

Product Variety in the Anti-Malarial Supply Chain

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Antimalarial Treatment Strategies: Getting the Most from Malaria Drugs

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Introduction

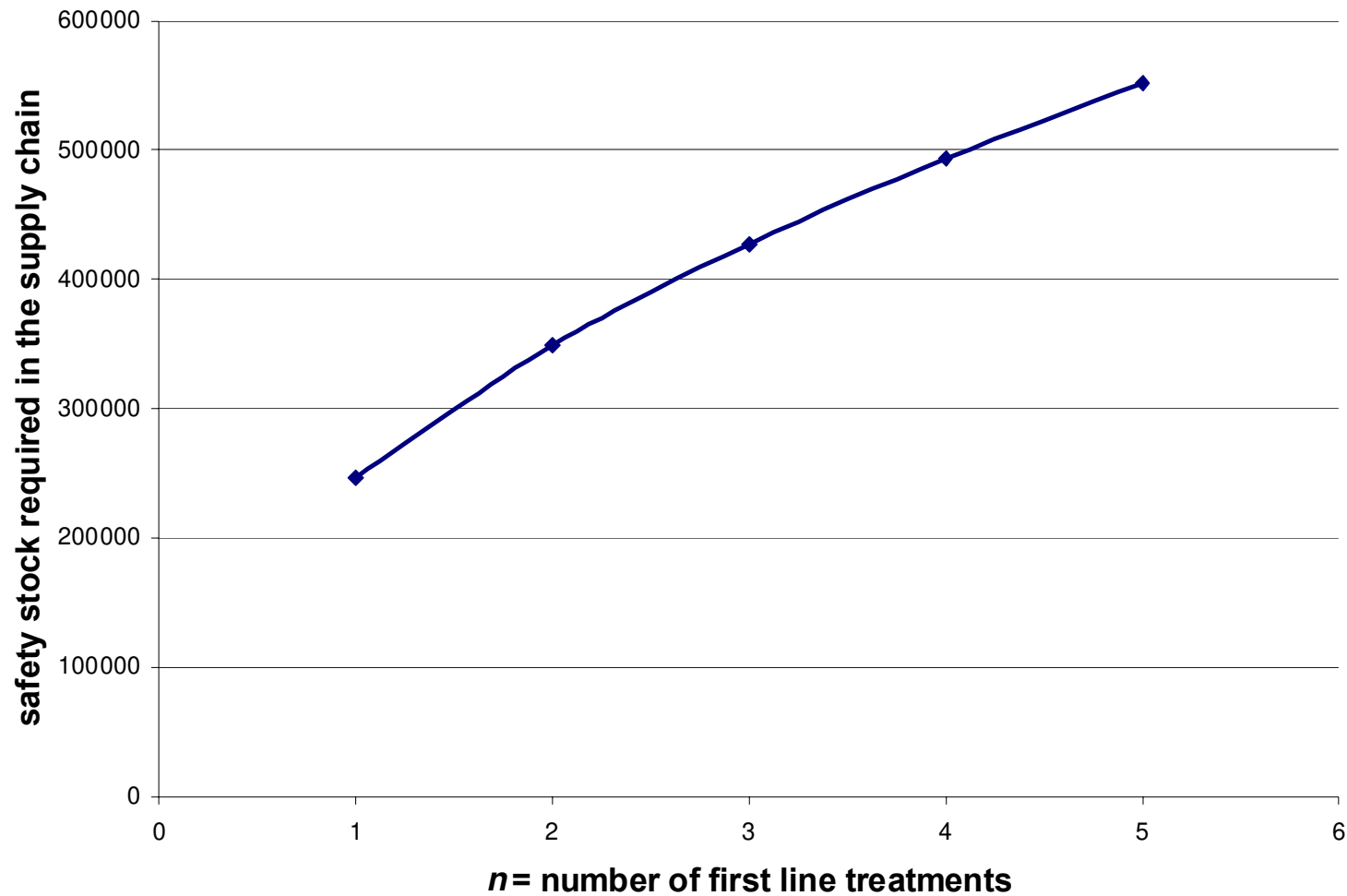
- **The use of multiple first-line therapies (MFT) delays the emergence of drug resistance**
- **Under MFT several therapies are available (in the public or private market) and prescribers and/or end-patients determine which therapy to use**
- **What are the incentives of the supply chain to choose multiple variants of the same product ?**
- **How do these vary in the public and private sector?**

Public sector
Levers exist to influence policy towards MFT

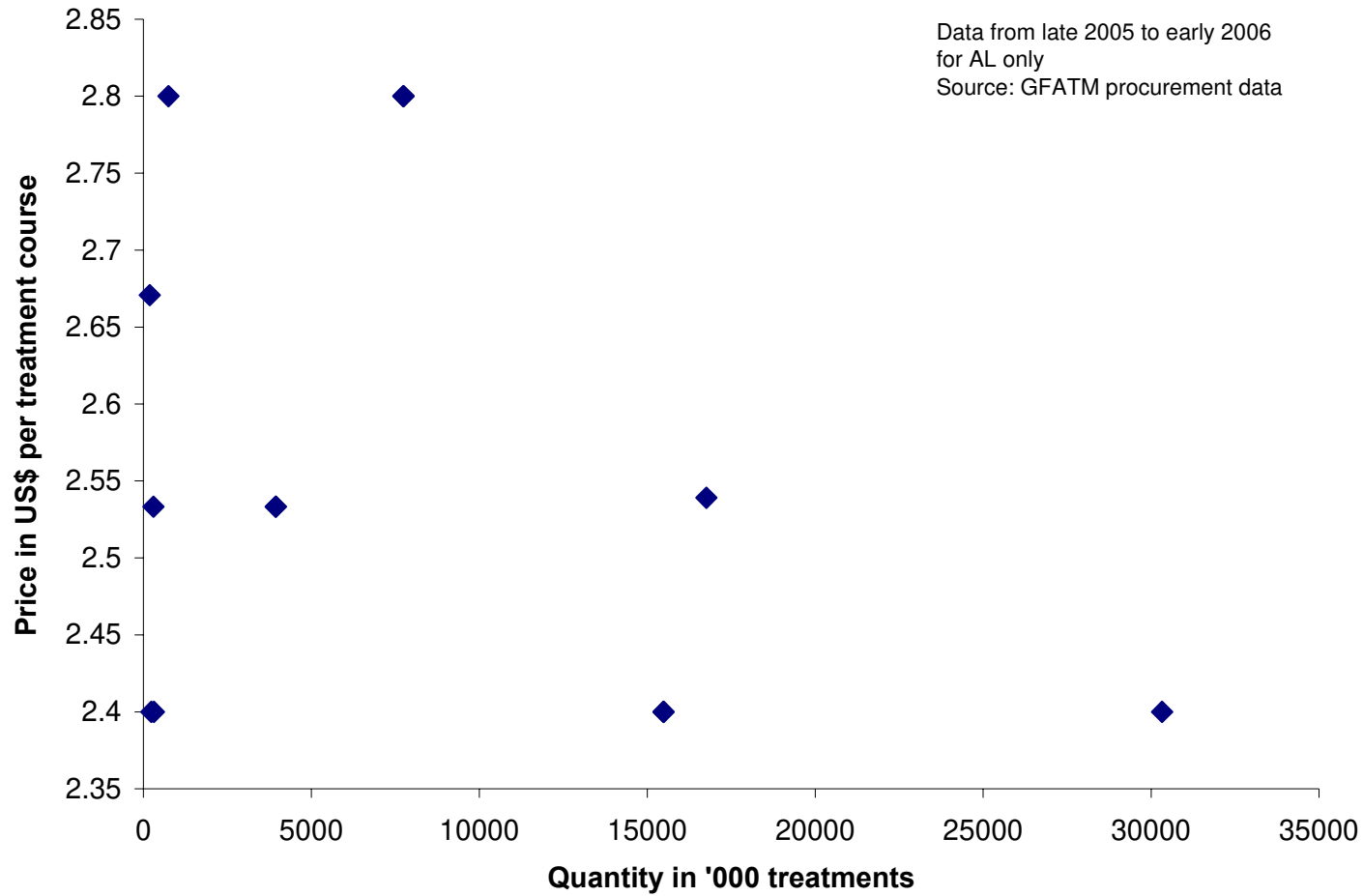
Anti-malarial variety in the public sector supply chain

- **Very few countries with multiple first line treatments**
- **High cost of maintaining more than one first line treatment**
 - ◆ Buffer/safety stock required to maintain the same level of service goes up by a factor of \sqrt{n}
 - ◆ Full substitutability between first line therapies can eliminate this need for additional safety stock
 - ◆ Substitution leads to confusing treatment guidelines
 - ◆ Pricing and bargaining power disadvantage with suppliers
 - ◆ Higher cost of training program staff for MFT
 - ◆ Managing synchronized procurement cycles for $n > 1$ products is a planning nightmare for already weak procurement systems

MFT and supply chain safety stock requirements



Concentrating volume on a single first line AM helps obtain better prices?



Realities and solutions

- **Higher quantity purchased does not lead to lower procurement price for AIDS, TB and Malaria drugs**
 - ◆ Evidence in Yadav and Lai 2007, *What Explains Prices of Pharmaceuticals Purchased by Developing Countries?*
 - ◆ Similar evidence in Waning et al. 2007 & 2008
- **Voluntary pooled procurement will further reduce any price differentials**
- **The crux of the safety stock problem is poor consumption data and demand forecasting.**
 - ◆ If that is resolved, the base quantity in the square root relationship itself is small
- **Procurement systems need to be strengthened to handle synchronized multiple product procurement**

Private sector
Driven by patient choice and assortment stocking incentives

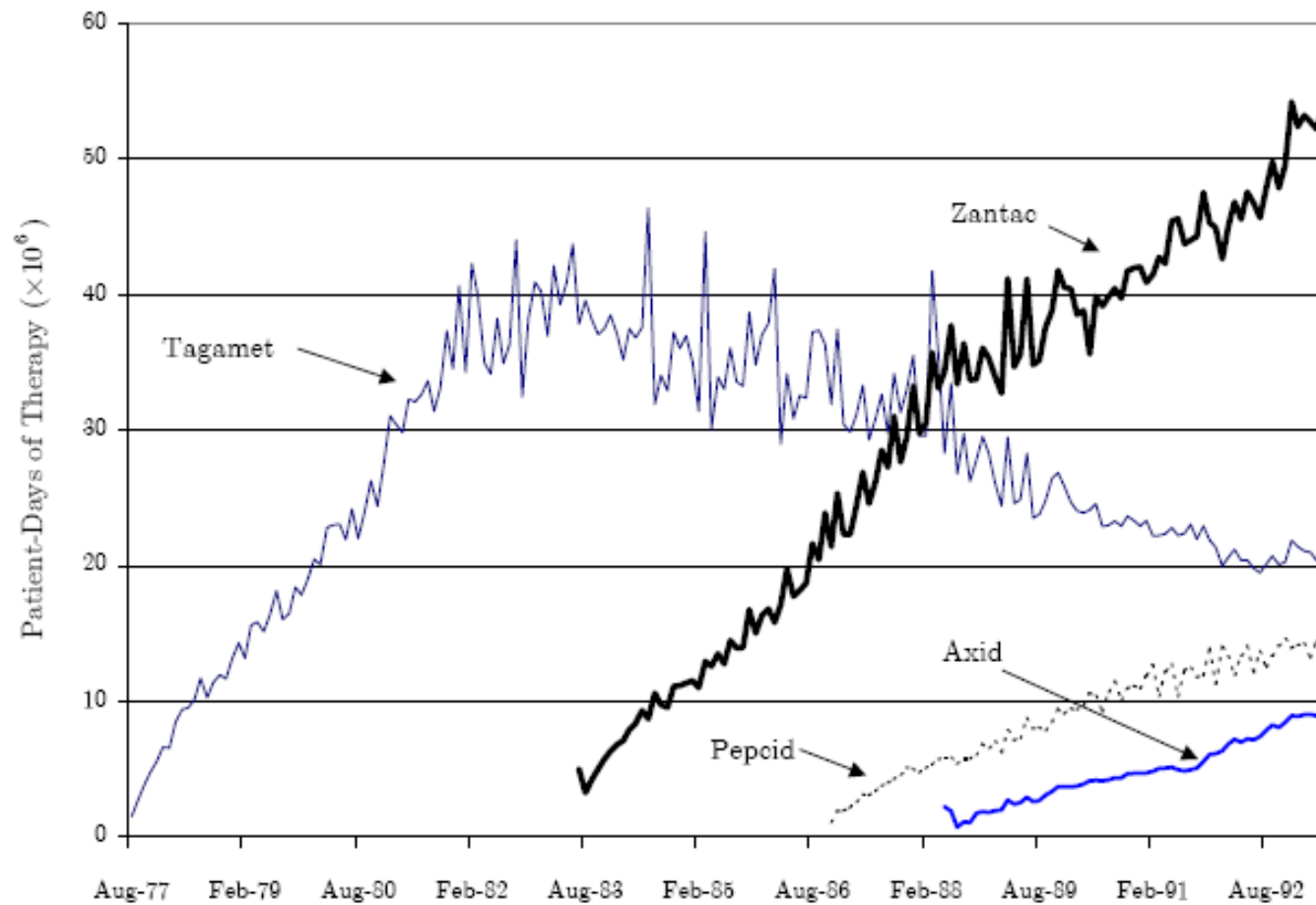
Variety in the private sector

- Patients and prescribers are heterogeneous in “taste”
- Anti-malarials with attributes closer to their desired attributes are purchased more
- Therefore, the private market has an incentive to offer a broad variety of anti-malarials to better cover the possible range of “tastes”
- There are direct and indirect costs of variety for the supply chain, higher costs of stockouts and overstocking impose an implicit cost on variety
- Trade-off: “breadth vs. depth” of assortment

Positive consumption externalities in purchase behavior

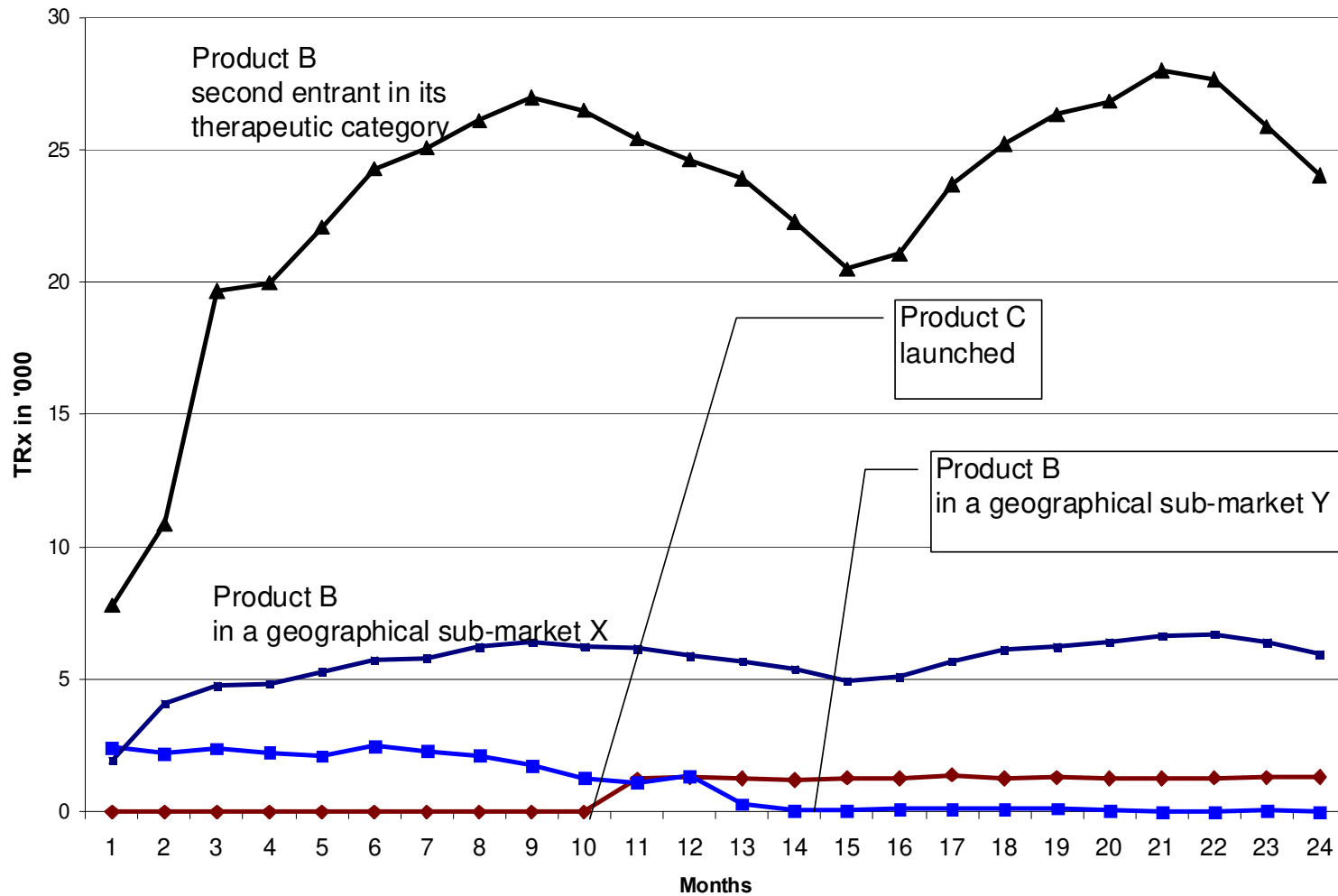
- Before purchasing any particular anti-malarial, the patient/prescriber has a prior valuation of its (expected) performance based on advertising, word-of-mouth, reference price, or general experience.
- Upon taking the drug, the patient/prescriber forms a judgment (perception) of the drug's efficacy, and changes her valuation of the drug based on it.
- It is this posterior valuation that determines the subsequent anti-malarial choice: We term this as **valuation carryover**
- Over time patients/prescribers increasingly trust their own experiences with the drug which makes it more difficult to influence choice at a later point in time.

Variety in the supply chain: A tale of four anti-ulcer products



Consumption Externalities and Diffusion in Pharmaceutical Markets: Anti-Ulcer Drugs
Ernst R. Berndt, Robert S. Pindyck and Pierre Azoulay, MIT Sloan School Working Paper 2000

Variety in the supply chain: A tale of three ID products



Source: Author's analysis. Data obtained from IMS Health

Modeling choice and assortment

- **Anti-malarial products are perceived as bundles of characteristics and individual preferences are defined on these characteristics rather than on the products themselves**
- **Demand is generated by an individual-level locational consumer choice model based on Hotelling (1929)**
- **The products in the category are horizontally differentiated, i.e., they differ by characteristics that do not affect quality or price**
- **Preference spectrum : the space of all possible combinations of levels of attributes, where each point corresponds to a potential product location in the category**
- **Each patient is characterized by the specification of her most preferred anti-malarial in the preference spectrum, defined as the good that represents the optimal transfer of characteristics to her**

Choice model details

- A patient i with most preferred good x_i associates a utility U_{ij} to a product j in the assortment
- $U_{ij} = Z - p - g(|x_i - b_j|)$
- Z is a positive constant representing the surplus associated with taking an antimalarial. p is the price of product
- Patients choose the variant with the highest utility among the set
 $\{U_j : j \in S \cup \{0\}\}$
- A no-purchase option, denoted $j = 0$ occurs if the patient does not derive positive utility from any option
- Denote by k the number of patients who choose not to purchase any anti-malarial from the assortment

Assortment optimization problem

The supply chain solves the following optimal assortment selection problem

Let $A_i = \{1, 2, \dots, i\}$ for $1 \leq i \leq n$.

Then, there exists an $S^* \in \{A_1, \dots, A_n\}$ that maximizes supply chain profits Π_{SC}

Define S_{SO}^* to be the long run socially optimal level of variety

Theorem 1: k is decreasing in the cardinality of S^*

Higher variety in the anti-malarial space improves the fraction of those who seek treatment for malaria

Theorem 2: $S^* \neq A_n$

The supply chain may choose not to cover the entire market in its optimal assortment, i.e., it may leave some segments of the attribute space uncovered by any anti-malarial

Will AMFm naturally lead to more variety?

- The size of the optimal assortment is not monotonic in the input cost of the product c
- A decrease in c expands the region of profitable products for the supply chain
- A decrease in c increases the supply chain's expected profit of the more popular products proportionately more than other products.
- A decrease in c increases the service levels of products, and thus, decreases the expected gain from substitution between products
- While the first effect is a drive towards more variety, the other two lead to less variety
- As a result, the size of the optimal assortment can increase or decrease in c