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**Smuggling Iron: A Spatial Regression Discontinuity Analysis of the Pink Tariff
on Women's Anemia Care in Mali**

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1. Abstract

In Mali, over 60% of women suffer from anemia, yet import tariffs of up to 15% inflate the cost of iron medicines, while contraband trade at porous borders circumvents these duties. This study exploits the resulting spatial price gap as a natural experiment. Using a spatial regression discontinuity design on pharmacy-level price data, I test whether distance from the border increases the price of iron drugs more than gender-neutral medicines, revealing a hidden “pink tariff.” The findings could support a zero-cost reform to eliminate duties on essential anemia treatments.

2. Introduction

Anemia remains a leading cause of morbidity among Malian women, directly reducing labor productivity and increasing maternal deaths. Because domestic production of iron drugs and ferritin tests is negligible, Mali relies almost entirely on imports. Officially, these products face import duties of up to 15%. In practice, customs enforcement is minimal at remote land borders, so large quantities of drugs enter informally and are sold in border-area pharmacies at prices close to world levels. Inland, where customs controls are tighter, the full tariff is incorporated into retail prices.

The main question is: Do import duties create a spatial price gap for antianemic drugs in Mali, reducing their availability to women compared to the border smuggling zones?

Testable

hypotheses:

H1: The price of an imported iron preparation increases by 3-5% for every 100 km away from the borders (Niger, Burkina Faso, Guinea), while controlling the income and density of pharmacies.

H2: The spatial gradient for iron preparations and ferritin tests (consumed mainly by women) is steeper than for the gender-neutral control basket (paracetamol, etc.), indicating a tariff "pink" component.

H3: Women within 50 km of the border are more likely to complete a full course of therapy (according to pharmacy sales) than those living in the interior of the country.

3. Literature review

Grossman's Health model (1972) predicts that rising prices reduce investments in health, especially when physiological needs are high. Amiti et al. (2019) recorded a complete transfer of duties to retail prices. UNCTAD (2020) has shown that tariffs on women's goods are a regressive tax. Deloitte (2023) estimated the "pink tax" on healthcare in the United States at \$15 billion. For the Sahel countries, the Baxerres & Le Hesran study (2020) revealed massive drug smuggling due to price gaps, and Cameron et al. (2016) showed that African drug prices are 20-60% higher than world prices due to tariffs. However, none of the studies used the spatial gap as a natural experiment to assess the gender-specific tariff burden.

4. Methodology

We apply spatial regression discontinuity (RD) with a local linear regression in distance and an optimal bandwidth selected by the Calonico–Cattaneo–Titiunik criterion. The running variable is the road distance from each pharmacy to the nearest official border crossing, computed via OpenStreetMap. The continuity of pretreatment covariates is tested with the McCrary density test; we additionally verify that local mean income (from geocoded DHS clusters) and population density (WorldPop) do not jump at the border. To separate tariff

evasion from geographic sorting, we estimate a spatial difference-in-discontinuities model. This specification interacts with a treatment indicator (iron drug) with the running variable and a border-zone dummy, allowing the price gradient to differ between iron products and the control basket while holding location fixed. All results are presented graphically with binned means and fitted RD polynomials. We cluster standard errors at the pharmacy level and report wild bootstrap p-values for inference with small clusters. A placebo test applies the same RD design to locally produced duty-free medicines, where no gradient should appear. As a robustness check, we re-estimate the model with half and twice the optimal bandwidth and exclude Bamako pharmacies to ensure the capital's centralized procurement does not drive the results. Finally, in a subsample of border towns, we compare prices on informal open-air markets with official pharmacy prices to directly measure the tariff wedge.

Primary data: a cross-sectional price audit of 40 pharmacies, stratified by distance (0–50 km, 50–150 km, >150 km) across four regions — Kayes, Sikasso, Gao, and Bamako. In each pharmacy we record retail prices of 5 iron-containing drugs, 3 ferritin test kits, and 5 control medicines. Data are collected by trained students from the Université de Bamako using a standardized KoboCollect form; the full survey is completed within three weeks. All prices are recorded in CFA francs and later converted to defined daily doses to ensure comparability. The analysis is implemented in Stata 18 using the robust package.

The control basket comprises medicines with comparable import dependence, shelf life, and distribution channels but without a gender skew in consumption: paracetamol tablets, amoxicillin capsules, and oral rehydration salts. By comparing the spatial price gradient of iron products to that of the control basket, we net out common logistics and market costs, isolating the tariff component that is specific to goods consumed primarily by women.

5. Expected results, feasibility, and Conclusion

We expect a gradient of 4-7% per 100 km for iron preparations with a flat control trend; the tariff contribution is 10-20% of the price difference. Accessibility for women at the borders is higher, and adherence to therapy is better. Work plan: weeks 1-2 — secondary data, 3-5 — field collection (40 pharmacies, students, KoboCollect), 6-7 — RD and tests, 8 — accessibility analysis, 9-10 — text. The main limitations are the sample size (offset by a narrow bandwidth) and possible instability in the Gao and Mali. If they are inaccessible due to instability, Mopti provides a comparable border zone with similar smuggling patterns. The zero-fee reform eliminates the spatial "pink tax" on women's health. This study will provide the first causal evidence that import tariffs function as a hidden spatial "pink tax" on women's anemia care in a low-income setting. By turning informal cross-border trade into a natural experiment, it demonstrates how trade policy can be redesigned to advance both gender equity and public health at zero fiscal cost.

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