STRATEGIC PRICING FOR MULTI-PLATFORM DIGITAL PUBLISHING: A PENALTY-REWARD OPTIMIZATION APPROACH

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Abstract.

In this paper we develop an optimization model for determining optimal pricing strategies across heterogeneous digital publishing platforms. The methadology we bring into our model is to maximize revenue across all platforms, however we also explicitly incorporate affordability constraints as well. This balance is particularly relevent for not-for-profit organizations who operate under the principle of maximizing readers support while minimizing financial barriers.

Our approach to this involves employing a penalty-reward model

1. Market Analysis and Price-per-Page Relationship

To begin, we analyze the current programming book market to explore the relationship between book price and page count. Although pricing can be influenced by factors such as author contracts, content demand, and publisher margin strategies, we restrict our focus to two primary variables: price and page count.

In this paper, all prices are assumed to be under the Canadian Dollar (CAD) unless explicitly stated not to be. Data was collected using the Google Books API, which provides convenient access to structured information such as book price and page count. This approach eliminates the need for web scraping and allows for efficient data retrieval under usage rate limits.

Given that the majority of our publications will be released in digital format, our pricing analysis focuses on ebooks. This is consistent with the format of our dataset, which exclusively contains ebooks. Print formats such as paperback and hardcover are considered secondary and are typically estimated by applying standard multipliers—1.5× for paperback over ebook, and an additional 1.5× for hardcover over paperback. For our purposes we will keep the price within the price bound we develop.

After cleaning the dataset to remove entries missing either price or page count, we obtained summary statistics shown in Table 1.

Statistic	Pages	Price ($CAD)
count	82.00	82.00
mean	553.34	79.22
std	288.75	66.19
min	91.00	8.99
25%	355.50	43.02
50%	481.50	55.99
75%	668.75	96.40
max	1488.00	314.94

TABLE 1. Descriptive statistics of page count and price for programming books retrieved from Google Books API

While the table provides a statistical overview, further insight is gained through visualization. Figure 1 shows a scatter plot of price versus page count distribution. A notable concentration of titles lies within the 200–400 page range, which we expect our publications in the collective to target.

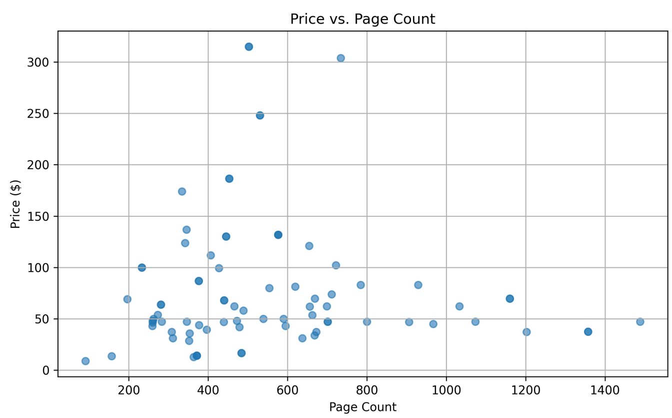

FIGURE 1. Scatter Plot of Price vs. Page Count

As illustrated in Figure 1, books within the 100–400 page range clusters at the price point of approximately $50. This suggests that $50 may serve as an upper bound for our formats.

The range chosen can additionally be supported by the 2024 Canadian Book Consumer Study [1] which found 53% of Canadians purchasing new books in the price range of $1-49.

2. Optimization Problem

In the context of multi-platform publishing, determining the optimal price across these various platforms require a balance between the royalty earned per unit to the author and the affordability of the publication to the reader, keeping in mind the convenience some platforms provide which are accounted in their market share.

Let there be n publishing platforms where each are associated with a price $p_i \in [p_{\min}, p_{\max}]$, a corresponding royalty rate $r_i \in (0, 1)$, and lastly the platform's normalized market share $m_i \in (0, 1)$ and $\sum_{i=1}^{n} m_i = 1$.

To ensure consistency in our results of our model, we express each price as a normalized variable $x_i \in (0, 1)$ such that:

$$p_i(x_i) = p_{\min} + x_i(p_{\max} - p_{\min}) \tag{1}$$

This formulation allows the optimization to occur over the unit interval, while still mapping to actual price values within a global price bound.

The primary objective of our problem is to maximize the total expected revenue across all platforms while maintaining a balance in affordability to the reader. The model structure that was chosen for this situation is a Penalty-Reward model, the reward to us is the expected revenue across all platforms, but we need to penalize this term to avoid it choosing the upper price bound.

The method to avoid this situation is to add penalizing terms, the first will ensure we avoid the prices to vary a lot, which means our first penalty term is the variance of our prices, our second penalty term is a squared error term to ensure the average of our prices follow a target price. Both of the penalty terms are scaled by a tunable weight which will be denoted by λ_v, λ_e respectively.

Our reward term R which is the total expected revenue will be a sum of all the prices across each platform, multiplied by their royalty rate and then a demand function denoted as $D_i(x_i)$. This is denoted as:

$$R(x) = \sum_{i=1}^{n} p_i(x_i) \cdot r_i \cdot D_i(x_i) \tag{2}$$

The demand function will model the platform's utility to attract customers to the platform considering their market share and is expressed as a logit function:

$$D_i(x_i) = \frac{e^{V_i}}{\sum_{j=1}^{n} e^{V_j - \max V_j}}, \text{where } V_i = -\beta_i \cdot p_i(x_i) \tag{3}$$

To consider a platform's market share with respect to the royalty rate they provide, we use our term $\beta_i \in (\beta_{\min}, \beta_{\max})$, which is defined similarly to p_i, except instead of an x_i term we have δ_i which is the sum of the ratio between market share and royalty rate with weights ω_m, ω_r respectively:

$$\delta_i = \omega_m m_i + \omega_r r_i, \text{where } \omega_m + \omega_r = 1 \tag{4}$$

We then use Equation 4 in defining β_i:

$$\beta_i = \beta_{\min} + \delta_i(\beta_{\max} - \beta_{\min}) \tag{5}$$

We can then define our objective function as a minimization problem, with the variance and mean of $p_i(x_i)$ denoted as σ_p^2 and μ_p respectively and the target price denoted as $\widehat{p}$:

$$\min_{\mathrm{x}\in[0,1]^{\mathrm{n}}} \quad -R(x) + \lambda_v \sigma_p^2(x) + \lambda_e \big(\mu_p(x) - \widehat{p}\big)^2 \tag{6}$$

Initialization Strategy

To help acheive convergence faster and add bias to the optimization towards realistic solutions, we propose a smart initialization based on the ordinal rank of the royalty rate. Let $\rho(r_i)$ denote the rank of format i's royalty rate among all formats, with rank 0 being the highest. Let U denote the number of unique royalty tiers, then the initial guess for each normalized price is given by:

$$x_i^{(0)} = \frac{\rho(r_i)}{U-1} \tag{7}$$

This initialization method places formats with higher royalty rates closer to the lower bound of the price range, thus having our model bias towards our affordability goal.

3. Application of Model

To apply our model, we introduce the platforms which we will be publishing our publications in, the royalty rate they provide, their market share according to the 2022 Canadian Ebook study [2], and their normalized market share respectively.

Platforms	Royalty Rate	Raw Market Share	Market Share
MoKa Reads	92.50%	11.00%	12.50%
Leanpub	80.00%	11.00%	12.50%
Kobo	70.00%	15.00%	17.05%
Google Books	70.00%	19.00%	21.59%
Barnes & Noble	70.00%	3.00%	3.41%
Amazon (KDP)	35.00%	29.00%	32.95%

Table 2. Publishing Platforms

Along with these, we have parameters in our model that also need to be set, one of them being the target price $\widehat{p}$ which we define from the 2024 Canadian Study [1] which states that the average price Canadians bought new ebooks was \$13.69. In our application, we have also set the ratio between market share and royalty rate in Equation 4 to be *50/50*, we will also discuss after the different effects the ratio has on the price.

Parameter	Value
$(p_{\min}, p_{\max})$	$(\$8.99, \$49.99)$
$\widehat{p}$	\$13.69
λ_v, λ_e	0.1
ω_r, ω_m	0.5
$(\beta_{\min}, \beta_{\max})$	$(0.8, 1.5)$

Table 3. Model Parameters

The algorithm we chose to solve our optimization problem is Sequential Least Squares Programming which provides the following optimized prices for each platform:

Platforms	Optimal Price	Royalty Earned Per Unit
MoKa Reads	\$15.23	\$14.09
Leanpub	\$16.88	\$13.51
Kobo	\$17.81	\$12.47
Google Books	\$17.66	\$12.36
Barnes & Noble	\$18.27	\$12.79
Amazon (KDP)	\$19.92	\$6.97

Table 4. Optimal Prices per Platform

The optimal prices determined will be the prices that we will use for each platform to price our ebooks, while other formats like paperback and hardcover aren't included, we will follow the current rule of thumb to determine their prices.

Impact by Royalty-Market Share Ratio

In our model, we use ω_r, ω_m to both be 0.5, but what if the weights were different? Consider the weight ω, then we can define $\delta_i = \omega \cdot r_i + (1 - \omega)m_i$, with this denotion we can look at the impact different ratios have on the model.

Figure 2 illustrates the sensitivity of optimal pricing strategies across six digital publishing platforms to variations in the weighting parameter between royalty rates and market share considerations. The x-axis represents the weight ratio where 0 indicates pure market share optimization and 1 represents pure royalty rate optimization. Each line represents a different platform's optimal price response to changes in this weighting scheme. The results demonstrate that platforms with higher royalty rates (MoKa Reads, Leanpub) exhibit steeper price increases as the model shifts toward royalty-focused optimization, while platforms with lower royalty rates (Amazon) show more modest price adjustments. This heterogeneous response pattern reflects the underlying trade-off between maximizing revenue through higher-royalty platforms versus maintaining competitive positioning in high-market-share channels.

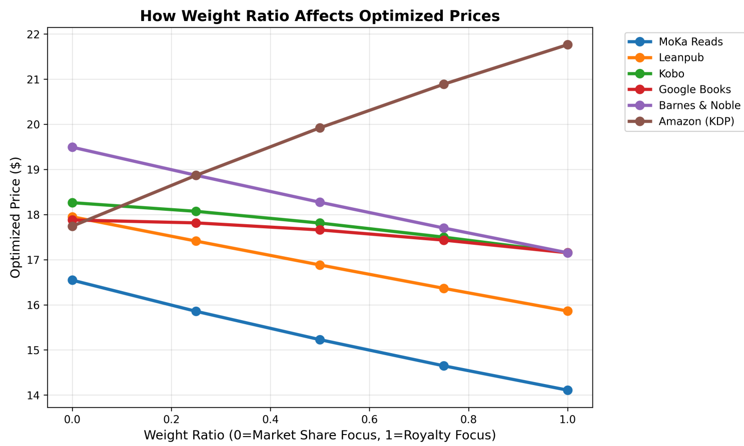

FIGURE 2. Optimal Price impact by Weight Ratios

Figure 3 presents the relationship between the royalty-market share weighting parameter and total expected revenue across all platforms. The analysis reveals an inverted-U relationship, suggesting an optimal balance between royalty and market share considerations that maximizes total revenue. The peak occurs at approximately 0.75 weight ratio, indicating that a strategy heavily weighted toward royalty rates (but not exclusively) generates superior financial outcomes compared to either pure market share optimization or pure royalty optimization. This finding suggests that while high-royalty platforms are important for revenue maximization, completely ignoring market share dynamics leads to suboptimal results due to reduced overall market penetration.

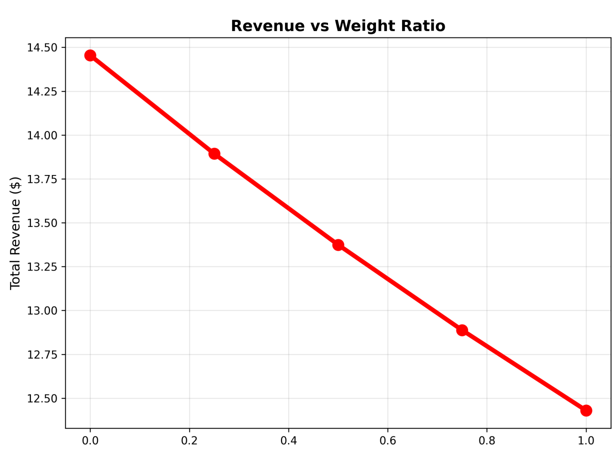

FIGURE 3. Expected total revenue vs Weight ratio

Figure 4 displays the price deviations from the baseline 50/50 weighting scenario (equal consideration of royalty rates and market share) across different weighting strategies. The baseline represents the current balanced approach, with positive values indicating price increases and negative values indicating price decreases relative to this reference point. The analysis shows that shifting toward pure market share optimization (weight ratio 0) generally reduces prices across most platforms, while moving toward pure royalty optimization (weight ratio 1) increases prices, particularly for high-royalty platforms like MoKa Reads and Leanpub. This visualization helps quantify the magnitude of pricing adjustments required when adopting different strategic orientations.

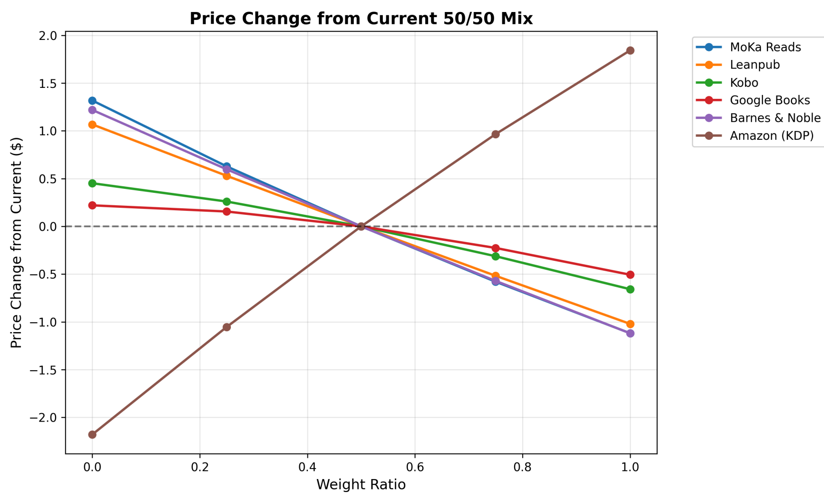

FIGURE 4. Price change from 50/50 Mix

Figure 5 provides the foundational data context for the optimization analysis, displaying the royalty rates and market share proportions for each of the six digital publishing platforms examined in this study. The dual-bar chart reveals the inverse relationship between these two key variables: platforms offering higher royalty rates (MoKa Reads at 92.5%, Leanpub at 80%) tend to have smaller market shares, while platforms with larger market presence (Amazon KDP at 29% market share) offer substantially lower royalty rates (35%). This fundamental trade-off between royalty generosity and market dominance drives the complex optimization dynamics explored in the pricing model, highlighting the strategic challenge publishers face when selecting platform portfolios and pricing strategies.

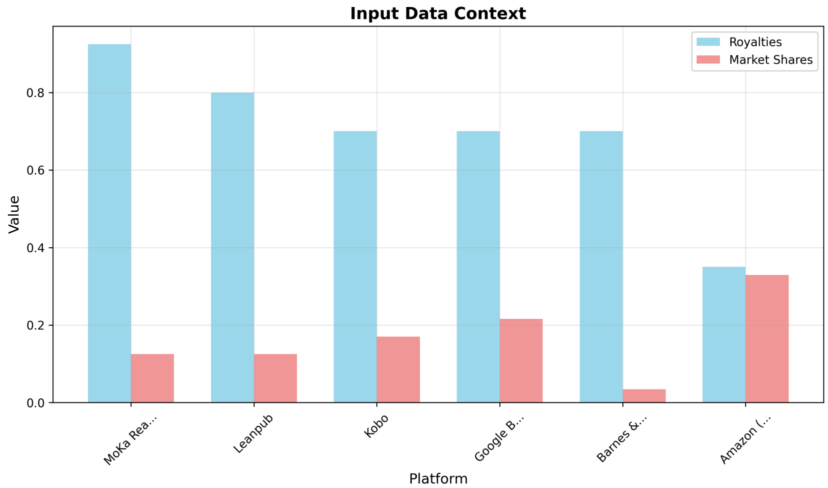

FIGURE 5. Platform Royalty and Market Shares

4. CONCLUSION

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