

# Patent Evaluation and Pricing Methodology

## Abstract

This paper proposes a quantitative methodology for evaluating and pricing patents based on two key dimensions: the likelihood of infringement and the relative market impact of the patent. The approach enables patent holders, investors, and legal professionals to derive price estimations using structured data and transparent mathematical functions, moving beyond heuristics or precedent-based estimations.

## 1. Introduction

Intellectual property (IP), particularly patents, plays a central role in technology-driven economies. Accurate valuation of patents is essential for licensing, transactions, and litigation. Traditional methods often rely on comparable transactions or expert judgment, which can lack reproducibility. This paper introduces a reproducible, scalable, and statistically calibrated model that links the technical scope of infringement to its projected market effect.

While our methodology primarily bases valuation on damages estimates and the extent and likelihood of patent infringement, it is recommended that valuations be performed with financial items and actual encumbrances in mind for more in-depth research. However, IPDefine Ratings stands out from other models in that it provides statistical evaluations based on actual patent transactions.

## 2. Infringement Scoring Model (IS)

### 2.1 Conceptual Foundation

The Infringement Score (IS) quantifies how likely it is that a given patent's claims are being infringed by existing products.

Each claim is evaluated using a predefined rubric and assigned one of several judgment categories. These categorical assessments are then aggregated across all relevant claims to calculate a weighted score.

## 2.2 Data Structure and Preprocessing

Each record in the assessment dataset includes the following fields:

- `paragraph` : the claim paragraph number
- `claim` : the text of the claim
- `reason_yes` : reasoning supporting potential infringement
- `reason_no` : reasoning against infringement
- `judgment` : the assigned categorical judgment

Rows are preprocessed as follows:

- Entries with non-numeric `paragraph` values are excluded.
- Rows labeled as "no judgment needed" in the `judgment` field are ignored in score calculation.

## 2.3 Judgment Categories and Weights

The following table outlines the judgment categories used in the evaluation process, along with their conceptual weight ranges:

Judgment Category	Weight Range (Conceptual)
absolutely yes	1.00 – 1.25
maybe yes	0.65 – 1.00
unable to determine	0.50
maybe no	0.25 – 0.35
absolutely no	0.00
no judgment needed	ignored

**Note:** The values in the table represent plausible scoring ranges based on the interpretive confidence of each label.

In the current implementation of the scoring model, **fixed representative values** are used for each category, as shown below.

## 2.4 IS Score Formula

The Infringement Score (IS) is computed using weighted category counts.

Let  $N$  be the total number of valid judgments (excluding “no judgment needed”), and let  $N_{ay}$ ,  $N_{my}$ ,

$N_{ud}$ , and  $N_{mn}$  represent the number of instances labeled as:

- $N_{ay}$ : absolutely yes
- $N_{my}$ : maybe yes
- $N_{ud}$ : unable to determine
- $N_{mn}$ : maybe no

Then, the IS score is calculated as:

$$IS = \frac{1.25 \cdot N_{ay} + 1.00 \cdot N_{my} + 0.50 \cdot N_{ud} + 0.25 \cdot N_{mn}}{N}$$

The resulting score ranges from 0.0 to 1.25, with higher values indicating a greater likelihood of infringement across the claim set.

## 3. Market Impact Rating (MIR)

### 3.1 Definition

MIR quantifies the share of the potentially infringing product space that the target patent affects:

$$MIR = \frac{N_{infringed\_by\_this\_patent}}{N_{all\_infringement\_predictions}} \times 100$$

### 3.2 Nonlinear Transformation

Normalized MIR

$$m = MIR/100$$

is mapped using a piecewise function:

$$m_{trans} = \begin{cases} 0.07 \cdot m^2 & \text{if } m < 0.1 \\ 1.05 \cdot m & \text{if } 0.1 \leq m < 0.9 \\ 1.7 \cdot e^{2.3(m-0.9)} & \text{if } m \geq 0.9 \end{cases}$$

## 4. Patent Pricing Model

### 4.1 Core Formula

The patent price is computed using the following formula:

$$P = C \cdot m_{trans} \cdot e^{a(IS-0.8)}$$

Where:

- *C*: regional base price coefficient
- *a* = 5.8: calibration constant
- *IS*: infringement score (range: 0 to 1.25)
- *m<sub>trans</sub>*: transformed Market Impact Rating (MIR)

## 4.2 Base Coefficient C by Region

Patent Prefix	C Value (USD)
US	20,000 - 35,000
EP	10,000 - 25,000
Other	10,000

## 4.3 Calibration and Median Pricing

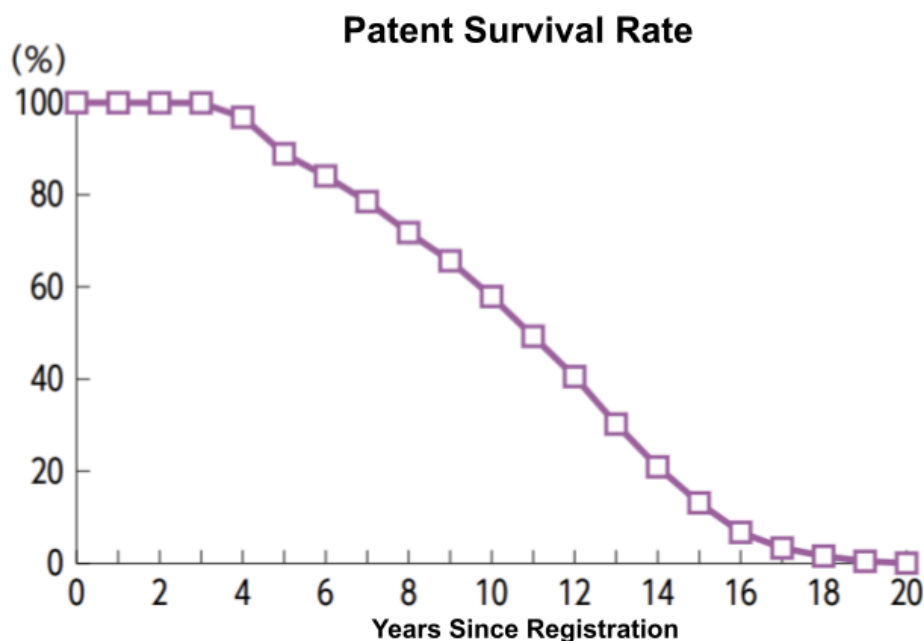
This model has been calibrated such that the **median price of patent families including U.S. patents converges around USD 250,000**.

For individual U.S. patents, observed valuations typically range from USD 80,000 to 90,000.

All parameters were selected based on empirical transaction data collected over the past five years.

To account for uncertainty and practical variation, valuation weights and regional base coefficients (C values) may be presented as ranges (e.g., yes: 1.00–1.25, US: 20,000–35,000) in applied contexts.

## 4.4 Reference Chart: Patent Survival Rate



**Note:**

- The survival rate represents the proportion of patents still in force relative to the number of granted patents.
- Figures as of the end of 2023.

**Source:**

Compiled by the Japan Patent Office based on Part II, Chapter 2, Section 20 (2).

The chart above illustrates the typical survival rate of patents over a 20-year period, based on publicly available registration and maintenance data as of 2023.

This information can be integrated into pricing models to estimate the remaining economic lifespan of a patent, adjusting for attrition trends observed in historical data.

## 4.5 Patent Rating Classification

To enhance interpretability and comparability across patents of varying economic significance, we assign a **Patent Rating** to each evaluated patent based on its computed price.

This rating scheme follows a tiered structure that mirrors traditional credit rating systems, allowing stakeholders to categorize patents by potential strategic or market value.

The classification logic is defined as follows:

Patent Price (USD)	Rating
≥ 300,000,000	AAA
≥ 100,000,000 and < 300M	AA
≥ 10,000,000 and < 100M	A

Patent Price (USD)	Rating
$\geq 1,000,000$ and $< 10M$	BBB
$\geq 100,000$ and $< 1M$	BB
$\geq 10,000$ and $< 100K$	B
$\geq 1,000$ and $< 10K$	CCC
$\geq 100$ and $< 1K$	CC
$\geq 0$ and $< 100$	C
$< 0$	Unknown

## 5. Extensions and Future Work

Component	Description
Validity Score	Adjustment based on litigation or reexamination history
Remaining Lifetime	Discounting based on years left before expiration
Revenue-based MIR	Use product revenue to weight MIR
Time Series Dynamics	Tracking price evolution over time