of *EURO*, *ASIA* and *ALTIP*, falls to -20.62%, -8.32%, and -0.37%, respectively. Note that the insurance provided by a high share of bonds reduces the negative impact of salience on the expected returns of the *50/50*, *S-EURO* and *S-ASIA* portfolios.

**TABLE 5**
**EXPECTED UNBIASED AND DISTORTED RETURNS**

| Portfolio | Annual Returns % | |
|---|---|---|
| | Unbiased | Distorted |
| *ZERO* | 2.47 | 2.47 |
| *ETF* | 8.46 | -5.84 |
| *75/25* | 7.27 | -2.77 |
| *50/50* | 5.91 | 1.09 |
| *25/75* | 4.34 | 8.90 |
| *EURO* | 13.51 | -20.62 |
| *ASIA* | 12.50 | -8.32 |
| *ALTIP* | 12.15 | -0.37 |
| *S-EURO* | 6.56 | -0.00 |
| *S-ASIA* | 6.06 | 1.83 |
| ***S-ALTIP*** | **5.90** | **12.12** |

Next we look at the impact of salience on the ranking of the 11 portfolios. We use the expected utility defined in equation (21), with the distorted probabilities $\tilde{\pi}_s$. The results are presented in table 6 (see the appendix for the complete table). The results are clear : individuals with low or intermediate risk-aversion prefer the *S-ALTIP* portfolio, whereas the very highly averse to risk prefer the 100% zero coupon portfolio. Note that the fully insured bond-share portfolio (*25/75*) his ranked either second or third.

**TABLE 6**
**THE RANKING OF THE PORTFOLIOS, WITH A CRRA UTILITY AND A SALIENCE DISTORTION**

| γ | First Ranked | Second Ranked | Third |
|---|---|---|---|
| 0 to 8.95 | *S-ALTIP* | *25/75* | *ZERO* |
| 9 to 12.75 | *S-ALTIP* | *ZERO* | *25/75* |
| 12.8 to 20 | *ZERO* | *S-ALTIP* | *25/75* |

To understand the impact of salience on the valuation of the portfolios we must look at the pattern of the probability distortions. Table 7 gives an overview of the real and distorted distributions of the expected returns of four portfolios : the *ETF*, the balanced mix (50/50), the structured euro call and the *JET3*. For each portfolio, we break the distribution in three : a bad state, a good state and the intermediate states.

The expected log-return of the *ETF* is roughly normal. The investor has a 8.55% probability of losing some capital and a 20.58% probability of tripling his capital. Yet the small probability of capital loss is magnified by salience (to 98.66%). This comes at the expense of the other intermediate states which have a much higher real probability. The impact of salience on the *50/50* is roughly similar.

The structured products offer partial capital insurance (the investor can lose at most $\tau_s = 4\%$ of his capital). Yet the salience of this small capital loss is not the same for both products. The *S-EURO* portfolio yields a capital loss with probability 4.13%, and more than three times the invested sum with probability 11.76%. Salience magnifies the probability of the bad state (to 98.98%), and reduces the probability of the other states to a bit more than 1%.

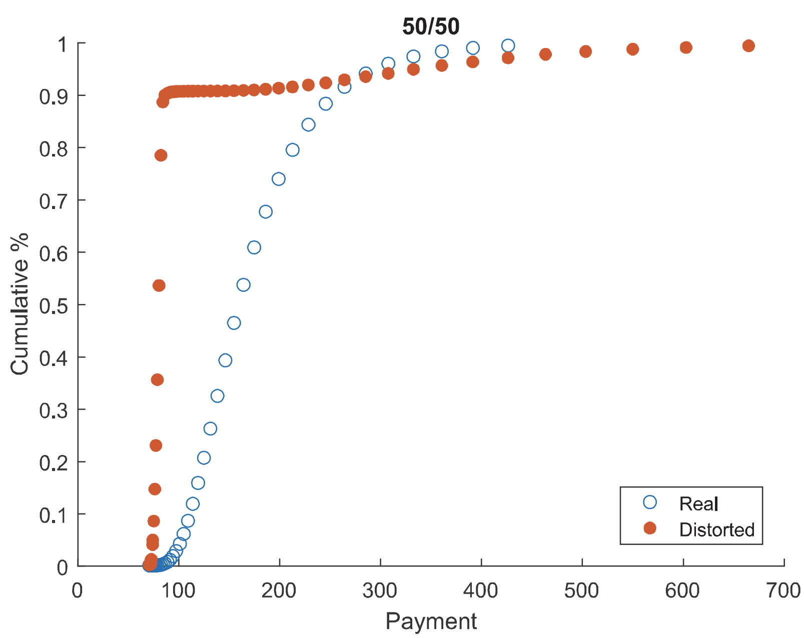
The impact of salience on the *S-ALTIP* is slightly different. The probability of *both* the good and the bad states are magnified at the expense of the intermediate state. However, the big payoff looms larger than the small capital loss (the distorted probability jumps to 81.58%).

## TABLE 7
## REAL AND DISTORTED PROBABILITIES FOR SOME PORTFOLIOS

| Portfolio | Events | | |
|---|---|---|---|
| *ETF* | Payoff ≤ 100 | Payoff ≥ 300 | Other Payoffs |
| Real probability | 8.55% | 20.58% | 70.88% |
| Distorted probability | 98.66% | 1.16% | 0.19% |
| *50/50* | Payoff ≤ 100 | Payoff ≥ 300 | Other Payoffs |
| Real probability | 2.75% | 6.01% | 91.24% |
| Distorted probability | 90.57% | 6.59% | 2.84% |
| *S-EURO* | Payoff ≤ 100 | Payoff ≥ 300 | Other Payoffs |
| Real probability | 4.13% | 11.76% | 84.11% |
| Distorted probability | 98.98% | 0.073% | 0.29% |
| *S-ALTIP* | Payoff ≤ 100 | Payoff ≥ 300 | Other Payoffs |
| Real probability | 2.75% | 6.01% | 91.24% |
| Distorted probability | 9.83% | 81.58% | 8.58% |

The near disappearance of the non salient states can also be visualized in figures 2, 3 and 4. Figure 2 represents the cumulative distribution functions of the balanced mix (both the real and distorted distributions are represented in the same figure). As expected, the real distribution is smooth (recall that the underlying distribution function is log-normal). Yet the distorted distribution has a big mass point at the initial capital (nearly 95% of the outcomes).

## FIGURE 2
## REAL AND DISTORTED DISTRIBUTIONS FUNCTION OF THE *50/50* PAYOFFS.




The same distortion can be seen in figures 3 and 4, which represent the cumulative distribution functions of the *S-EURO* and *S-ALTIP* payoffs. The real distribution of the *S-EURO* is a truncated log-normal (nearly 4% of the payoffs are concentrated in a single point at the beginning of the distribution). The mass point is much bigger for the distorted distribution (nearly 99% of the outcomes). The *S-ALTIP* distorted distribution is slightly different, since it has two mass points : a small one at the beginning of the distribution and a big one for the big prize (the $\times 3$ payoff). The payoffs bigger than 288 correspond to the highest payoffs of the Asian call.

**FIGURE 3**
**REAL AND DISTORTED DISTRIBUTIONS OF THE *S-EURO* PAYOFFS**

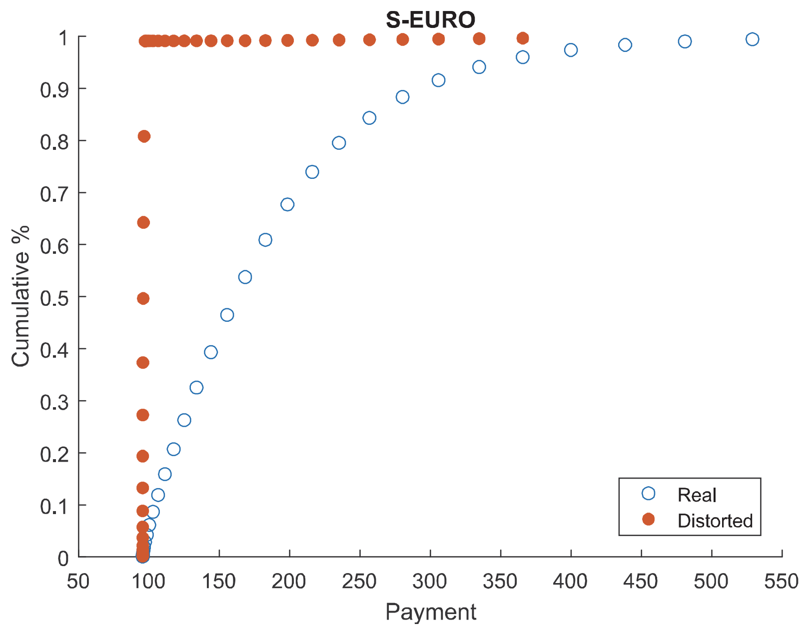
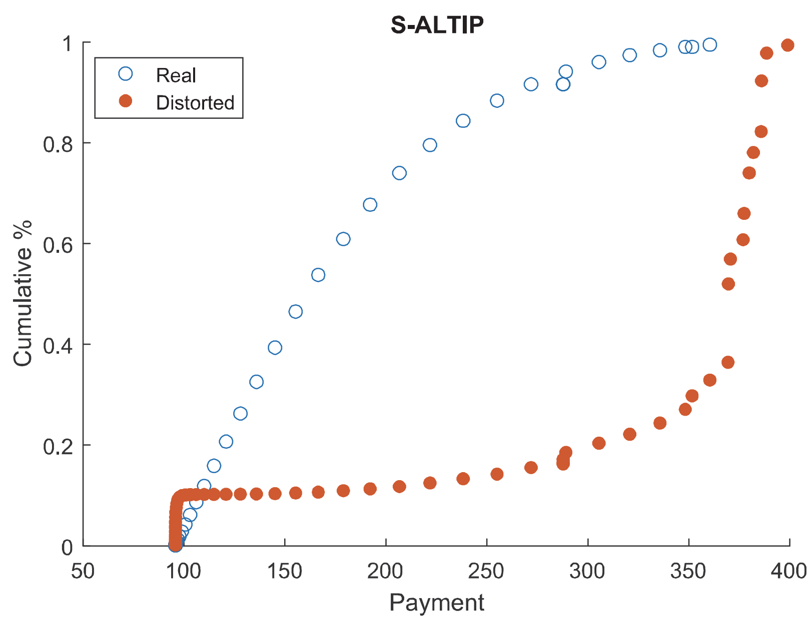



**FIGURE 4**
**REAL AND DISTORTED DISTRIBUTIONS OF THE *S-ALTIP* PAYOFFS**



## On the Robustness of our Results

The salience distortion depends on the value taken by parameter $\delta$. $\delta$ is a discount factor that parameterizes the strength of the salience distortion. Reducing $\delta$ increases the difference between the objective and subjective relative probabilities (but has no impact on the salience ranking). Appendix 9 shows what happens when we vary parameter $\delta$ from 0.05 to 1. As can be seen in the ranking tables of this appendix, our main results hold for a plausible range of risk-return preferences, as long as $\delta \leq .8$.

## Did the Bank Use Salience Pricing ?

We have argued so far the the JET3 contract was designed to lure naive customers with a very attractive promise : a 12% yearly return with full capital insurance. This brings out a new questions : did the banks try to fully exploit salient thinking by using a salience pricing strategy ? To answer this question we must take another look at the *JET3* contract, while bearing in mind the general principle of a salience pricing strategy : fees must be low in the salient states and high in the non salient states.

As said before, the contract specified two kind of fees : a subscription fee (up to 8% of the invested capital) and a management fee (up to 2.5% per year). The contract also indicated that the payoff formula (the capital guarantee and the (conditional) promise to triplicate the capital) applied to the invested capital *minus subscription fees*. And that was all.

It should be clear by now that the fee strategy did not take advantage of the salience biases. Fees were formulated in a an imprecise and inconsistent way, but were not lower in the salient states. A classic obfuscation strategy aimed at shrouding the high level of the fees seems therefore much more likely. Note that this does not contradict our main thesis : hiding high fees is much easier when customers expect high returns.

# CONCLUSION

This paper presents an in-depth evaluation of the *BNP Garantie JET3*. The *JET3* was a retail structured product made of a zero coupon bond and an *Altiplano* option. This highly complex product was sold to unsophisticated French middle class investors in the early 2000s.

Our main results are the following. First we show that the demand for the *JET3* can't be explained with standard risk-return preferences. This is a consequence of the peculiar risk profile of the *JET3*, which offers both nearly full insurance and a highly speculative bet. Our simulation shows that the payoff distribution of the *JET3*, is always dominated by some simple combination of its main components (a zero-coupon bond, a basket of shares or an option). Risk-averse individuals tend to prefer a bond-share mix, whereas risk-seeking individuals prefer 100% options portfolios.

Then we show that this result is reversed if we assume that the investors have a salience bias à la (Bordalo et al., 2012). The salience hypothesis holds that investors overweight salient payoffs (ie payoffs that are much bigger or much smaller than the average). The *JET3* has two built-in features that are particularly attractive for salient biased investors : nearly full insurance and a very high payoff in the good states. These features lead the investor to overlook the highly probable intermediate states, which have very poor payoffs. We show that the salient biased investor overestimates the return of the *JET3* and underestimates the returns of the alternative portfolios. If the salience bias is big enough, the *JET3* dominates the other portfolios. This result is robust, since it holds for a vast range of the salience parameters.

Finally, we address the issue of behavioral pricing. We show that the bank did not tailor the fees to exploit the salience bias. However, fees were formulated in an imprecise and inconsistent way. This points to a classic obfuscation strategy aimed at shrouding high fees.

## ENDNOTES

1. BNP Paribas for the *JET3* contract, La Poste for *Bénéfic*, and Caisse d'épargne for *Doubl'ô*.
2. Their database covers approximately 55,000 products issued across 16 different countries by more than 400 distributors between 2002 and 2010, totaling more than 1.3 trillion euros of issuance.
3. An earlier paper by Breuer & Perst (2007) use prospect theory to study the german RCBs (Reverse Convertible Bond) of the late 90s. Their conclusion is that RCBs might be an instance of behavioral financial engineering, since RCBs are far more attractive to boundedly rational investors than they are for rational ones.
4. The general properties of the salience function are explained in Bordalo et al. (2013).
5. States with the same salience are given the same ranking.
6. For the sake of simplicity, we assume that the discount rate is zero.
7. We assume $\Gamma_G > \Gamma_A$. When both states have the same salience, the expected gross return is $\tilde{R} = R_M + \frac{(1-\alpha)(1-\delta^2)}{2+\delta^2}\gamma\Delta$.
8. Recall that the market yields 1.75 (a 75% gain) in the good state, 1.25 in the average state (a 25% gain), and .75 (a 25% loss) in the bad state.
9. The other options had similar names : *Himalaya*, *Everest*, *Kilimanjaro*, and *Atlas*.
10. Both banks were later sentenced to reimburse the fees (and to pay a small fine).
11. Total, Axa, Alcatel, British Telecom, British Petroleum, HSBC, Lloyds TSB, Procter & Gamble, Coca-Cola, General Motors, Mitsubishi Tokyo Finance Group and Sony.
12. Performance was defined as the average of the capital gains of the 12 stocks. Note that the capital gains were computed using the average price of each stock in the last five years of the contract, instead of the final price.
13. This section draws heavily on Bouzoubaa & Osseiran (2010), which give a detailed presentation of the *Mountain Range* options.
14. An Asian option is an option whose payoff is computed using the average value of the underlying basket over a predetermined period.
15. The simulation was done using Matlab R2016.
16. We assume that the bank can adjust the annual management fees over the life of the contract to exhaust $F_M$.
17. The BNP sales people had considerable leeway to reduce the subscription fee.
18. We use the values computed in the previous section $Z_0 = 100e^{-rT} = 60.65$ and $A_0 = 20.308$.
19. The expected value and the variance of the multiplying factor of share $i$ does not depend on $\pi$ (since the value of share $i$ is multiplied by $u$ with probability $1/2$ and $v$ with probability $1/2$).
20. By (18) and $\text{Var}(S_i(t+\Delta t)/S_i(t)) = \frac{(u-v)^2}{4}$, the correlation coefficient between two shares is $\rho = (1 - 4\pi(1-\pi))$. We choose the solution of this quadratic equation that is higher than 1/2.
21. Seen appendix A.
22. An individual that invests 75% of his portfolio in zero coupon bonds with 22.23% fees, is sure to get back at least $(1 - 22.32\%) \times 75\% \times e^{-rT} \approx 96\%$ of his initial capital.
23. $ES_{s,T}^k$ is the expected final value of portfolio $k$ in state $s$.
24. Changing the value of α does not modify the main results, as long as α>0.

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## APPENDIX

### A: THE FINANCIAL DATA

The underlying of the *BNP Garantie JET 3* were 12 blue chip stocks, from Paris (Total, Axa and Alcatel), London (British telecom, British Petroleum, HSBC Holdings and Lloyds TSBC), New York (Procter & Gamble, Coca-Cola and General Motors) and Tokyo (Mitsubishi Tokyo Finance Group and Sony).

We use the past performance of those stocks to assess the value of the Altiplano options and the prospects of the investor. Four parameters must be estimated : the average standard deviation ($\sigma$), the average correlation coefficient ($\rho$), the average risk premium ($\mu$) and the average dividend rate ($q$).

Our source is a dataset provided by FactSet which gives both daily prices adjusted for splits and issues and daily prices adjusted for splits, issues and dividends. We use those two series to compute the daily and monthly log returns (with and without dividends) for the ten years period before the beginning of the marketing period of the *JET3* (i.e. from may 1 1991 to april 30 2001).

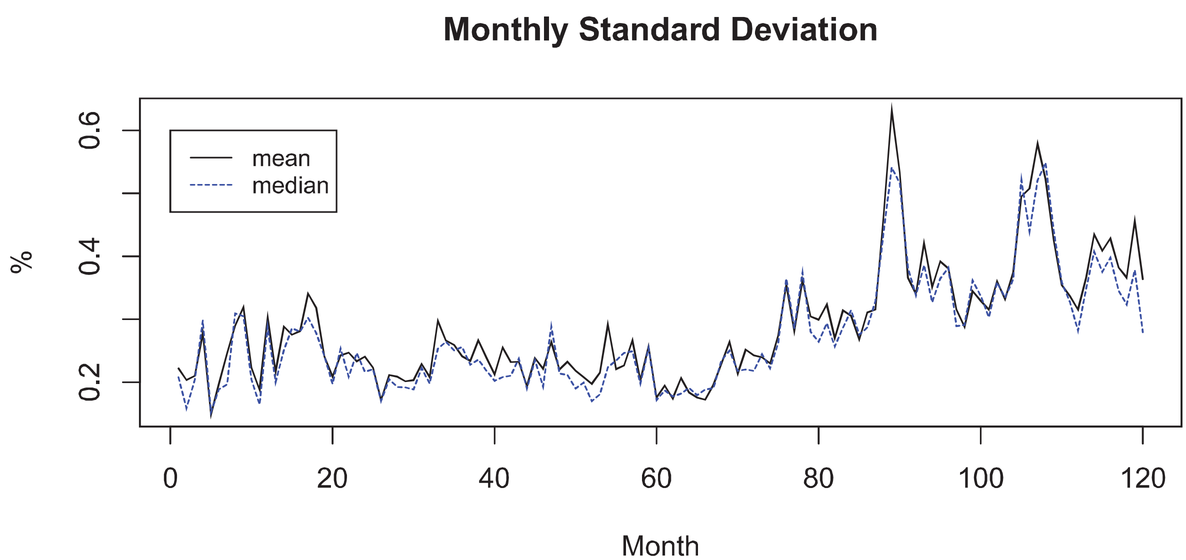
It shall be noted that the FactSet does not provide price data on the Mitsubishi Tokyo Finance Group (MTFG) before april 2001 (which might due to the fact that MTFG was the result of two successive mergers - the Mitsubishi bank and the Bank of Tokyo merged in april 1996, the resulting entity merged again with three other japanese banks in april 2001), and MTFG merged again (with UFG Holdings) in october 2005) This forced us to exclude MTFG from our sample. Otherwise, the dataset gives complete price data for the remaining stocks (except for HSBC, whose price data starts on july 1992). Note however that the four stock markets have different closing days, which generate a lot of missing data in the ten years sample.

First, we compute monthly standard deviations over the 120 month period using the full log returns (i.e. price returns plus dividends). This yields a $120 \times 11$ dataset. We use it to compute the average and the median of the monthly standard deviations for each month. Figure 5 shows the evolution of those two measures over the 10 year period. The mean and the median are close, which is good news, but both measures follow a rising trend. Calculating the mean of those two measures over the whole set and the second half of the set confirms this intuition : the ten years average of the monthly standard deviation is

28.69% (the median is 26.5%), the five years average (from may 1996 to april 2001) is 33.72% (the median is 33.05%). This is line with the findings of Campbell et al. (2001), who shows that stock market volatility was rising in the late 1990s.

Given that making a "clean" estimation of the 11 stocks volatility is beyond the scope of this paper, we think that the best solution is to take the five years average of the monthly standard deviations as our measure of volatility, which yields a $\sigma$ around 34% (this is in line with the usual estimation procedures which tend to give more weight to recent data).

**FIGURE 5**
**AVERAGE AND MEDIAN MONTHLY STANDARD DEVIATION OF THE 11 ELEVEN STOCKS (MAY 1991 TO APRIL 2001)**




We did use, at first, the same procedure to compute the monthly correlation matrixes. But, as said before, the daily price dataset has a lot of missing data (due to the different closing days). And missing data is known to have a big impact on the estimation of the correlation matrixes. To get around this problem we use monthly full log returns to compute the correlation matrix of the 11 stocks. Then we compute the average and the median of the correlation coefficients. As before the results depend on the period chosen : the ten years average of the correlation coefficients is 21.04% (the median is 22.11%), the five years average is 23.82% (the median is 25.84%). As before, we take the five years average.

For the sake of coherence, we also use the monthly log returns to estimate the average standard deviation. The results of this procedure are (fortunately) very close to the one obtained with daily data : the five years average of the monthly standard deviation is 34.89% (the ten years average is 29.97%).

To compute the estimation of the expected dividend rate, we use the monthly log returns series (with and without dividends). The (implicit) dividend rate is the difference between the full log returns $R_t^F$ and the price log return $R_t$, i.e. $q_t = R_t^F - R_t$. Table 8 shows the average annual returns and the average annual dividend (average are computed over two periods : may 1991 to april 2001, and may 1996 to april 2001). As before, we take the five year average, so that $q = 2.1\%$.

**TABLE 8**
**AVERAGE ANNUAL RETURNS AND DIVIDENDS**

| | 1991-2001 | 1996-2001 |
|---|---|---|
| Average Full Returns ($R^F$) | 15.15% | 16.59% |
| Average Price Returns ($R$) | 12.74% | 14.44% |
| Average Dividend Date ($q$) | 2.39% | 2.1% |

Our last parameter is the average risk premium ($\mu$). The simplest solution would be to use the past returns. But this would be a bad idea since past returns are considered a poor predictor of future returns. The efficient market hypothesis, for instance, holds that past returns can't be used to forecast future returns. Other works maintain that stock returns exhibit mean reversion (Shiller, 2015). This may have some relevance here, since the *JET3* stocks had a stellar performance in the ten years period prior 2001 (HSBC had the most spectacular performance - 25% per year between 1992 and 2001, followed by LLoyds - 22% per year between 1991 and 2001). One might wonder if the analysts of BNP Paribas expected the continuation of this trend for the ten following years...

Yet, what we need is the expectation of a small, unsophisticated, investor. Here the *JET3* contract gives an interesting clue : the objective is to triplicate the investor's capital - i.e. a 11.62% annual return (the number is mentioned in the contract). Taking the difference between 11.62% and the zero coupon interest rate (5%) yields a (subjective) estimate of the risk premium, which is - admittedly - quite high ($\mu = 6.62\%$). But other cues seems to justify the choice of a high $\mu$. The Siegel (1994) book, very popular in the 1990s, shows that US stocks real returns were close to 7% over the last 150 years. More recent data shows that US stocks real returns averaged 10.1% between 1981 and 2001, with an equity premium between 3% and 6%. Given the very high stock performance of the late 1990s, we think that taking an expected risk premium equal to 6% is not unreasonable for our unsophisticated investors (this implies a expected nominal return equal to $r + \mu = 11\%$ or 9% in real terms, since expected inflation was close to 2%).

## B: RANKING OF THE PORTFOLIOS

Table 9 shows the complete ranking of the 10 portfolios with a CRRA utility function, for $\gamma \in [0,20]$.

Table 10 shows the complete ranking of the 10 portfolios with a CRRA utility function, and a salience distortion, for $\gamma \in [0,20]$ and $\delta = 0.75$.

**TABLE 9**
**COMPLETE RANKING OF THE PORTFOLIOS**

| γ | *ZERO* | *ETF* | *75/25* | *50/50* | *25/75* | *CALL* | *ASIA* | *ALTIP* | *S-CALL* | *S-ASIA* | *S-ALTIP* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 - 0.35 | 11 | 4 | 5 | 8 | 10 | 1 | 2 | 3 | 6 | 7 | 9 |
| 0.4 - 1.3 | 11 | 4 | 5 | 9 | 10 | 1 | 2 | 3 | 6 | 7 | 8 |
| 1.35 | 11 | 4 | 5 | 9 | 10 | 2 | 1 | 3 | 6 | 7 | 8 |
| 1.4 - 1.65 | 11 | 4 | 5 | 9 | 10 | 3 | 1 | 2 | 6 | 7 | 8 |
| 1.7 - 1.75 | 11 | 4 | 5 | 8 | 10 | 3 | 1 | 2 | 6 | 7 | 9 |
| 1.8 - 1.85 | 11 | 3 | 5 | 8 | 10 | 4 | 2 | 1 | 6 | 7 | 9 |
| 1.9 | 11 | 1 | 5 | 8 | 10 | 4 | 3 | 2 | 6 | 7 | 9 |
| 1.95 - 2 | 11 | 1 | 4 | 8 | 10 | 5 | 3 | 2 | 6 | 7 | 9 |
| 2.05 | 11 | 1 | 4 | 8 | 10 | 6 | 3 | 2 | 5 | 7 | 9 |
| 2.1 - 2.2 | 11 | 1 | 2 | 7 | 10 | 9 | 4 | 3 | 5 | 6 | 8 |
| 2.25 | 11 | 1 | 2 | 7 | 10 | 9 | 5 | 4 | 3 | 6 | 8 |
| 2.3 | 11 | 1 | 2 | 5 | 10 | 9 | 8 | 7 | 3 | 4 | 6 |
| 2.35 - 2.5 | 11 | 1 | 2 | 5 | 9 | 10 | 8 | 7 | 3 | 4 | 6 |
| 2.55 - 2.6 | 11 | 1 | 2 | 5 | 7 | 10 | 9 | 8 | 3 | 4 | 6 |
| 2.65 | 11 | 1 | 2 | 4 | 7 | 10 | 9 | 8 | 3 | 5 | 6 |
| 2.7 - 2.9 | 10 | 1 | 2 | 4 | 7 | 11 | 9 | 8 | 3 | 5 | 6 |
| 2.95 | 9 | 1 | 2 | 4 | 7 | 11 | 10 | 8 | 3 | 5 | 6 |
| 3 - 3.3 | 8 | 1 | 2 | 4 | 7 | 11 | 10 | 9 | 3 | 5 | 6 |
| 3.35 - 3.4 | 8 | 2 | 1 | 4 | 7 | 11 | 10 | 9 | 3 | 5 | 6 |
| 3.45 - 3.8 | 8 | 2 | 1 | 3 | 7 | 11 | 10 | 9 | 4 | 5 | 6 |
| 3.85 - 3.9 | 8 | 3 | 1 | 2 | 7 | 11 | 10 | 9 | 4 | 6 | 5 |
| 3.95 - 4.55 | 8 | 6 | 1 | 2 | 7 | 11 | 10 | 9 | 5 | 4 | 3 |
| 4.6 - 4.85 | 8 | 7 | 2 | 1 | 6 | 11 | 10 | 9 | 5 | 4 | 3 |
| 4.9 | 8 | 7 | 3 | 1 | 6 | 11 | 10 | 9 | 5 | 4 | 2 |
| 4.95 - 5.2 | 8 | 7 | 4 | 1 | 6 | 11 | 10 | 9 | 5 | 3 | 2 |
| 5.25 - 5.7 | 8 | 7 | 5 | 1 | 6 | 11 | 10 | 9 | 4 | 3 | 2 |
| 5.75 - 6.05 | 8 | 7 | 6 | 1 | 5 | 11 | 10 | 9 | 4 | 3 | 2 |
| 6.1 | 8 | 7 | 6 | 1 | 4 | 11 | 10 | 9 | 5 | 3 | 2 |
| 6.15 - 6.7 | 7 | 8 | 6 | 1 | 4 | 11 | 10 | 9 | 5 | 3 | 2 |
| 6.75 - 6.8 | 7 | 8 | 6 | 1 | 3 | 11 | 10 | 9 | 5 | 4 | 2 |
| 6.85 - 7.45 | 7 | 8 | 6 | 1 | 2 | 11 | 10 | 9 | 5 | 4 | 3 |
| 7.5 - 8.4 | 7 | 8 | 6 | 2 | 1 | 11 | 10 | 9 | 5 | 4 | 3 |
| 8.45 - 11.35 | 6 | 8 | 7 | 2 | 1 | 11 | 10 | 9 | 5 | 4 | 3 |
| 11.4 - 12.7 | 5 | 8 | 7 | 2 | 1 | 11 | 10 | 9 | 6 | 4 | 3 |
| 12.75 | 4 | 8 | 7 | 2 | 1 | 11 | 10 | 9 | 6 | 5 | 3 |
| 12.8 - 12.85 | 3 | 8 | 7 | 2 | 1 | 11 | 10 | 9 | 6 | 5 | 4 |
| 12.9 - 13.3 | 2 | 8 | 7 | 3 | 1 | 11 | 10 | 9 | 6 | 5 | 4 |
| 13.35 - 13.55 | 2 | 8 | 7 | 4 | 1 | 11 | 10 | 9 | 6 | 5 | 3 |
| 13.6 - 19.85 | 2 | 8 | 7 | 5 | 1 | 11 | 10 | 9 | 6 | 4 | 3 |
| 19.9 - 20 | 2 | 8 | 7 | 6 | 1 | 11 | 10 | 9 | 5 | 4 | 3 |

### TABLE 10
### COMPLETE RANKING OF THE PORTFOLIOS, WITH A SALIENCE DISTORTION

| $\gamma$ | *ZERO* | *ETF* | *75/25* | *50/50* | *25/75* | *CALL* | *ASIA* | *ALTIP* | *S-CALL* | *S-ASIA* | *S-ALTIP* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 - 0.25 | 3 | 9 | 8 | 5 | 2 | 11 | 10 | 7 | 6 | 4 | 1 |
| 0.3 - 0.55 | 3 | 9 | 7 | 5 | 2 | 11 | 10 | 8 | 6 | 4 | 1 |
| 0.6 - 0.75 | 3 | 8 | 7 | 5 | 2 | 11 | 10 | 9 | 6 | 4 | 1 |
| 0.8 - 8.95 | 3 | 8 | 7 | 6 | 2 | 11 | 10 | 9 | 5 | 4 | 1 |
| 9 - 12.75 | 2 | 8 | 7 | 6 | 3 | 11 | 10 | 9 | 5 | 4 | 1 |
| 12.8 - 20 | 1 | 8 | 7 | 6 | 3 | 11 | 10 | 9 | 5 | 4 | 2 |

## C: ROBUSTNESS

This section show how the expected subjective payoffs and the ranking of the portfolios are impacted by changes in the salience parameter $\delta$.

Table 11 summarizes the main results when we vary $\delta$ from 0.05 to 1, for a linear utility. Table 12 shows the rankings of the different portfolios when we vary $\delta$ from 0.05 to 1, for a CRRA utility with $\gamma = 2$. The following tables give the same information for $\gamma = 4$ and $\gamma = 6$. As can be seen in tables 11 to 14, our main results hold for a plausible range of risk-return preferences, as long as $\delta \leq .8$.

### TABLE 11
### IMPACT OF $\delta$, FOR A LINEAR UTILITY

| δ | Return of St. Altiplano (SA) | | Rank | | |
|---|---|---|---|---|---|
| | **Range %** | **Average %** | **SA** | **1st** | **2nd** |
| 0.05 - 0.58 | 10.581 - 12.939 | 11.76 | 1 | *S-ALTIP* | *ZERO* |
| 0.59 - 0.83 | 12.958 - 9.947 | 11.453 | 1 | *S-ALTIP* | *25/75* |
| 0.84 - 0.85 | 9.658 - 9.376 | 9.517 | 1 | *S-ALTIP* | *ALTIP* |
| 0.86 - 0.88 | 9.099 - 8.567 | 8.833 | 2 | *ALTIP* | *S-ALTIP* |
| 0.89 | 8.311 - 8.311 | 8.311 | 3 | *ALTIP* | *ASIA* |
| 0.9 | 8.061 - 8.061 | 8.061 | 5 | *ALTIP* | *ASIA* |
| 0.91 | 7.817 - 7.817 | 7.817 | 6 | *ALTIP* | *ASIA* |
| 0.92 | 7.579 - 7.579 | 7.579 | 7 | *ALTIP* | *ASIA* |
| 0.93 | 7.348 - 7.348 | 7.348 | 8 | *ALTIP* | *ASIA* |
| 0.94 - 1 | 7.122 - 5.899 | 6.511 | 9 | *CALL* | *ASIA* |

**TABLE 12**
**IMPACT OF $\delta$, FOR A CRRA UTILITY ($\gamma = 2$)**

| δ | S-ALTIP | Rank 1st | Rank 2nd |
|---|---|---|---|
| 0.05 - 0.66 | 1 | *S-ALTIP* | *ZERO* |
| 0.67 - 0.88 | 1 | *S-ALTIP* | *25/75* |
| 0.89 - 0.93 | 1 | *S-ALTIP* | *50/50* |
| 0.94 | 2 | *75/25* | *SALTIP* |
| 0.95 - 0.96 | 3 | *75/25* | *ETF* |
| 0.97 | 3 | *ETF* | *75/25* |
| 0.98 | 5 | *ETF* | *75/25* |
| 0.99 | 8 | *ETF* | *75/25* |
| 1 | 9 | *ETF* | *ALTIP* |

**TABLE 13**
**IMPACT OF $\delta$, FOR A CRRA UTILITY ($\gamma = 4$)**

| δ | S-ALTIP | Rank 1st | Rank 2nd |
|---|---|---|---|
| 0.05 - 0.69 | 1 | *S-ALTIP* | *ZERO* |
| 0.7 - 0.91 | 1 | *S-ALTIP* | *25/75* |
| 0.92 - 0.97 | 1 | *S-ALTIP* | *50/50* |
| 0.98 | 2 | *50/50* | *S-ALTIP* |
| 0.99 - 1 | 3 | *75/25* | *50/50* |

**TABLE 14**
**IMPACT OF $\delta$, FOR A CRRA UTILITY ($\gamma = 6$)**

| δ | S-ALTIP | Rank 1st | Rank 2nd |
|---|---|---|---|
| 0.05 -0.72 | 1 | *S-ALTIP* | *ZERO* |
| 0.73 -0.79 | 1 | *S-ALTIP* | *25/75* |
| 0.8 -0.94 | 2 | *25/75* | *S-ALTIP* |
| 0.95 -0.95 | 1 | *S-ALTIP* | *25/75* |
| 0.96 -0.97 | 1 | *S-ALTIP* | *50/50* |
| 0.98 - 1 | 2 | *50/50* | *S-ALTIP* |