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Exotic Collections Asset Pricing: The Lagrangian Optimization

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Abstract

Exotic collections include all non-traditional financial assets that investors pursue for investments and psychological satisfaction purposes. This paper proposes a dynamic Lagrangian model to price these assets, which carry special features compared to traditional assets. The model assumes two types of agents: one has a fixed ratio of traditional investment and the other faces the tradeoff between traditional and exotic investment. The model also incorporates risks of various assets in the utility function to best mimic the real world investor decision. This paper develops the dynamic model and derives the conditions that maximize the agent's utility in infinite lives. This paper also solves the optimization conditions to present a solution to investment decision.

Keywords: Non-traditional asset; utility; lagrangian model; alternative asset; asset pricing; art; luxury; optimization.

1 Background

Exotic collection investment is a growing category of financial vehicle in the global capital market [1]. It is a special asset class that distinguishes from all the existing financial instruments. It mainly includes art, storable luxury goods, and other cultural or hobby-related collections, such as

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antiques, big walnuts for the Chinese people, and rare breed dogs. Collections are traded as financial assets, because the primary reason of acquiring these assets is for resale and capital appreciation. Collections also bring real life utility to the owner. However, such utility is often different from the visible functions that other normal products, for instance, wheat or steel, can provide. This research therefore arrives at a new pricing model compared to the classical pricing models that emphasize on the pure return and risk features of an asset. To reach the new pricing mechanism that incorporates the real life utility and competitive returns offered by alternative investment vehicles, this paper first attempts to create a specific utility function for the holders of the exotic collections.

The major contribution of this paper is to create a utility function to incorporate the special features of exotic collections and solve the equilibrium price using the Lagrangian model method. This study includes the risk of the exotic item into the utility function as a financial asset. This paper also adds its consumption in the model to reflect its commodity-side feature. In addition, the model releases the assumption to allow exotic collections to compete with traditional asset for a typical investor.

Stocks and bonds are usually regarded as pure financial assets, and derivatives are also pure financial assets whose value is based on the fundamental financial assets. Alternative investments, which mainly refer to real estate, insurance, and private equity, offer investors visible utilities in addition to the financial appreciation. Spot and futures commodity markets also deliver such visible functions. All these instruments are regarded as traditional assets, in contrast to the exotic collections discussed in this paper.

Exotic asset not only takes the role of financial instrument but also carries invisible add-on utility for the investors. Such add-on utility, compared to other assets and goods, is not finance related and less real life related. Therefore pure financial assets like swaps are not included from this discussion; neither are goods with visible real life utility, such as real estate.

The purposes of incorporating exotic collections in the portfolio are primarily return pursuing and risk diversification. Hence investors have two key concerns: the return of exotic category at a given risk level, and the covariance of this category with traditional asset. The first one links to the performance measure, and the second one is related to the component weight of a portfolio.

However, setting threshold for the preference of exotic collections investment or traditional investment tool is not feasible. In addition, the combination of return and risk of exotic collections investment cannot be compared with other investment vehicles such as equity or bonds by some quantitative measures. Sharpe ratio, Treynor ratio, or Modigliani & Modigliani measure are not effective scales that investors can adopt to make exotic collections investment decisions. It is against the market reality to assume that an investor will turn to pursue bonds instead of exotic collections, even if the returns of exotic items are lower. The most significant reason for the failure of conventional measurement tools is due to the uniqueness of exotic collections, its add-on value, and the unique risk.

Firstly, the uniqueness of exotic collections leads to the different pricing mechanism. Free of arbitrage opportunity is the general methodology for regular asset pricing in classical finance theory. Nevertheless, such method assumes infinite supply and demand of investment instruments. Exotic asset has very limited supply, and the demand, due to the professional knowledge requirement, is narrow as well. The power of demand and supply takes an important role, rather than the non-feasible arbitrage. In this case, the price and return of exotic collections depends on the supplier's reserved value, and the maximum offer price from the demand side. The two sides usually have heterogeneous views in terms of exotic collections price [2]. This twists the equilibrium price, compared to the homogeneous prices of stocks and bonds in the open market.

Secondly, the add-on value of exotic collections refers to the non-pecuniary value that exotic collections bring for its owner. Such value can be from the recognition of the peers of the owner, and social respect. While owning one million dollar is a sign of wealth, owning a one-million-dollar-worth painting extends the signal from wealth to the combination of wealth, good taste, and higher social status [3]. Conclude that luxury good purchase signals subsequent externalities; [4] suggest that purchasing luxury goods meet the psychological need and the need of redistributing the wealth.

Thirdly, risk of conventional investment instruments is usually defined and measured by the variance and standard deviation of the return. This is partially appropriate of exotic collections investment. As the durations of buying, holding, and reselling of many exotic collections are extremely long, the short run turbulence of its price is not considered as risk at all [5]. In addition, hedonic or repeated sales pricing process is not applied to a unique exotic piece at a continuous manner. Exotic asset investment involves other significant and unique risk factors, for instance, forgery risk, legal risk, or physical damage risk [6]. Previous studies find the return of exotic collections investment underperforms equities and bonds, and the risk premia are negative. Examples of such conclusion are: [7,8,9,10]. Such conclusions are based on the traditional risk measure, which is used to measure, though cautions are necessary, for the uncertainty of the values of exotic pieces.

Therefore, comparing the pecuniary return of exotic collections investment is less meaningful, as exotic collections is a hybrid of consumption and investment. On contrast, it is reasonable to compare the utility of exotic collections investment with the utility of other investments and set up such comparison in a dynamic framework similar to [11]. The first step in this study is thus to specify the unique utility function of exotic collections investment in section 2. This paper then proceeds to solve the model and price the exotic collections in section 3.

2 The Model

This paper proposes the utility function of an infinitely lived agent as:

$$u_t = u_t(c_t, \sigma_t, p_t) \tag{1}$$

$$c_t = c_t((1-s)y_t + \gamma_t(p_t^{'} - p_{t-1}^{'}) - p_t) \tag{2}$$

$$sy_t = I(r^{TR}, \sigma_t^{Tr}) \tag{3}$$

The utility of the agent has the following assumptions:

1. $u(\cdot)$is defined on $\mathbb{R}_+^L \to C^4$, where L is the dimension of the consumption space.

2. $u(\cdot)$ is strictly concave: $\lambda u(c_t) + (1-\lambda)u(c_t+\varepsilon) \prec u(c_{t,_{\lambda+(1-\lambda)\varepsilon}})$, $\forall c$, where $\varepsilon > 0$

3. $\frac{\partial u_t}{\partial c_t} > 0, \frac{\partial u_t}{\partial \sigma_t} < 0, \frac{\partial u_t}{\partial p_t} \in \sin(x_1)$, where $x_1 \in (-\frac{\pi}{2}, \frac{\pi}{2}), \frac{\partial u_t}{\partial \gamma_t} \in \sin(x_2)$, where $x_2 \in (-\frac{\pi}{2}, \frac{\pi}{2})$

4. $\lim_{c_t \to 0} \frac{\partial u_t}{\partial c_t} = +\infty$

5. $\lim_{c_t \to 0} \frac{\partial u_t}{\partial c_t} = 0$

The utility of the agent is determined by three major factors: current consumption c_t, the risk of current exotic collections investment σ_t, and the price of the current period new exotic collections purchase p_t. The utility strictly increases as current consumption increases, and decreases as the risk of current exotic collections investment increases. However, the price of current exotic collections purchase has an ambiguous impact on utility. While the agent maximizes her utility by avoiding pay high price of the exotic collections collection, the higher price satisfies her psychological needs and increases her utility [12]. In addition, the resale ratio of the previously purchased asset can also affect the utility in two directions.

As Equation (2) suggests, the current consumption is an endogenous factor that is affected by the current output y_t, the marginal savings rate s, the current period resale ratio γ_t, the price change of the exotic collections collection that was purchased in the previous period $(p_t^{'} - p_{t-1}^{'})$, and the price of the current period new exotic collections purchase p_t . The current disposable consumption is the output after savings, with previous exotic collections appreciation added and current exotic collections investment excluded.

The current savings sy_t is the investment in traditional financial markets. For purpose of simplicity, this paper assumes that the marginal propensity to save (MPS) is a constant. This assumption is reasonable as the MPS is determined by habit and culture, which is stable across time for the agent. As Equation (3) presents, saving is an investment function $I(\cdot)$ of the risk of the traditional financial instruments, σ_t^{Tr} . The price appreciation for the previously purchased collection can increase the current consumption feasible set, if the agent no longer proceeds to hold the asset. In such case this paper adds the resale ratio $\gamma_t \in [0,1]$ as the probability of realizing the asset appreciation.

As unique financial asset and real life goods, exotic collections carries special risks and those uncertainties affect the utility of the agent who holds that exotic collections. This study therefore includes the risk term in the utility function. This is the first study that incorporates risk in the consumption based equilibrium model. The risk term σ_t reflects the fluctuation of the prices of the currently and previously purchased exotic collections, p_t and $p_t^{'}$. On the other hand, the risk of traditional investment instruments, σ_t^{Tr}, is not incorporated in Equation (1). This is because the marginal savings rate on these instruments is regarded as constant and their risk level is exogenous to the agent.

The major risk components are: (1) interest rate risk: when the prime interest rates in the major economies decreases and the bonds market booms, the time value of exotic collections will be diluted; (2) macroeconomic risk: the performance of firm earnings and equity market will distract investors and cash flow will be negative for exotic collections; (3) default risk: the counterparty of the exotic collections transaction is likely to default and the protection mechanism in exotic collections market is weaker than markets with daily settlement procedure; (4) legal risk: the transaction objective might carries illegal concerns and reaction cost is very high. For instance, it is frequently seen that an auction might be announced invalid by the government if the objective of transaction is illegal or is a forgery; (5) physical damage risk: while stocks cannot be destroyed by a cat or fire, exotic items could be destroyed; (6) cultural and country risk: big, unopened, and dated walnuts used by monks can be more expensive than diamond in China, while few U.S. investors will be willing to pay any price higher than a fresh walnut; (7) illiquidity risk: exotic collections is in general an illiquid asset, with thin demand from very specific groups.

3 The Dynamic Equilibrium

This paper sets up the agent's problem in the Lagrangian framework, and then solves the model with specifically assigned function form. An alternative dynamic framework that can also be adopted in the further study is the overlapping generation model. The infinitely lived agent maximizes her utility given the exogenous conditions of the risks of exotic collections and traditional investment instruments, σ_t and σ_t^{Tr}.

$$\max_{c_t, p_t, \gamma_t, p_t^{'}} E_0\left(\sum_{t=1}^{\infty} \beta^t u_t(c_t, \sigma_t, p_t)\right) \tag{4}$$

$$\text{s.t.: } c_t + sy_t + p_t \leq y_t + (1 + r^{TR})sy_{t-1} + (1 + r)(1 - \gamma_{t-1})(p_{t-1}^{'} - p_{t-2}^{'}) \tag{5}$$

The fundamental meaning of the constraint is that the total current expenditure should not exceed the aggregate feasible income. The total current expenditure is comprised of three cash outflows: current consumption c_t, investment on traditional instruments sy_t, and investment on exotic collections assets p_t. The aggregate feasible income includes three cash inflows: current output y_t, the current value of previous investment on traditional instruments $(1 + r^{TR})sy_{t-1}$, and the current value of previous investment on exotic collections$(1 + r)(1 - \gamma_{t-1})(p_{t-1}^{'} - p_{t-2}^{'})$. The investment on the traditional instruments in the previous period t-1 is sy_{t-1}, and assuming the average discount rate is r^{TR}, it current value is augmented by (1+r^{TR}). The investment appreciation on exotic collections in the previous stage is $(p_{t-1}^{'} - p_{t-2}^{'})$. The portion of such appreciation that is not realized and consumed in the previous period is $(1 - \gamma_{t-1})(p_{t-1}^{'} - p_{t-2}^{'})$, and the present value of this reserved exotic collections is $(1 + r)(1 - \gamma_{t-1})(p_{t-1}^{'} - p_{t-2}^{'})$, assuming the average discount rate is r. Note that the discount rates for traditional investment and exotic collections investment, r^{TR} and r, do not vary across time, as these are the average rates. The resale frequencies of exotic collections assets are low, and it is unrealistic to quote the continuous time series returns.

To summarize, the agent's problem is to maximize her utility by determining the current consumption c_t, current investment to exotic collections p_t, and the resale ratio γ_t of the previously purchased exotic collections. The other factors are exogenous and go beyond the control of the agent. As the utility function of the agent is strictly concave, the constraint in Equation (5) is bounded.

The first order conditions of the agent's problem are:

For current exotic collections investment p_t, the intertemporal Euler equation is:

$$(1 + r)(1 - \gamma_{t-1})u_{t-1}^{'}(c_{t-1}, \sigma_{t-1}, p_{t-1}) = \beta E_t(u_t^{'}(c_t, \sigma_t, p_t)) \tag{6}$$

For current resale ratio of previous exotic collections investment γ_t, the intertemporal Euler equation is:

$$-(1+r)u'_{t-1}(c_{t-1},\sigma_{t-1},p_{t-1}) = \beta E_t(u'_t(c_t,\sigma_t,p_t)) \tag{7}$$

This paper proceeds to assign specific function form for the utility maximizing problem. The choice of specific function type is not as important as the meaning it implies, as long as the function meets the assumptions listed in the previous section. The comparison of utility is only reasonable in terms of ordinal sense rather than cardinal setting. Therefore this paper uses the iso-elastic form [13]:

$$u_t(c_t,\sigma_t,p_t) = \frac{c_t^{1-\rho}}{1-\rho} + \frac{\sigma_t^{1-\xi}}{1-\xi} + \frac{p_t^{1-\delta}}{1-\delta}, \text{ where } \rho < 1, \xi < 1, \text{ and } \delta < 1 \tag{8}$$

From Equation (2), this paper explicitly updates the current consumption in Equation (8):

$$u_t(c_t,\sigma_t,p_t) = \frac{c_t((1-s)y_t+\gamma_t(p'_t-p'_{t-1})-p_t)^{1-\rho}}{1-\rho} + \frac{\sigma_t^{1-\xi}}{1-\xi} + \frac{p_t^{1-\delta}}{1-\delta} \tag{9}$$

From Equation (3), this paper updates the traditional investment in Equation (9):

$$u_t(c_t,\sigma_t,p_t) = \frac{c_t(y_t-I(r^{TR},\sigma_t^{Tr}))+\gamma_t(p'_t-p'_{t-1})-p_t)^{1-\rho}}{1-\rho} + \frac{\sigma_t^{1-\xi}}{1-\xi} + \frac{p_t^{1-\delta}}{1-\delta} \tag{10}$$

To maximize the agent's utility over time, the following first order conditions must hold, given the concavity of the function:

$$\frac{\partial u_t}{\partial p_t} = 0 \Leftrightarrow (1+r)(1-\gamma_{t-1})(-{c'_{t-1}}^{-\rho} + p_{t-1}^{-\delta}) = \beta(-{c'_t}^{-\rho} + p_t^{-\delta})$$

$$\Leftrightarrow p_t = (\beta^{-1}\left((1+r)(1-\gamma_{t-1})\left(-{c'_{t-1}}^{-\rho} + p_{t-1}^{-\delta}\right) + \beta {c'_t}^{-\rho}\right))^{-\frac{1}{\delta}} \tag{11}$$

$$\frac{\partial u_t}{\partial \gamma_t} = 0 \Leftrightarrow -(1+r)(-{c'_{t-1}}^{-\rho} \cdot p'_{t-2}) = \beta(-{c'_t}^{-\rho} \cdot p'_{t-1})$$

$$\Leftrightarrow p'_{t-1} = -\beta^{-1}(1+r)({c'_{t-1}}^{-\rho} \cdot p'_{t-2}){c'_t}^{\rho}$$

$$\Leftrightarrow p'_t = -\beta^{-1}(1+r)({c'_t}^{-\rho} \cdot p'_{t-1}){c'_{t+1}}^{\rho} \tag{12}$$

Equations (11) and (12) present the optimal conditions of the agent's decision. However, while Equation (12) concludes the level of the price of previously invested exotic collections that maximized the agent's utility, such price level is exogenous in terms of the agent's control. The only tradeoff that the agent needs to balance is the current consumption and investment on exotic collections, as the marginal savings rate on the traditional instruments is given. Hence the Euler Equation (11) is the only controllable investment that the agent can decide. The right hand side of Equation (11) provides the amount of capital that the agent should invest on exotic collections.

The above model is under the setting that the ratio, s, of the entire output invested into the traditional financial instruments is a constant. This assumption is realistic to the institutional investors who are highly disciplined or under regulation. This assumption, however, can be released for individual investors who pursue maximum return at an acceptable risk level and do not have a mental account of a constant portion. The following model thus describes another type of infinitely lived agent, who incorporates the marginal savings ratio of the conventional investment as an endogenous factor. In each period, the agent balances the tradeoff among three cash outflow options: consumption, investment on conventional asset, and investment on exotic collections. The ratio of capital output that is invested in traditional market is a function of the returns and risks of conventional and exotic collections assets.

The fundamental functions are updated to:

$$u_t = u_t(c_t, \sigma_t, \sigma_t^{Tr}, p_t) \tag{13}$$

$$c_t = c_t((1\text{-}s_t)y_t + \gamma_t(p_t^{'} - p_{t-1}^{'}) - p_t) \tag{14}$$

$$s_t y_t = I(r^{TR}, \sigma_t^{Tr}, r, \sigma_t) \tag{15}$$

The problem of agent without mental account is:

$$\max_{c_t, p_t, \gamma_t, p_t^{'}, s_t} E_0\left(\sum_{t=1}^{\infty} \beta^t u_t(c_t, \sigma_t, \sigma_t^{Tr}, p_t)\right) \tag{16}$$

$$\text{s.t.: } c_t + s_t y_t + p_t \le y_t + (1 + r^{TR}) s_t y_{t-1} + (1 + r)(1 - \gamma_{t-1})(p_{t-1}^{'} - p_{t-2}^{'}) \tag{17}$$

The first order conditions of this updated agent's problem are:

For current exotic collections investment p_t, the intertemporal Euler equation is:

$$(1 + r)(1 - \gamma_{t-1}) u_{t-1}^{'}(c_{t-1}, \sigma_{t-1}, \sigma_{t-1}^{Tr}, p_{t-1}) = \beta E_t(u_t^{'}(c_t, \sigma_t, \sigma_t^{Tr}, p_t)) \tag{18}$$

For current resale ratio of previous exotic collections investment γ_t, the intertemporal Euler equation is:

$$-(1 + r) u_{t-1}^{'}(c_{t-1}, \sigma_{t-1}, \sigma_{t-1}^{Tr}, p_{t-1}) = \beta E_t(u_t^{'}(c_t, \sigma_t, \sigma_t^{Tr}, p_t)) \tag{19}$$

For current traditional asset investment ratio s_t, the intertemporal Euler equation is:

$$((1 + r^{TR}) y_{t-1} - y_t) u_{t-1}^{'}(c_{t-1}, \sigma_{t-1}, \sigma_{t-1}^{Tr}, p_{t-1}) = \beta E_t(u_t^{'}(c_t, \sigma_t, \sigma_t^{Tr}, p_t)) \tag{20}$$

This paper use the similar function form presented in Equation (8) for the utility maximizing problem:

$$u_t(c_t, \sigma_t, \sigma_t^{Tr}, p_t) = \frac{c_t^{1-\rho}}{1-\rho} + \frac{\sigma_t^{1-\xi}}{1-\xi} + \frac{{\sigma^{Tr}}_t^{1-\varphi}}{1-\varphi} + \frac{p_t^{1-\delta}}{1-\delta}, \text{ where } \rho < 1, \xi < 1, \varphi < 1, \text{ and } \delta < 1 \tag{21}$$

From Equation (14), This paper explicitly update the current consumption in Equation (21):

$$u_t(c_t, \sigma_t, \sigma_t^{Tr}, p_t) = \frac{c_t((1-S_t)y_t + \gamma_t(p_t^{'} - p_{t-1}^{'}) - p_t)^{1-\rho}}{1-\rho} + \frac{\sigma_t^{1-\xi}}{1-\xi} + \frac{{\sigma^{Tr}}_t^{1-\varphi}}{1-\varphi} + \frac{p_t^{1-\delta}}{1-\delta} \tag{22}$$

From Equation (15), This paper update the traditional investment in Equation (22):

$$u_t(c_t, \sigma_t, \sigma_t^{Tr}, p_t) = \frac{c_t(y_t - I(r^{TR}, \sigma_t^{Tr}, r, \sigma_t) + (p_t' - p_{t-1}') - p_t)^{1-\rho}}{1-\rho} + \frac{\sigma_t^{1-\xi}}{1-\xi} + \frac{\sigma^{Tr}{}_t^{1-\varphi}}{1-\varphi} + \frac{p_t^{1-\delta}}{1-\delta} \tag{23}$$

The following first order conditions must hold to maximize the agent's utility presented in Equation (16), given the concavity of the iso-elastic utility function:

$$\frac{\partial u_t}{\partial p_t} = 0 \Leftrightarrow (1+r)(1-\gamma_{t-1})(-c_{t-1}'^{-\rho} + p_{t-1}^{-\delta}) = \beta(-c_t'^{-\rho} + p_t^{-\delta})$$
$$\Leftrightarrow p_t = (\beta^{-1}\left((1+r)(1-\gamma_{t-1})(-c_{t-1}'^{-\rho} + p_{t-1}^{-\delta}) + \beta c_t'^{-\rho}\right))^{-\frac{1}{\delta}} \tag{24}$$

$$\frac{\partial u_t}{\partial \gamma_t} = 0 \Leftrightarrow -(1+r)(-c_{t-1}'^{-\rho} \cdot p_{t-2}') = \beta(-c_t'^{-\rho} \cdot p_{t-1}')$$
$$\Leftrightarrow p_{t-1}' = -\beta^{-1}(1+r)(c_{t-1}'^{-\rho} \cdot p_{t-2}')c_t'^{\rho}$$
$$\Leftrightarrow p_t' = -\beta^{-1}(1+r)(c_t'^{-\rho} \cdot p_{t-1}')c_{t+1}'^{\rho} \tag{25}$$

$$\frac{\partial u_t}{\partial s_t} = 0 \Leftrightarrow ((1+r^{TR})y_{t-1} - y_t)(-c_{t-1}'^{-\rho} \cdot y_{t-1}) = \beta(-c_t'^{-\rho} \cdot y_t)$$
$$\Leftrightarrow r^{TR} = (c_{t-1}'^{-\rho} y_{t-1}^2)^{-1} \cdot (\beta c_t'^{-\rho} y_t + c_{t-1}'^{-\rho} y_t y_{t-1} - c_{t-1}'^{-\rho} y_{t-1}^2) \tag{26}$$

Similar with the agent's problem in which the marginal savings rate on traditional assets is constant, the agent in the above problem still face an exogenous exotic collections price p_t'. This price level is determined by market demand and supply equilibrium, and hence is not under the control of the agent. However, the agent can maximize her utility by pursuing the exotic collections when the price equals the level determined by Equation (24) and when the return of the traditional asset reaches the level specified by Equation (26). The designing of the utility function with the iso-elastic form [13] guarantees the maxima is global instead of local, therefore this study does not further present the second order condition to make valid of the conclusions of the first order condition. This is consistent with the settings used in [14].

4 Conclusion

This paper uses the infinitely-lived Lagrangian model to price the exotic collections and identify the endogenous conditions that maximize the utility of an infinitely lived agent.

This paper set up two types of agents: an agent who only needs to determine the tradeoff of exotic collections investment and consumption, with fixed marginal propensity to save on traditional asset. Such stickiness on traditional investment instrument is reasonable for reasons like regulation, knowledge of collections learning curve barrier, or portfolio needs. For this agent, when the contemporary exotic collections price equals the level presented in Equation (11), sacrificing one unit of consumption to invest in one unit of exotic collections can make her better off.

The other type of agent in this study is more appropriate for non-sophisticated individual investors. This agent does not exhibit stickiness in terms of the ratio of investment on the traditional assets, *e.g.*, bonds and stocks. This agent is less disciplined and show higher level of flexibility on investment preference. She pursues higher return with controllable risk level, and the ratio of exotic collections vis-à-vis traditional asset is affected by the risk and returns of these assets over time. In such case, she faces the tradeoff among three capital outflows: consumption, traditional investment, and exotic collections investment. This paper proposes that the utility of such agent is optimized when the conditions presented in Equation (24) and (26) hold.

To conclude, Equation (11) and (12) provide the equilibrium price for the first agent, and Equation (24), (25), and (26) price the exotic collections for the second agent. Further studies that are relevant but independent might be expanding the exotic collections set in an infinite dimensional $\mathbb{R}^+$ space. This will allow the individual exotic collections to be priced. Exotic asset competes among one other as substitute goods in this case and the pricing can better mimic the real behavior of an agent.

Competing Interests

Author has declared that no competing interests exist.

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