AI-OPTIMIZED MARKET ACCESS: A BILATERAL FRAMEWORK FOR AFFORDABLE AND EQUITABLE DRUG PRICING IN EMERGING AND ADVANCED ECONOMIES

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Abstract: *This article proposes a bilateral, AI-optimized framework to achieve affordable and equitable drug pricing across advanced and emerging economies, using the United States and Uzbekistan as case studies. The approach integrates demand forecasting, value-based pricing, and income-adjusted tiered pricing into a single optimization routine that reconciles patient access with the sustainability of pharmaceutical innovation [1], [3]. We formalize a welfare function that values health outcomes in each country and incorporates payer budget constraints, while imposing a profit floor for manufacturers to maintain incentives to invest in R&D [4], [7]. An AI layer learns price–volume relationships from multi-source data including epidemiology, claims, registries, and macroeconomic indicators and searches for Pareto-efficient price pairs (P_US, P_UZ) subject to policy ceilings and equity thresholds [8], [12].*

Scenario analysis (2025–2030) compares three regimes: (A) status quo with fragmented bargaining and limited access in emerging markets; (B) unilateral Most-Favored-Nation (MFN) policies; and (C) a bilateral AI-optimized agreement that includes non-reference safe harbors, volume guarantees, and outcomes-linked adjustments [15], [16]. We find that the bilateral model can reduce the effective U.S. price by ~20% while enabling an Uzbek price at ~10–20% of the U.S. level without meaningfully eroding aggregate manufacturer profit, due to scale effects and reduced uncertainty [18], [21]. The framework translates into actionable policy clauses and a governance blueprint, emphasizing transparency, algorithmic explainability, and protections against parallel trade. We argue that such bilateral pilots can seed a broader transition toward fair global pricing norms consistent with WHO guidance and the ethics of equitable access [40], [44].

INTRODUCTION

Ensuring affordable access to essential medicines while preserving incentives for biomedical innovation is a defining paradox of modern health systems. Advanced economies struggle with rapidly rising drug expenditures, increasing patient cost-sharing, and political pressure to curb prices; emerging economies face budget ceilings, import dependence, and supply fragility. Both realities generate inequities: some U.S. patients delay or skip therapy due to out-of-pocket burdens, while many patients in low- and middle-income countries lack access altogether [1], [3].

The United States exemplifies the innovation affordability tension. Launch prices for specialty drugs often exceed six figures, buoyed by exclusivity periods and fragmented payer negotiations [4], [7]. Recent reforms most notably the Inflation Reduction Act (2022) enable Medicare drug price negotiations for high-expenditure products, with phased implementation through the late 2020s [8], [11]. Yet policy instruments that unilaterally compress prices, such as MFN anchoring to the lowest international price, risk unintended global spillovers: firms may delay or avoid launches in lower-income markets to protect prices in larger wealthy markets [15], [20].

Uzbekistan reflects the other side of the coin. An import-dependent market (~87% by value), coupled with income constraints, necessitates strong affordability protections: capped wholesale and retail mark-ups and external reference pricing (ERP) at registration [24], [28], [29]. Per capita health spending remains orders of magnitude below the U.S. level [26], [27], so even value-justified prices in rich countries can be catastrophic in Uzbekistan. At the same time, the country is pursuing industrial policy (e.g., Tashkent Pharma Park) and digital transformation, including an AI roadmap in healthcare analytics [30], [35]–[37], creating an environment where evidence-driven pricing can be piloted at national scale.

The global literature has long endorsed tiered pricing selling the same product at income-sensitive price points to expand access without destroying innovation incentives [40], [41]. However, the mechanism is fragile: if wealthy markets import low prices via MFN or aggressive external referencing, differential pricing collapses and firms reduce low-price launches [16], [19], [20]. The challenge is therefore not simply technical but institutional: how can countries coordinate to preserve socially efficient price dispersion while meeting domestic political imperatives?

Our central thesis is that bilateral AI-optimized pricing offers a practical compromise. By placing two asymmetric markets inside one optimization problem constrained by affordability thresholds and a profit floor we can discover price pairs that deliver measurable health gains in both countries while maintaining the economic feasibility for manufacturers. Crucially, the agreement is accompanied by clauses that prevent cross-market contamination (non-reference safe harbor), transform low prices into reliable revenue streams (volume guarantees), and adjust for real-world performance (outcomes-linked rebates).

Methodologically, we make three contributions. First, we formalize a welfare function that values QALY gains in each country and penalizes payer spending, subject to a manufacturer profit constraint. Second, we integrate an AI learning layer that estimates price–volume response and simulates policy counterfactuals. Third, we provide a policy playbook data agreements, governance, and compliance that turns the optimizer into implementable contracts. Scenario analysis illustrates the approach and stresses robustness to demand uncertainty. Throughout, we preserve the ethical stance that fair pricing must reflect both health gains and ability-to-pay [43], [44], [72].

Comparative Overview: United States and Uzbekistan

United States. The U.S. pharmaceutical market is characterized by scientific leadership, rapid adoption of breakthrough therapies, and high introductory prices. Manufacturers enjoy broad discretion over launch pricing, while the multi-payer landscape commercial insurers, Medicare, Medicaid—creates heterogeneous bargaining outcomes and opaque net price dynamics shaped by rebates and pharmacy benefit management [4], [7]. Consequently, Americans pay substantially more for many on-patent medicines than patients in peer countries, and per capita pharmaceutical spending approaches three times the OECD average [3].

Policy evolution in the 2020s has focused on constraining expenditure growth without extinguishing innovation. The Inflation Reduction Act’s negotiation provisions identify high-expenditure drugs and apply formula-based caps on negotiated ‘maximum fair prices,’ referencing clinical value and comparators [8], [11]. Objections from industry have produced litigation and policy uncertainty, but the direction of travel is clear: evidence-based bargaining will expand. However, unilateral ‘price equalization’ concepts e.g., MFN multiply strategic responses that have deleterious externalities for global access [12], [16], [18], [21].

Uzbekistan. A mid-sized, rapidly reforming economy, Uzbekistan’s pharmaceutical sector is deeply exposed to import prices and currency volatility. To maintain affordability, policy caps wholesale mark-ups at 15% and retail at 20%, and deploys ERP to prevent local list prices from exceeding external benchmarks [28], [29]. While these instruments protect consumers, they also limit firms’ pricing flexibility, which can translate into delayed launches or absent registrations for high-cost therapies. Per capita health spending (~$170) compared with the U.S. (> $12,000) highlights the necessity of deep discounting for access [26], [27].

Industrial and digital policy in Uzbekistan is reshaping the environment: the Tashkent Pharma Park aims to localize production capacity and skills, while a national AI roadmap funds pilots in healthcare forecasting and procurement analytics [30], [35], [37]. These initiatives increase the feasibility of outcomes tracking, pharmacovigilance, and AI-supported procurement capabilities that make sophisticated pricing agreements operationally manageable.

Global frame. Differential pricing underpins access programs for vaccines and anti-infectives, often via alliance structures (e.g., pooled procurement) and donor support [40], [41]. Yet, when richer countries import the lowest global prices into their domestic rules, firms react by raising floors or restricting low-price launches to avoid contaminating high-revenue markets [16], [19], [20]. The result is a collective-action failure: unilateral domestic cost containment can reduce global access and, paradoxically, undermine long-run innovation if expected returns collapse [43], [44].

Implication. A cooperative mechanism must explicitly protect price differentials, reward volume commitments, and link price to value and income. A bilateral agreement anchored by an AI optimizer and surrounded by legal safe harbors offers a tractable path that is faster to implement than complex multilateral treaties while still scalable through replication.

The Case for AI in Market Access

Demand forecasting. AI models trained on claims, prescription trajectories, and socio-demographic indicators estimate elasticities at the level of patient segments and providers. In the U.S., formulary placement, step therapy, and co-pay design shape realized demand; in Uzbekistan, out-of-pocket exposure and public procurement cycles dominate utilization. Elasticities are thus context dependent; the AI captures these differences and enables counterfactual simulations such as co-pay caps, tender timing, or entry of generics [45], [52].

Value assessment. Predictive systems trained on health technology assessment (HTA) archives can infer the probability that a price point will satisfy cost-effectiveness thresholds in a given jurisdiction. By synthesizing clinical trial outcomes with real-world evidence, the AI proposes value-consistent price corridors and projects budget impact across time horizons, accelerating negotiation convergence [48], [50].

Tender analytics. In settings where hospitals or ministries procure via tenders, machine learning on historical bids identifies competitive ranges and red flags for collusion. Buyers can calibrate reserve prices; suppliers can avoid over- or under-bidding, increasing participation and supply reliability [55], [58].

Acquisition cost prediction. Predictive acquisition cost (PAC) methods align reimbursement with underlying market conditions by estimating pharmacy purchase costs and detecting distortions in wholesale lists. Applying PAC narrows spreads, discourages arbitrage, and ultimately informs price policy through more accurate cost baselines [59], [62].

Governance and ethics. Risks include biased training data, opacity ('black box') in decision logic, and confidentiality constraints around rebates and private contracts. Mitigations include explainable AI, bias audits, privacy-preserving computation (e.g., secure enclaves, differential privacy), and oversight committees that retain final decision authority with documented rationales [65], [67].

Bilateral AI-Optimized Pricing Framework

Model setup. Two markets (US, UZ) with prices P_{US} and P_{UZ}, demands $Q_{US}(P_{US})$ and $Q_{UZ}(P_{UZ})$, marginal cost c, and a profit floor Π_{min}. Public welfare W aggregates health gains ($H_i \propto$ treated patients × average per-patient QALYs) minus payer expenditures ($C_i = P_i \times Q_i$ net of rebates). Optimization selects prices and optional quantity commitments to maximize W subject to policy ceilings and equity constraints [68]–[70].

Objective and constraints. We consider the problem: $W = \alpha_1 H_{US} + \alpha_2 H_{UZ} - \beta_1 C_{US} - \beta_2 C_{UZ}$, subject to $\Pi = (P_{US} - c)Q_{US} + (P_{UZ} - c)Q_{UZ} \geq \Pi_{min}$; $P_{UZ} \leq P_{cap}$; $P_{US} \leq P_{max}$. Equity via income: $P_{UZ} = P_{US} \cdot (GDP_{UZ}/GDP_{US})^{\theta}$ with $\theta \in [0,1]$, linking relative prices to ability-to-pay [70]. The Lagrangian solution yields first-order conditions that balance marginal health returns against marginal fiscal cost while keeping the profit constraint active when binding.

Learning layer. Instead of imposing parametric demand functions, we train a supervised learner on historical analogues (therapeutic class, biomarker-defined subpopulations) to estimate $Q_i(P_i)$ and uncertainty bands. Policy variables—co-pay ceilings, prior authorization, tender cadence—enter as features. Monte Carlo draws propagate uncertainty into W, producing robust price recommendations and guardrails for renegotiation triggers.

Contract translation. The optimizer’s outputs map to clauses: (i) price schedules for US and UZ over a 3–5 year horizon; (ii) minimum purchase commitments for UZ with flex bands; (iii) an explicit non-reference clause exempting UZ prices from U.S. reference rules; (iv) outcomes-based rebates if real-world effectiveness falls below agreed thresholds; (v) anti-parallel-trade surveillance; and (vi) automatic re-openers upon biosimilar entry.

Governance. A joint board supervises data pipelines, audits model performance, and publishes plain-language summaries. Data rooms operate with anonymization and strict access control. Manufacturers receive observer status to validate technical assumptions without vetoing public-interest terms.

Ethical calibration. Weights (α, β) and the affordability threshold are set via structured stakeholder deliberation. Equity adjustments can prioritize vulnerable populations (e.g., pediatric, rural) by modulating effective out-of-pocket exposure within the same P_{UZ}.

Scenario Analysis (2025–2030)

Assumptions. Consider a high-cost oncology therapy launching in 2025. List price $100,000/course in the U.S.; marginal cost c = $5,000; 10,000 eligible U.S. patients/year; Uzbek initial uptake limited by affordability and registration lags. We compare: (A) Status Quo; (B) MFN; (C) AI Bilateral. Figures are illustrative but consistent with industry patterns [16], [19], [20], [40], [41].

A) Status Quo. U.S. price remains near list (or net ~$80,000 after rebates), with utilization controls limiting inappropriate use. Uzbekistan sees negligible access due to ERP caps still pricing above household capacity. Five-year profit approximates $4.5B. Health gains occur largely in the U.S.; global equity remains poor.

B) MFN. U.S. policy pegs to the lowest peer-country price (≈$60,000). Manufacturers protect global revenue by withholding deep discounts elsewhere or delaying lower-income launches. Uzbekistan access remains near zero. Five-year profit declines to ~$3.8B; the access gap widens relative to potential, undermining global welfare.

C) AI Bilateral. Prices: U.S. ~$80,000; Uzbekistan ~$10,000 with a three-year minimum volume commitment and donor-eligible co-financing. U.S. coverage criteria ease modestly, raising treated patients to ~12,000/year; Uzbekistan initially treats ~500/year, scaling with program maturation. Five-year profit ~ $4.0B. Crucially, total treated patients across both markets is maximized; the solution passes a value-based sense check (2 QALYs per patient → $100,000 in U.S., ~$10,000 in UZ) [72].

Sensitivity. If Uzbek uptake underperforms, the price can step down or outreach investment can rise to stimulate appropriate use. If U.S. demand is price inelastic, the optimizer can raise P_{US} modestly without harming UZ pricing, preserving Π_{min}.

Biosimilar entry triggers automatic renegotiation, with both markets shifting to new efficient points.

Implementation Considerations

Data infrastructure. U.S. claims/EHR repositories and Uzbek registries/procurement logs feed a harmonized schema. Cloud computation with secure enclaves enables cross-border analytics while preserving privacy and sovereignty. A joint technical unit curates data quality, maintains model code, and issues quarterly performance reports [35], [37].

Institutional roles. HHS/CMS anchors U.S. negotiation pilots; Uzbekistan’s Ministry of Health and Pharmaceutical Industry Development Agency manage tendering and patient support. The manufacturer contributes non-public cost and supply information under NDA to calibrate Π_{min} and capacity constraints. WHO or the World Bank may provide methodological validation and catalytic financing for first-year procurement and training [43], [44].

Contract mechanics. Key clauses include: (1) non-reference safe harbor; (2) minimum purchase guarantees with flexibility bands; (3) outcomes-based rebates tied to real-world effectiveness; (4) step-down schedules upon biosimilar market entry; (5) anti-parallel-trade and diversion monitoring; (6) annual AI recalibration with transparent change logs.

Capacity building. Scholarships and staff exchanges build local HTA and data-science expertise; a center of excellence embedded in Tashkent Pharma Park anchors long-term capability and reduces reliance on external consultants [30], [37].

Ethical and Risk Considerations

Transparency. Public trust requires clear articulation of objectives, weights, and constraints in the optimizer. Plain-language summaries should explain how trade-offs were evaluated and how patient subgroups are protected from adverse prioritization [65], [67].

Privacy and security. De-identification, access controls, and privacy-preserving computation are mandatory. Cross-border data sharing must comply with domestic statutes; when raw data cannot move, federated learning can train models locally and aggregate gradients centrally.

Legal robustness. Agreements should be drafted to survive political turnover, with dispute-resolution mechanisms and contingency plans for supply disruptions. Fallback pricing formulas should be codified to maintain access during system outages or renegotiation delays.

Outlook and Global Implications

Scaling path. Bilateral pilots can proliferate across therapeutic areas and country pairs, establishing a de facto standard that later informs formal multilateral instruments. A WHO-facilitated consortium could maintain reference algorithms, curate de-identified datasets, and certify transparency, creating a public good for fair pricing analytics [16], [43], [44].

Industry adaptation. Firms can internalize global optimization, designing launch strategies that accept lower margins in constrained markets in exchange for volume commitment and reputational capital. Payers gain predictability and can align benefits design with dynamic value estimates, increasing the efficiency of health spending.

Conclusion and Future Outlook (2025–2030)

AI-optimized bilateral frameworks offer a practical way to balance affordability and innovation across markets with very different economic realities. By integrating advanced modeling and cooperative agreements, the United States and Uzbekistan can jointly set fair prices for high-cost medicines. Such arrangements expand access in emerging economies while supporting rational cost control in advanced ones, without undermining incentives for pharmaceutical innovation.

From a policy standpoint, this approach aligns with current global trends. The U.S. is shifting toward evidence-based pricing and outcome-linked payments, while emerging economies like Uzbekistan are investing in AI and digital health reforms [37]. Our bilateral model reflects these directions, providing a structured, data-driven path toward equitable access.

Looking ahead to 2030, wider adoption of such frameworks could lead to a more balanced pricing landscape, where differences between rich and poor countries narrow as firms pursue higher volumes at moderate margins. Global health security would improve as new drugs become accessible faster worldwide, reducing the risks of outbreaks and resistant diseases. Pharmaceutical companies may adopt AI to plan global launches holistically, transitioning from high-margin, low-volume models to broader, volume-based strategies.

Institutionally, a "Global Center for Fair AI Pricing" under WHO or similar alliances could emerge to standardize algorithms and ensure transparency. Ethical safeguards will remain central AI systems must stay explainable, fair, and auditable, preventing bias in how value and access are distributed.

In essence, AI-Optimized Market Access can redefine how countries collaborate on drug pricing. What begins as a U.S.–Uzbekistan pilot could inspire broader coalitions for instance, EU–Africa or Japan–Southeast Asia collectively negotiating through AI-driven analytics. This evolution requires trust, data sharing, and political will, but the reward is transformative: a future where access to essential medicines depends not on national wealth but on shared human need.

Appendix: Illustrative Calculations and Extended Data

Table A1. Comparative outcomes under three scenarios for a new high-cost drug (2025–2030)

Scenario	U.S. Price (2025)	U.S. Patients Treated	UZ Price (2025)	UZ Patients Treated	5-Year Profit	Summary of Access & Outcomes
A. Status Quo	$100,000	10,000/year	Not launched	0	High (~$4.5B)	U.S.: high spending, moderate access. UZ: no access.

Scenario	U.S. Price (2025)	U.S. Patients Treated	UZ Price (2025)	UZ Patients Treated	5-Year Profit	Summary of Access & Outcomes
B. U.S. MFN	$60,000	11,000/year	Not launched	0	Medium (~$3.8B)	U.S.: lower price, slightly better access; UZ excluded.
C. AI Bilateral	$80,000	12,000/year	$10,000	500/year	Medium (~$4.0B)	U.S.: wider access; UZ: affordable launch for first time.

Key Insights:

Scenario C (AI Bilateral) achieves the best global balance U.S. price decreases ≈ 20%, expanding local access, while Uzbekistan obtains ~ 85% lower pricing and begins treatment rollout. Overall profit remains viable, and total patients treated globally increase the most.

Sensitivity & Value Validation:

If Uzbek demand underperforms (e.g., 300 vs 500 patients), the AI model can lower price or enhance outreach. If U.S. demand proves inelastic, the system adjusts upward slightly without harming Uzbek affordability. Each market’s price aligns with value-based thresholds: ≈ $50k per QALY in U.S. and ≈ $5k per QALY in UZ, confirming both economic efficiency and ethical fairness [72].

Limitations:

The model excludes local manufacturing and voluntary licensing, which could further reduce Uzbek costs. Future versions can incorporate phased tech-transfer or donor co-financing scenarios for more inclusive design.

Summary:

The comparative exercise underscores how AI-driven bilateral negotiation can deliver affordability, preserve innovation, and maximize global health benefit a scalable blueprint for equitable access worldwide.

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