The pay-for-success contract: A valuation note

Andreas Andrikopoulos
University of Piraeus
Department of Maritime Studies
21 Grigoriou Lampraki & Distomou Str.
18533 Piraeus, Greece
E-mail: apa@unipi.gr
Contact author

Andrianos E. Tsekrekos
Athens University of Economics and Business
Department of Accounting and Finance
76 Patission Str.
10434 Athens, Greece
E-mail: tsekrekos@aueb.gr

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Abstract

Pay-for-success contracts are social and financial innovations in social policy and capital markets, respectively. This paper argues that they exhibit option-like payoffs and implements standard option-pricing arguments in assessing the value of investing in pay-for-success contracts. Sensitivities vis-à-vis contract specifications are reflected in the valuation formula and help reach investment and social policy decisions. These sensitivities are demonstrated via a numerical application that uses parameters drawn from the Massachusetts Juvenile Justice Pay for Success Initiative, the largest pay-for-success initiative in the U.S. at the time of its launch.

JEL: G13; I30; Z19

Keywords: pay-for-success contracts; social impact bonds; pay-for-performance contracts; social finance; option pricing

Introduction

Pay-for-success contracts are joint projects of public sector, private sector, and civil society to address social or environmental problems in a way that lowers the costs and exceeds the performance of similar activities that are implemented by the public sector exclusively. Pay-for-success contracts are also known as social impact bonds or pay-for-performance contracts and funded projects are part of the growing impact-investment ecosystem (OECD, 2016; Andrikopoulos, 2021). In these contracts investors provide funds for a project that tackles a social problem. Tackling the social problem involves the articulation of a network of collaborating nodes, namely a) government authorities who have undertaken the political responsibility for addressing a social problem such as homelessness, unemployment, recidivism of former prisoners, early school leavers etc. b) suppliers of capital that include for-profit investors, impact investors, civil society organizations and organizations affiliated with the government (e.g., the National Community Lottery Fund in the UK), c) private-sector or civil-society social service providers that consume the largest part of the project's budget, d) service users, which are citizens, e) independent evaluators who identify and measure project outcomes, and f) intermediaries who coordinate all involved nodes in this network (for an introduction to the rationale and structure of these contracts, see, e.g., Gustafsson et al. (2015), Maduro et al. (2015), Edmiston and Nicholls (2018) and Millner and Meyer (2022)).

If the problem is successfully resolved, then the investors receive a payoff. The payoff is financed by the government that achieves cost savings since it is the investors who pay to implement a social policy, provided that the amount of accomplished savings exceeds the payoffs to investors. The payoff to investors has an upper bound, reflecting, in principle, that investments in social policy are not purely speculative. The first social impact bond was launched in 2010 and aimed at reducing the recidivism of young former prisoners in HMP Peterborough in United Kingdom (Nicholls and Tomkinson, 2015). Subsequent similar projects in the US include the social impact bond for addressing recidivism in the Rikers Island prison in 2012 (Olson and Phillips, 2013), the Massachusetts Juvenile Justice Pay for Success Initiative in 2014 (Pandey et al., 2018), the Integration SIB Project in Finland in 2017, the Inclusive Youth Employment Pay For Performance Platform in South Africa in 2018, and the AiLSi jail diversion program for homeless people suffering from mental illness in Marseille in 2021. Critically, payoff depends on causally associating the funded social intervention with observed social change. For example, if the pay-for-success contract addresses recidivism of former prisoners, the reduction of recidivism helps the government save expenses on the penitentiary system (e.g., less bed-days for prisons) and these savings can trigger payments to investors. Likewise, in social inclusion projects, successful project implementation may imply steady employment and residence for citizens that have formerly been socially excluded, thereby helping the government save expenses on the respective welfare services and make payments to investors. The causal link between the implemented social policy and observed social changes is usually assessed by an independent validator that employs methodologies largely based on randomized control trials.

As an emerging policy instrument, pay-for-success contracts have spawned an ongoing debate on the limitations, the span and the synergies between the public sector, the private sector, and the civil society as systems for shaping the content and prospect of social welfare (e.g., Schinckus, 2017; Harvey and Ogman, 2019; Andrikopoulos, 2020). The limitations of pay-for-success contracts hinder their way to becoming mainstream (Walker et al. 2022), even though there have been 292 contracts initiated since 2010 and their population keeps growing.[1] First, sustainable social outcomes may require stakeholder involvement long after these contracts have expired (Sinclair et al., 2021). Second, significant transaction costs are involved in designing a contract that is uniquely context-specific, bringing together counterparties with substantially diverse priorities and identities, thereby raising agency problems and challenging the possibility of pursued social and monetary benefits (Pauly and Swanson, 2017; Del Giudice and Magliavacca, 2019; Muñoz and Kimmit, 2020; Millner and Meyer 2021). Third, an evidence-informed and reward-based social policy that accommodates a profit-making private sector is exposed to making the provision of commodified social services contingent upon the attainment of profit, as opposed to the provision of social services by the government that is accountable to citizens whose problems are being addressed (Harvey and Ogman 2019; Sinclair et al. 2021). Despite all these reasonable concerns, pay-for-success contracts are important and can bear a positive impact on policy design since they expand the range of contractual possibilities and can therefore provide solutions to social problems where conventional policy designs and financial contracts fail to do so.

Admittedly, social policies cannot be exhaustively contained in valuation formulas and the epistemic foundations of financial economics are substantially challenged in the field of social finance (e.g., Lagoarde-Segot, 2019; Paranque and Revelli, 2019). Nevertheless, the discussion on investment problems can be richer when properly quantified, and, when discussions on impact investments grow, the range on available responses to social challenges widens. The following section derives a valuation result, and the subsequent section provides a numerical application of the valuation formula, using parameters drawn from the Massachusetts Juvenile Justice Pay for Success Initiative, the largest pay-for-success initiative in the US at the time of its launch in 2014. The last section concludes this note.

[1] https://golab.bsg.ox.ac.uk/knowledge-bank/indigo/impact-bond-dataset-v2/ .

Pay-for-success contracts: valuation

Pay for success contracts exhibit immense variety in their contractual arrangement because they reflect the diverse characteristics of the social problems being addressed. For simplicity, we assume all contract cash flows take place at contract expiry. The payoff to an investment in a pay-for-success contract is

$$\min\left(\alpha \times \max(K - S_T, 0), B\right), \tag{1}$$

where:

K is the cost currently incurred by the public sector in the provision of the social service within a $[0, T]$ time span, where T is the time when the contract expires. If the implemented contract does not deliver cost savings for the public sector, then there is no payoff to the investor.

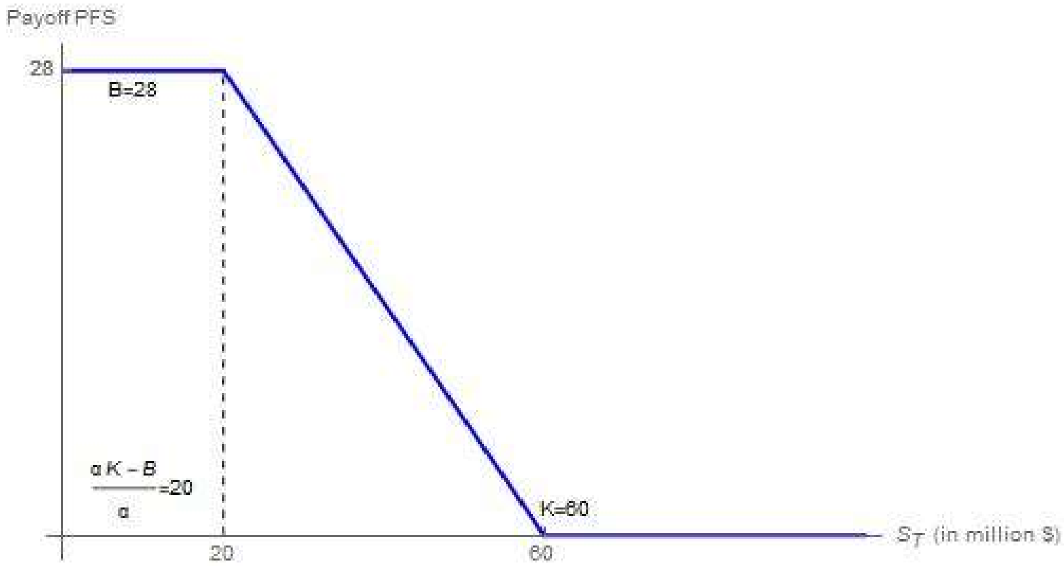
S_T is the cost incurred by the public sector in the provision of the social service under the pay-for-success contract, at contract expiry; e.g., S_T stands for the cost of welfare services that are provided by the government in the context of a pay-for-success contract that pursues inclusion for the socially excluded, whereas K stands for the cost of welfare services if no pay-for-success contract is implemented.

Parameter α is the fraction of public-sector cost savings, $max(K - S_T, 0)$, that is the paid to the investor, $0 \leq \alpha \leq 1$. Parameter α could be called a *profit sharing constant*.

B is the maximum amount that can be paid to the investor according to the contract. B could be called a *surplus cap*. Contract specifications for α and B must be such that $\alpha K - B > 0$.

Figure 1 shows the payoff to the impact investor, demonstrating the similarity between the pay-for-success contract and a put spread.

Figure 1. Pay-for-success payoff at maturity



Note: $K = 60$, $a = 0.70$, $B = 28$.

The payoff to this capped option resembles that of a put spread where the underlying asset is $Y = \alpha S$, the strike price of the long put position is αK and the strike price of the short put position is $\alpha K - B$. Therefore, (1) can be rewritten as $\max(\alpha K - Y_T, 0) - \max\,(\alpha K - B - Y_T, 0)$, i.e., the difference of two put options. However, a pay-for-success contract is different from a put spread in two ways. First, there is no optional exercise involved, in the sense that, provided investors are rational, the option is automatically exercised when in-the-money at the points in time when payments to investors are contractually arranged to take place. Second, there are no traded European options and traded underlying assets involved, thereby rendering the pay-for-success contract more similar to a real option on a non-traded asset rather than a financial option on a traded asset.

The problem of pricing (European) options on non-traded assets was first tackled in Smith and Nau (1995) in the context of real options and by Detemple and Sundaresan (1999) in the context of portfolio constraints. However, our treatment below follows the subsequent work of Davis (1999). Assume that the cost for the provision of the social service under the pay-for-success contract is a stochastic process that follows a Geometric Brownian Motion under the risk-adjusted measure $\mathbb{P}$

$$dS_t = vS_t dt + \eta S_t dW_t, \tag{2}$$

where η is the diffusion (volatility) parameter and dW_t is the increment of a Wiener process. Observe that the drift parameter v does not include a dividend yield because pay-for-success contracts do not include payments resembling dividend payments. A simple application of Ito's lemma yields $dY_t = vY_t dt + \eta Y_t dW_t$.

Although S_t is not traded, assume there is a correlated asset, P_t, that is traded and whose dynamics under the risk-adjusted measure $\mathbb{P}$ are given by the Geometric Brownian Motion

$$dP_t = \mu P_t dt + \sigma P_t dB_t, \tag{3}$$

where σ is the diffusion (volatility) parameter and dB_t is the increment of a correlated Wiener process, with

$$\mathbb{E}^{\mathbb{P}}[dW_t dB_t] = \rho dt$$

and ρ the (constant) correlation coefficient. For simplicity, we assume that the traded asset pays no dividend, although it would be straightforward to relax this assumption.

Davis (1999) provides an approach, based on utility maximization, for pricing options in such an incomplete market setting. An option is fairly priced (for a particular decision-maker) in this setting, if going long or short a small amount of it has a neutral effect on the decision maker's achievable utility. Such fair prices are also known as utility indifference prices (see, e.g., Henderson and Hobson, 2008) or reservation prices (see, e.g., Munk, 1999).

Let's assume that the investor has a logarithmic utility function, $U(X_t) = \log X_t$, where X_t the value of the investor position at time t. The investor forms a portfolio that invests a fraction π_t in the traded asset P_t and $(1 - \pi_t)$ in cash, with a view towards maximizing the expected terminal value of the position, $\mathbb{E}^{\mathbb{P}}[U(X_T)]$. In this setting the fair price $\hat{p}$ of a European put option with underlying asset current value Y_0 and strike price K is given by

$$\hat{p}(Y_0, K) = p(F(T), K, r, r, \eta, T), \tag{4}$$

where

$$F(T) = Y_0 \exp\left[\left(v - \frac{\eta\rho}{\sigma}(\mu - r)\right)T\right] \tag{5}$$

and $p(x, K, r, \delta, \eta, T)$ is the dividend-inclusive, Black and Scholes (1973) European put option pricing formula, for an underlying price x, risk-free interest rate r, dividend yield δ, volatility η and maturity T (see Davis, 1999, Theorem 18.2 for the proof). Observe that in (4), one needs to set $x = F(T)$ and $\delta = r$ to get the fair price $\hat{p}$.[2] Given that the pay-for-success contract (PFS) is

$$PFS = \hat{p}(Y_0, aK) - \hat{p}(Y_0, aK - B), \tag{6}$$

we can use equations (4)-(6) to estimate its fair price.

Numerical application: Drawing on the Massachusetts Juvenile Justice Pay for Success Initiative

Injecting theory to practice, this section delivers a calibration of our model that is based on the Massachusetts Juvenile Justice Pay for Success Initiative (JJ-PFS hereafter), a program that was launched in 2014 and amended in 2016. While our model design is different than the Massachusetts Initiative in that it involves a single final payoff instead of many intermediate ones, the rationale of our model reflects the architecture of JJ-PFS and all our parameters are calibrated on the basis of the prison system of Massachusetts at the time of the project's implementation.

JJ-PFS aimed at reducing crime rates among former inmates in Chelsea, Springfield and Boston, Massachusetts. The program was planned to apply to up to 1,036 young men between the ages of 17 and 24. The time span of JJ-PFS was seven years and it was extended for two additional years in 2021, completing operations in 2023, outcome reports being expected in

[2] The Black and Scholes (1973) formula $p(x, K, r, \delta, \eta, T)$, with $x = F(T)$ and $\delta = r$ is equivalent to the Black (1976) formula for pricing futures options, with a current futures price $F(T)$ given in (3).

early 2024. The main parties were the Commonwealth of Massachusetts, Third Sector Capital Partners, and Roca. Third Sector Capital Partners coordinated the implementation of the project via its subsidiary Youth Services Inc. and Roca provided the social services in the context of its own cognitive-behavioral intervention model. The State of Massachusetts would not pay more than $28 million, would pay nothing if the reduction of recidivism was less than 5% and would make savings of $22 million if recidivism was reduced by 40% (reflecting a reduction of 223,577 bed-days in prison).

Financial resources were provided by lenders of diverse capital outlay, seniority, and interest rate (Goldman Sachs Social Impact Fund, Kedge Foundation and Living Cities), as well as by donors, such as the Laura and John Arnold Foundation, New Profit Inc and Boston Foundation. The US Department of Labor suppled a grant up to $10.77 million, which was contingent on early-stage success. The assessment of JJ-PFS outcomes would rely on quarterly reporting by Roca, independent evaluation by Sibalytics and the Urban Institute, independent validation by Public Consulting Group, and pro bono technical assistance by the Kennedy School Social Impact Bond Technical Assistance Lab.

To apply our valuation model to the JJ-PFS, we need to estimate the maximum amount that can be paid to the investor according to the contract (B), the cost of the service (incarceration costs) to the Commonwealth of Massachusetts if no pay-for-success contract is implemented (i.e., the exercise price K), the cost incurred by the Commonwealth of Massachusetts in the provision of the social service if the pay-for-success contract is successfully implemented (i.e., the (non-traded) underlying asset, S), the drift (v) and volatility (η) of the dynamics of the (non-traded) underlying asset, S (see equation 2), and the fraction of public-sector cost savings that is the paid to the investor, i.e. the profit sharing constant $0 \leq \alpha \leq 1$.[3]

From the data and information that are publicly available for the JJ-PFS, we can infer that the incarceration costs to the Commonwealth of Massachusetts if no pay-for-success contract is implemented are close to $K = \$60$ million and that the profit sharing constant α ranges from 0.6 to 0.73.[4] We set $\alpha = 0.70$. From the same source, we know that the Commonwealth of Massachusetts will make up to at most $\$28$ million in success payments for this seven-year project, which provides us of an estimate of the maximum paid amount $B = \$28$ million. Finally, from the same source, we know that the project's target impact is a 40% decrease in days of incarceration, which translates to gross savings for the Commonwealth of Massachusetts of $\$22$ million, making the cost incurred if the pay-for-success contract is successfully implemented equal to $\$60 - \$22 = \$38$ million. This is the value we employ for the current value, S_0, of the (non-traded) underlying asset.

Unfortunately, we do not have a time-series of the (non-traded) underlying asset, the cost incurred by the Commonwealth of Massachusetts in the provision of the social service if the pay-for-success contract is successfully implemented, from which to estimate the drift (v) and volatility (η) of its dynamics. However, we can proxy these parameters from an alternative source. As the pay-for-success contract provides intervention to at-risk young men who are in the probation or parole system or are leaving the custody of the Suffolk, Essex, Hampden, and Middlesex Houses of Correction, we hand-collected the costs for the operation of the Suffolk,

[3] We also need to estimate the dynamics of the correlated traded asset P (see equation 3), along with the correlation coefficient. We discuss their estimation further down in this section.

[4] See https://www.thirdsectorcap.org/wp-content/uploads/2021/10/MA-JJ-PFS-Fact-Sheet-Revised-210101.pdf, and more specifically the Table of the incarceration-based payment terms on p. 3.

Essex, Hampden, and Middlesex Sheriff's offices from the annual budget of the Commonwealth of Massachusetts, for the years 2012-2019.[5] Under the assumption that the costs associated with recidivism in Suffolk, Essex, Hampden, and Middlesex are, every year, a constant fraction of the total operating costs of the Sheriff's offices in these areas, we can proxy the drift (v) and volatility (η) of our underlying asset with the average return and standard deviation of returns of the total operating costs of the four Sheriff's offices. This yields estimates of $v = 5\%$ and $\eta = 10\%$.

Finally, for the correlated, traded asset, we select the FTSE US Broad Investment-Grade Social Impact Bond Index, which is a multi-sector social bond benchmark of investment-grade, US Dollar denominated debt issued by US Treasury, government-sponsored organizations, and corporations.[6] From the time-series of the index over the life of the JJ-PFS, we get estimates of $\mu = 5.5\%$ and $\sigma = 15\%$ for the drift and volatility of the correlated asset (see equation 3). The correlation between the two-time series (our proxies for S and P) is $\rho = 0.6$.

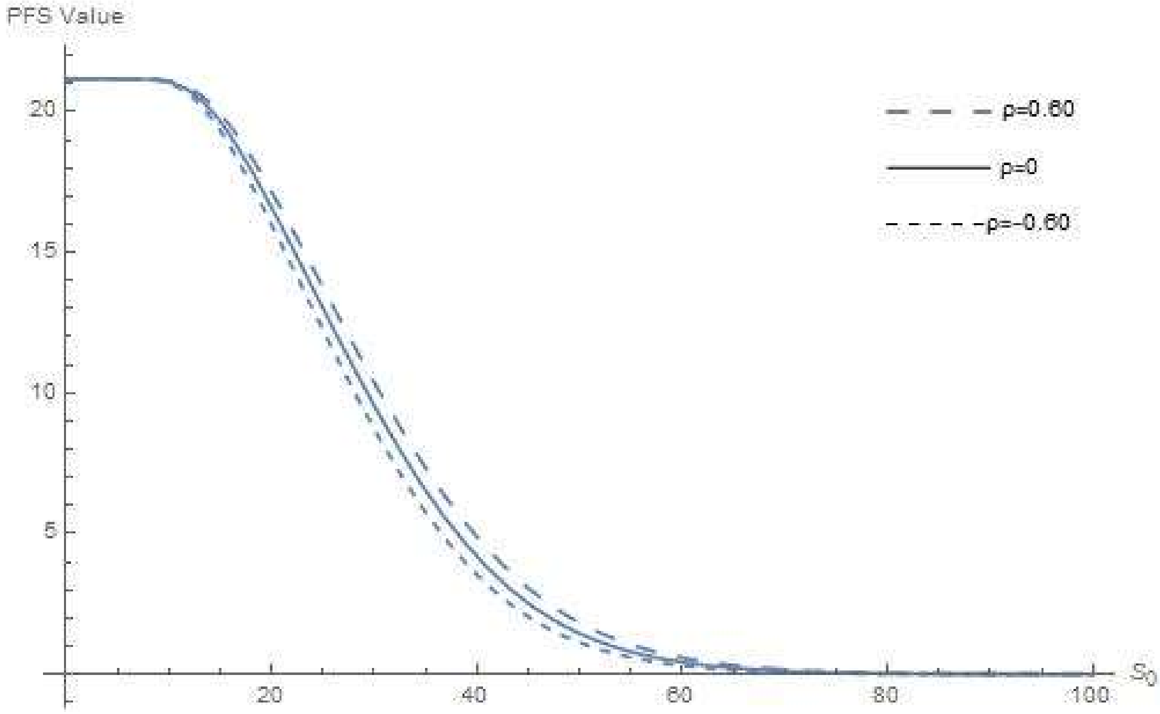
For these parameter values, and a risk-free rate of 4% (r), the value of the Massachusetts Juvenile Justice Pay for Success contract is estimated at \$5.7786 million ($\hat{p}(Y_0, aK) = \$5.7788$ million and $\hat{p}(Y_0, aK - B) = \$0.0002$ million). Valuation of the PFS contracts requires estimation of the drifts (μ, v) and volatilities/correlation (σ, η, ρ) of both S and P. Difference of opinion on these parameters between suppliers and users of impact capital is what makes pay-for-success investments plausible. The rest of the parameters can either be directly identified in the contract or calibrated thereof, as we demonstrate with our numerical application.

Figure 2 plots the value of the JJ-PFS as a function of the social service cost S for different correlation coefficients between changes in the traded asset and the social service cost S. The value of the project decreases in the social service cost S and increases in the correlation ρ. For $\mu - r > 0$, as in our numerical application, a higher correlation ρ reduces the underlying price $F(T)$ in equation (5), making the put options $\hat{p}(Y_0, aK)$ and $\hat{p}(Y_0, aK - B)$ more valuable, and overall increasing the value of the JJ-PFS. Moreover, the value of the investment is increasing in the maximum amount that can be paid to the investor, namely the surplus cap B (see Figure 3). Interestingly, the increasing effect is more pronounced, the higher the correlation of the traded asset with the cost of social service S. In Figure 3, as B increases the term $\frac{\alpha K - B}{\alpha}$ decreases (see Figure 1), making the $\hat{p}(Y_0, aK - B)$ put option deep-out-of-the-money, and hence the investment value almost insensitive to further increases of B.

[5] These are items 8910-0102, 8910-0107, 8910-0619 and 8910-8800 from the Commonwealth's annual budgets, that are available at https://www.mass.gov/lists/budget-archives.

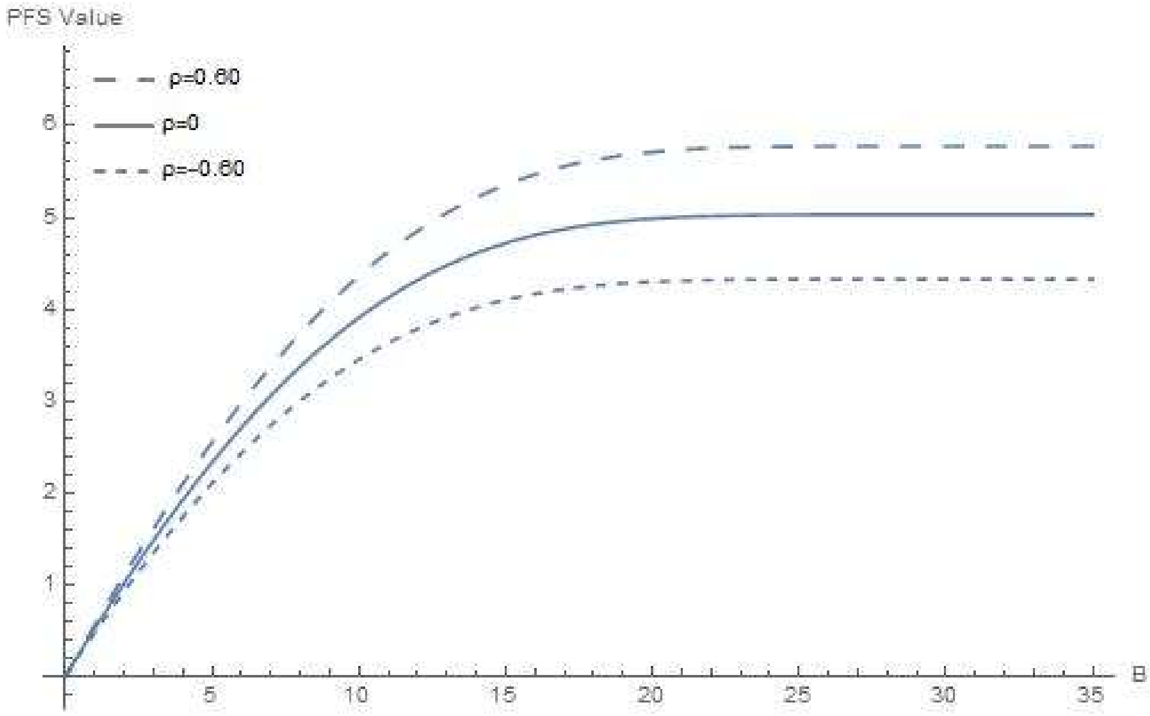
[6] The constituents of the index are eligible Social and Sustainability Bonds that are in line with the core components of International Capital Markets Association (ICMA) Social Bond Principles (SBP). See https://www.lseg.com/en/ftse-russell for details.

Figure 2 Pay-for-success value and the social service cost



Note: $K = 60$, $\alpha = 0.70$, $r = 4\%$, $\mu = 5.5\%$, $v = 5\%$, $\sigma = 15\%, \eta = 10\%$, $T = 7$, $B = 28$.

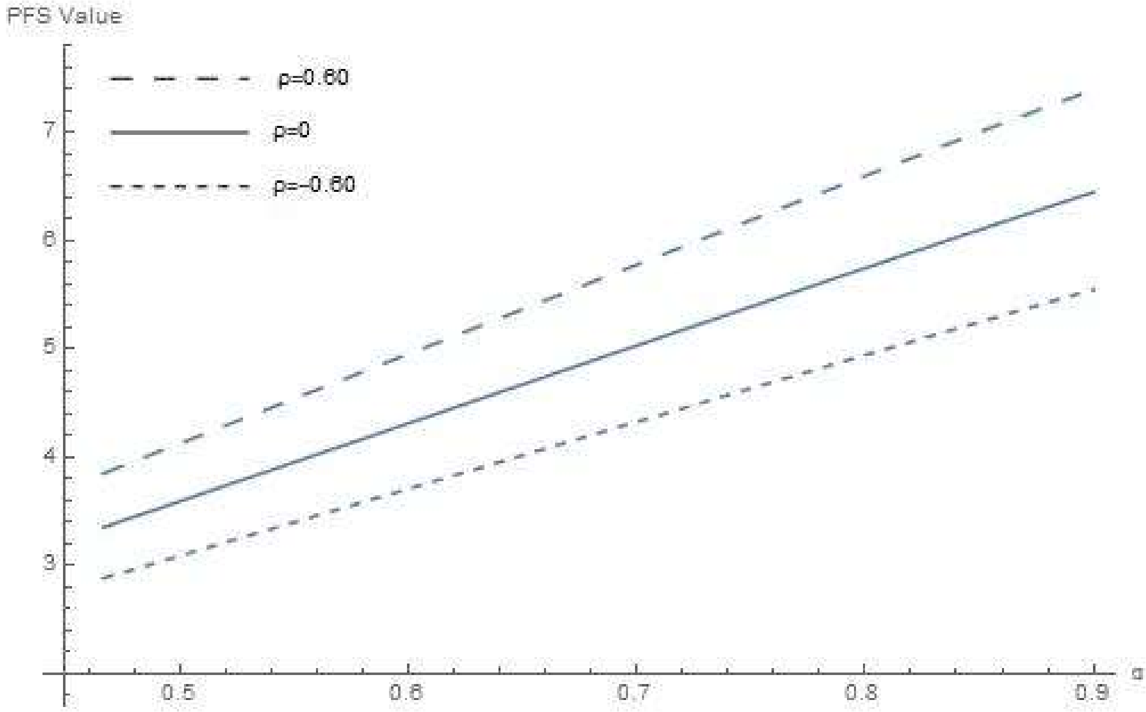
Figure 3 Pay-for-success value and the surplus cap



Note: $K = 60$, $S_0 = 38$, $\alpha = 0.70$, $r = 4\%$, $\mu = 5.5\%$, $v = 5\%$, $\sigma = 15\%, \eta = 10\%$, $T = 7$.

In a similar vein, the value of the investment is increasing in the profit sharing constant α, since the higher the portion of surplus accumulating to the investor, the more valuable the investment will be (see Figure 4).

Figure 4 Pay-for-success value and the surplus profit sharing constant

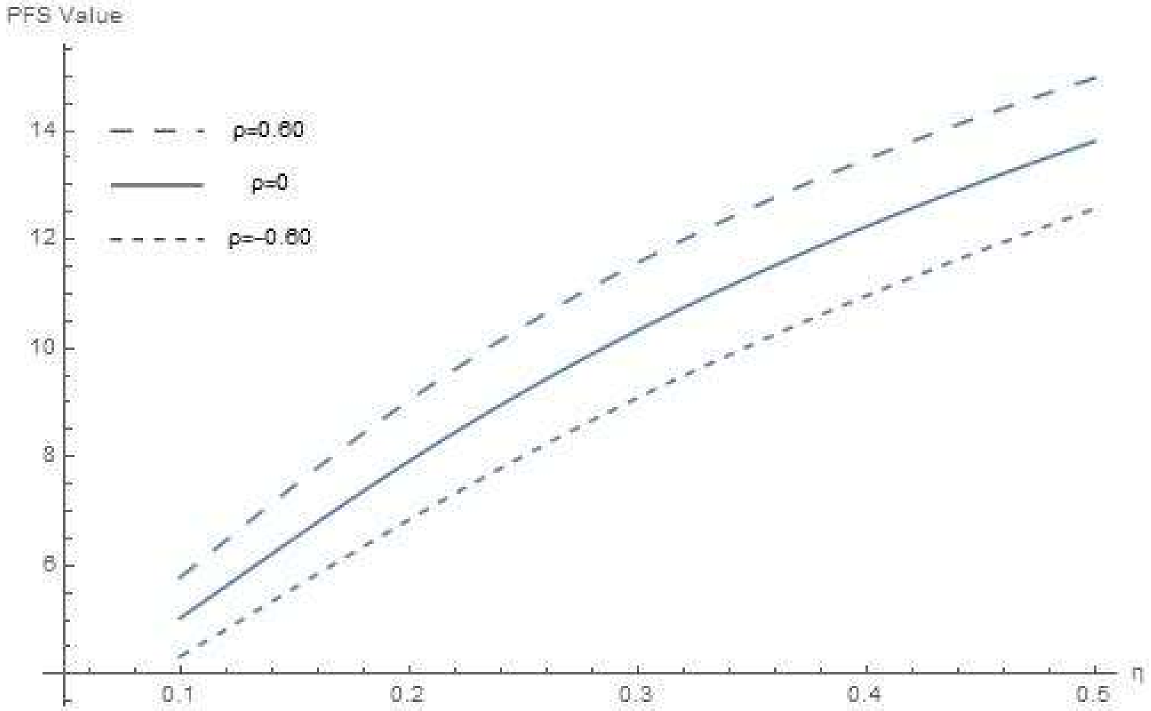


Note: $K = 60$, $S_0 = 38$, $r = 4\%$, $\mu = 5.5\%$, $v = 5\%$, $\sigma = 15\%$, $\eta = 10\%$, $T = 7$, $B = 28$.

Figures 5 plots the pay-for-success value with respect to the volatility η for different correlation coefficients, while Figure 6 plots the sensitivity of PFS with respect to η (i.e. the PFS vega), as a function of the cost of social service S. In Figure 5, the PFS value is increasing in the volatility η, with the effect being more pronounced the more positive the correlation of the traded asset with the cost of social service S. However, as Figure 6 demonstrates, the vega of the PFS contract (i.e. the sensitivity $\partial PFS/\partial \eta$) can be an increasing or decreasing function of the social service cost S and of the correlation coefficient ρ (observe that the dependence of vega on ρ reverses sign to the left and to the right of the point where vega attains its maximum in Figure 6).

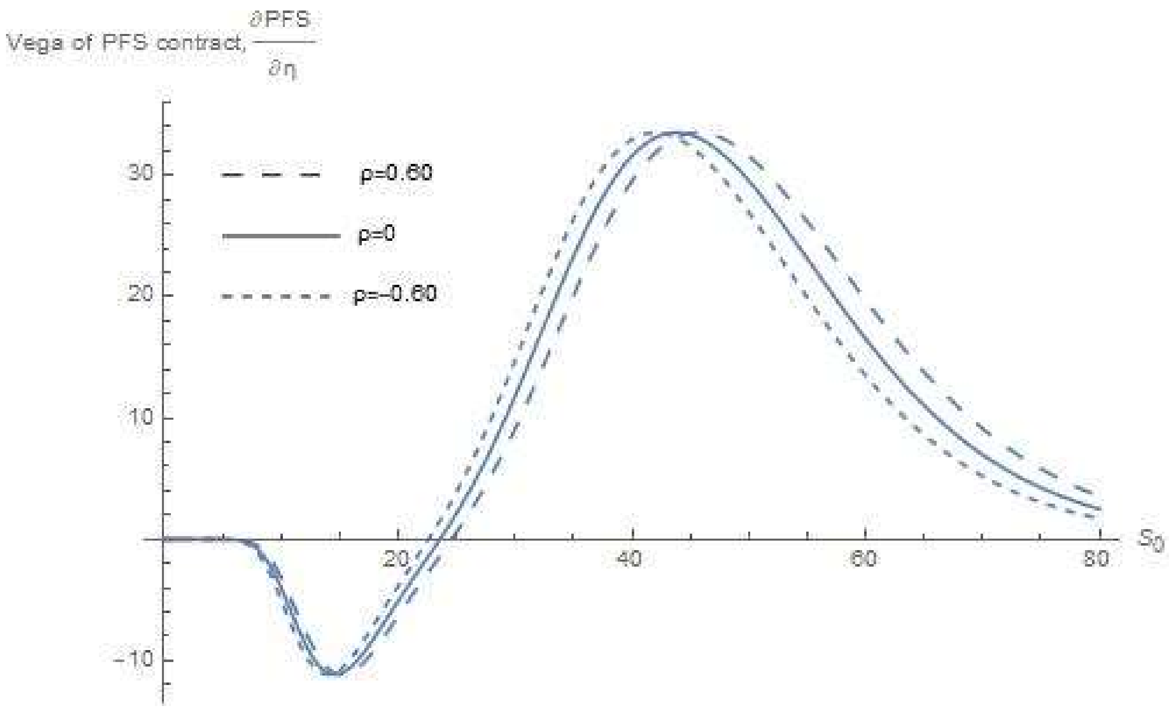
Finally, Figure 7 demonstrates that the PFS contract value could be increasing or decreasing in the volatility of the traded asset, depending on (a) the correlation of the social service cost with the traded asset ρ, and (b) the sign of $\mu - r$. Observe from (5) that $F(T)$, and thus the investment value, is insensitive to σ if $\rho = 0$, i.e. if the traded asset is uncorrelated with the cost of social service S.

Figure 5 Pay-for-success value and the volatility of the social service cost



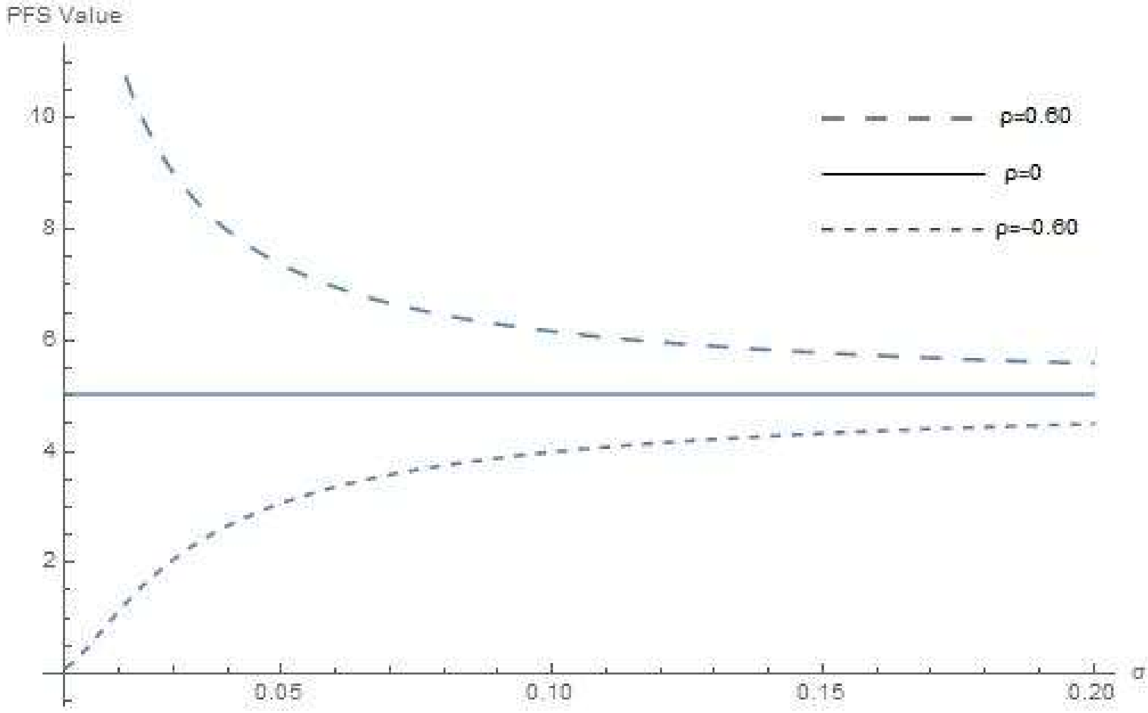
Note: $K = 60$, $S_0 = 38$, $\alpha = 0.70$, $r = 4\%$, $\mu = 5.5\%$, $\upsilon = 5\%$, $\sigma = 15\%$, $T = 7$, $B = 28$.

Figure 6 The vega of the Pay-for-success contract as a function of the social service cost



Note: $K = 60$, $\alpha = 0.70$, $r = 4\%$, $\mu = 5.5\%$, $\upsilon = 5\%$, $\sigma = 15\%$, $\eta = 10\%$, $T = 7$, $B = 28$.

Figure 7 Pay-for-success value and the volatility of the correlated traded asset



Note: $K = 60$, $S_0 = 38$, $\alpha = 0.70$, $r = 4\%$, $\mu = 5.5\%$, $v = 5\%$, $\eta = 10\%$, $T = 7$, $B = 28$.

Conclusion

Pay-for-success contracts (or pay-for-performance contracts or social impact bonds) are emerging tripartite fusions of the public sector, the private sector, and the civil society, set to tackle social and environmental problems. This note shows that investment payoffs exhibit option-like characteristics, accommodating stochastic calculus arguments in investment appraisal, and yielding familiar (from option pricing) intuition on the importance of investment parameters. The calibration of our contingent claims model -a put spread in partially complete markets- was based on the Massachusetts Juvenile Justice Pay for Success Initiative, a project on the recidivism of formerly incarcerated young men.

Admittedly, option pricing formulas cannot capture all essential aspects of a social policy instrument, like the pay-for-success contract. Therefore, a comprehensive assessment will have to complement the valuation formula in this note with an analysis of the social, political, and historical context that is unique for each pay-for-success contract. Furthermore, at the cost of closed-form solutions, future research could incorporate more realistic contract specifications, such as a piecewise contract implementation bearing similarities with compound options, pay-for-success underwriting that minimizes investor risk and partial funding of the pay-for-success investment with donations.

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