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*Article*

# Balancing Food Safety and Trade Facilitation in Uzbekistan Customs Administration

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**Abstract:** This study examines how Uzbekistan's customs administration can facilitate food trade while maintaining effective safety controls. It brings together a reassessment of six reported regression equations, a hypothetical queueing example and a proposal for coordination among border agencies. Each equation reports 44 observations and four predictors; Holm adjustment is applied to all 24 slope coefficients. Eight coefficients meet the nominal five percent threshold. Four remain significant under a conservative allowance for rounded p values, compared with five when probabilities are approximated from the reported t statistics. The association between customs value and food imports holds under both calculations, whereas the negative import coefficient for fiscal relief depends on reporting precision. In the separate queueing example, four lanes operating at 6.073 vehicles per lane-hour minimize cost among the specified alternatives, with a mean queue wait of 4.716 minutes. These figures describe a hypothetical scenario. The proposed coordination mechanism uses a common consignment identifier, verified agency decisions and documented routing according to risk, drawing on European Common Health Entry Document practices. The findings support further evaluation at consignment level; they do not establish causal improvements in food security or national cost savings.

**Keywords:** Customs administration; food safety; trade facilitation; multivariate regression; queueing; interagency coordination.

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## 1. Introduction

Food consignments present customs authorities with a demanding management task: goods must move promptly, yet release decisions must rest on adequate regulatory evidence. Avoidable delays can increase costs and affect product condition. Faster clearance, however, does not by itself demonstrate that food is safe or accessible to households. FAO's framework distinguishes food availability, access, utilization and stability [1]. This distinction guides the present study, which considers how border management may contribute to these outcomes while recognizing that trade volumes alone cannot measure food security.

International instruments offer a basis for designing clearance procedures. The WTO Trade Facilitation Agreement addresses risk management, cooperation among agencies and the handling of perishable goods [2], while the SPS Agreement sets out principles for scientific justification and risk assessment [3]. They are used here as design references, without making a claim about Uzbekistan's accession status. For operational measurement, the WCO Time Release Study Guide, Version 4, published in 2025, provides

a framework for tracing the process from arrival to physical release across the agencies involved [4].

The European Common Health Entry Document (CHED) offers a useful example of how control information can be shared. Through TRACES, it records entry-control information and the decisions of competent authorities, with different document types for different consignment categories [5]. Adapting this approach requires more than a common digital form: each authority must retain responsibility for its decision, and the evidence required for each product must remain available. The shared record proposed in this article would connect those decisions while preserving the certificates and controls required by law.

In Uzbekistan, the relevant policy context includes Law No. O'RQ-1023 of 3 February 2025, On Food Security, and Presidential Decree No. PF-21 of 16 February 2026 concerning reforms within the priority development directions through 2030 [6], [7]. These instruments establish the broader context for the study; they are not evidence that the proposed mechanism has been implemented. The analysis addresses two questions: what the available econometric results reveal about food trade, and what further operational evidence is needed to design clearance procedures that are both safe and economically justified.

## 2. Data and analytical method

The empirical analysis draws on dissertation summaries that report six regression equations, their fit statistics and all slope coefficients [8]. The dependent variables are food imports, food exports, total declarations, import declarations, export declarations and enterprises. Each equation contains 44 observations and five estimated parameters: an intercept and four predictors. The predictors are customs payments, customs value, import duty and fiscal relief. Enterprises appear as an outcome rather than as an additional explanatory variable.

The source describes a study period of 2014–2025, equivalent to 48 quarters. Its outcome and regression tables nevertheless report 44 observations, while some predictor summaries contain 48. The available material does not identify the estimation dates or explain which observations were excluded. The analysis therefore uses the reported estimation sample of N = 44, without assuming a balanced quarterly dataset. Monetary units and transformations are also incompletely documented, so the coefficients are presented on their original reported scale. They cannot reliably be read as elasticities, dollar changes or policy multipliers. No observation-level values have been reconstructed or imputed.

Equation (1) presents the reported multivariate specification. Here j identifies the outcome, t identifies a reported observation, and P, V, D and E denote customs payments, customs value, import duty and fiscal relief. When every equation uses the same regressors, mvreg produces the same equation-level coefficients and standard errors as separate ordinary least squares regressions; joint estimation also permits analysis of covariance across equations [9]. A high $R^2$ indicates close in-sample fit, but it cannot establish a causal effect of customs administration or separate price changes from changes in physical food availability [10].

$$Y_{jt} = \alpha_j + \beta_{1j}P_t + \beta_{2j}V_t + \beta_{3j}D_t + \beta_{4j}E_t + \varepsilon_{jt}. \quad (1)$$

Multiple testing is addressed across all 24 slope coefficients, including those for administrative outcomes outside the main food-trade table. Holm's procedure is applied to this full family [11]. The reported p values have three decimal places. To allow conservatively for rounding or truncation, the first calculation uses $p^+ = \min(1, p_{printed} + 0.001)$; a printed zero is therefore assigned an upper bound of 0.001. A sensitivity calculation approximates two-sided p values from the rounded t statistics, using 39 residual degrees of freedom implied by 44 observations and five parameters [12]. Both calculations reassess the reported results; neither constitutes a new regression estimation.

The underlying predictor matrix and residuals were not available. Claims about normality, collinearity and serial correlation therefore could not be checked independently and are not accepted here as verified diagnostics [13]. Normality and constant error variance are separate assumptions, and the adjusted p values remain conditional on the validity of the original tests. The summary calculations and queueing example were implemented in Python using NumPy, pandas and SciPy; the figures were prepared with Matplotlib.

## 3. Results

### Econometric findings

**Table 1.** Reported fit of the six outcome equations

| Outcome | N | $R^2$ | F(4,39) |
|---|---|---|---|
| Food imports | 44 | 0.9225 | 116.108 |
| Food exports | 44 | 0.7276 | 26.047 |
| Total declarations | 44 | 0.9487 | 180.278 |
| Import declarations | 44 | 0.9039 | 91.707 |
| Export declarations | 44 | 0.9650 | 269.151 |
| Enterprises | 44 | 0.9028 | 90.607 |

Each equation includes four slopes and an intercept. The reported p values for the F tests are <0.0001. These fit statistics are reproduced from [8], rather than re-estimated, and do not measure causal effects.

The reported $R^2$ is 0.9225 for food imports and 0.7276 for food exports. The declaration equations also show high fit. These results describe associations between the outcomes and the four fiscal and valuation variables within the estimation sample. They do not show that customs administration accounts for 92.25 percent of an improvement in food security. Customs payments, declared value and trade flows may be jointly determined, and shared trends or overlapping definitions can produce high fit even when no intervention effect has been identified.

**Table 2.** Complete reported coefficients for food imports and exports

| Outcome and predictor | β | Reported 95% CI | p | Holm upper bound |
|---|---|---|---|---|
| Food imports Customs payments | 187.476 | [-20.701, 395.653] | 0.076 | 1.000 |
| Food imports Customs value | 605.641 | [329.951, 881.330] | <0.001 | 0.024 |
| Food imports Import duty | 35.181 | [-224.495, 294.858] | 0.786 | 1.000 |
| Food imports Fiscal relief | -206.160 | [-331.328, -80.991] | 0.002 | 0.060 |
| Food exports Customs payments | 198.686 | [1.142, 396.230] | 0.049 | 0.850 |
| Food exports Customs value | 137.405 | [-124.203, 399.012] | 0.295 | 1.000 |

| Outcome and predictor | | β | Reported 95% CI | p | Holm upper bound |
|---|---|---|---|---|---|
| Food Import duty | exports | -117.054 | [-363.467, 129.359] | 0.343 | 1.000 |
| Food Fiscal relief | exports | -28.877 | [-147.652, 89.898] | 0.626 | 1.000 |

CI denotes the reported, unadjusted confidence interval. Coefficients are shown on the source scale; their units and transformations remain to be clarified. Holm upper bounds are calculated across all 24 slopes, including the administrative equations. The supplement provides standard errors and the alternative p-value calculations. Source: [8] and the present calculations.

Customs value is positively associated with food imports: the reported coefficient is 605.641, with a 95 percent confidence interval of 329.951–881.330. This association remains significant under both multiple-testing calculations. The coefficient for fiscal relief is −206.160, with a reported confidence interval of −331.328 to −80.991 and p = 0.002. Its conservative Holm upper bound is 0.060, compared with an approximate adjusted p value of 0.038 reconstructed from the t statistic. The evidence for this association consequently depends on reporting precision. Neither the negative sign nor its nominal significance identifies a mechanism involving domestic production or imports of production inputs, which are not observed in these summaries.

For food exports, customs payments are the only predictor meeting the nominal five percent threshold (β = 198.686; reported p = 0.049). This result does not remain significant after adjustment across the 24 tests, and no food-export coefficient meets either adjusted criterion. The aggregate equation also provides no statistically significant evidence for an import-duty association. A duty coefficient estimated for a particular fruit category in another model cannot be used in place of the aggregate result. Assessing differences across products, reverse causality or imported-input linkages would require separate data and specifications.

Across the six equations, eight slopes meet the nominal threshold, four meet the conservative Holm criterion and five meet the criterion based on approximate p values reconstructed from t statistics. Beyond the import–customs-value association, the conservative calculation retains payments and relief in the export-declaration equation and relief in the enterprise equation. These are administrative associations; they do not directly measure food supply or a reduction in informal trade. Figure 1 shows all 24 signed t statistics, including negative and non-significant estimates. It is a comparison of test statistics, not a ranking of standardized effects or causal importance.




**Figure 1.** Reported t statistics for all 24 slope coefficients. Stars mark coefficients meeting the conservative Holm criterion at five percent. Colors indicate the direction of the test statistic, not causal effect size. Source: supplied summaries [8] and the present calculations.

**Capacity planning under hypothetical conditions**

The regression summaries do not contain observations on arrivals, service times or spoilage. A separate queueing example is therefore used to explore capacity choices for a homogeneous group of consignments eligible for the same processing stage. Its parameters are hypothetical and are not calibrated to a border post in Uzbekistan. The M/M/c model assumes independent Poisson arrivals, independent exponential service times, identical parallel lanes and service in arrival order within the group. It describes one stage of processing rather than the entire border or laboratory system. Under the stability condition in equation (2), the Erlang-C formulas yield the stationary waiting measures [14].

$$a = \lambda/\mu; \quad \varrho = \lambda/(c\mu) < 1. \quad (2)$$

$$P_0 = [\Sigma_{n=0}^{c-1} a^n/n! + a^c/\{c!(1-\varrho)\}]^{-1}. \quad (3)$$

$$C = a^c P_0/\{c!(1-\varrho)\}; \quad Wq = C/(c\mu-\lambda). \quad (4)$$

In these equations, $\lambda$ is the hourly arrival rate, $\mu$ is the service rate per lane, c is the number of lanes, C is the probability that a vehicle must wait, and Wq is its mean queue waiting time in hours. Mean service time, $1/\mu$, is additional to that wait. The example represents the fraction of value lost during a delay w as $\delta(w) = 1-\exp(-\gamma w)$, where $\gamma$ is a non-negative deterioration parameter measured per hour. Conditional on a positive wait, M/M/c waiting time follows an exponential distribution with rate $c\mu-\lambda$. The expected loss fraction is therefore $C\gamma/(c\mu-\lambda+\gamma)$. Taking this expectation accounts for the nonlinear loss function; applying the function directly to the mean wait would give a different result.

Equation (5) combines operating, waiting and deterioration costs per hour. The term $c(k_0+k_1\mu^2)$ represents the cost of lanes and service capacity, cw is the waiting cost per vehicle-hour, and cd is the value lost per vehicle at complete loss. All costs use the same illustrative currency. Table 3 lists the assumed parameter values. The calculation compares $c \in \{2,4,6\}$ and $5 \le \mu \le 30$, retaining only stable configurations. The resulting minimum applies to these alternatives and bounds, rather than to every possible staffing arrangement.

$$TC(c,\mu) = c(k_0+k_1\mu^2) + cw\lambda Wq + cd\lambda C\gamma/(c\mu-\lambda+\gamma). \quad (5)$$

**Table 3.** Hypothetical parameters for the capacity illustration

| Parameter | Assumed value | Unit or definition |
|---|---|---|
| $\lambda$ | 18 | Vehicles per hour |
| c | 2, 4, 6 | Alternative lane counts |
| $\mu$ | 5 to 30 | Vehicles per lane-hour |
| $k_0$ | 40 | USD per lane-hour |
| $k_1$ | 1.2 | Chosen so $k_1\mu^2$ is USD per lane-hour |
| cw | 25 | USD per vehicle-hour waiting |
| cd | 100 | USD per vehicle at complete loss |
| $\gamma$ | 0.15 | Per hour |

All parameter values are assumptions selected for this example. They are not observed border costs, customs tariffs or estimated deterioration rates.

For each lane count, bounded numerical minimization is checked against both endpoints and a dense grid. Table 4 reports the resulting minima, which are also marked in Figure 2. Among the specified alternatives, four lanes with $\mu = 6.073$ give the lowest cost, at 393.11 illustrative USD per hour. The mean queue wait is 4.716 minutes, with approximately 9.880 minutes of mean service time at this processing stage. These results cannot be interpreted as measured savings, total clearance time or a common time standard for inspections.

**Table 4.** Calculated optima within the hypothetical choice set

| | | | |
|---|---|---|---|
| 2 | 11.437 | 8.533 | 495.17 |
| 4 | 6.073 | 4.716 | 393.11 |
| 6 | 5.000 | 0.983 | 431.74 |

Results refer to the hypothetical stationary queue. The service rate $\mu$ applies to one lane, rather than to the checkpoint as a whole. For six lanes, the minimum occurs at the lower bound $\mu = 5$. No observed time saving is estimated.

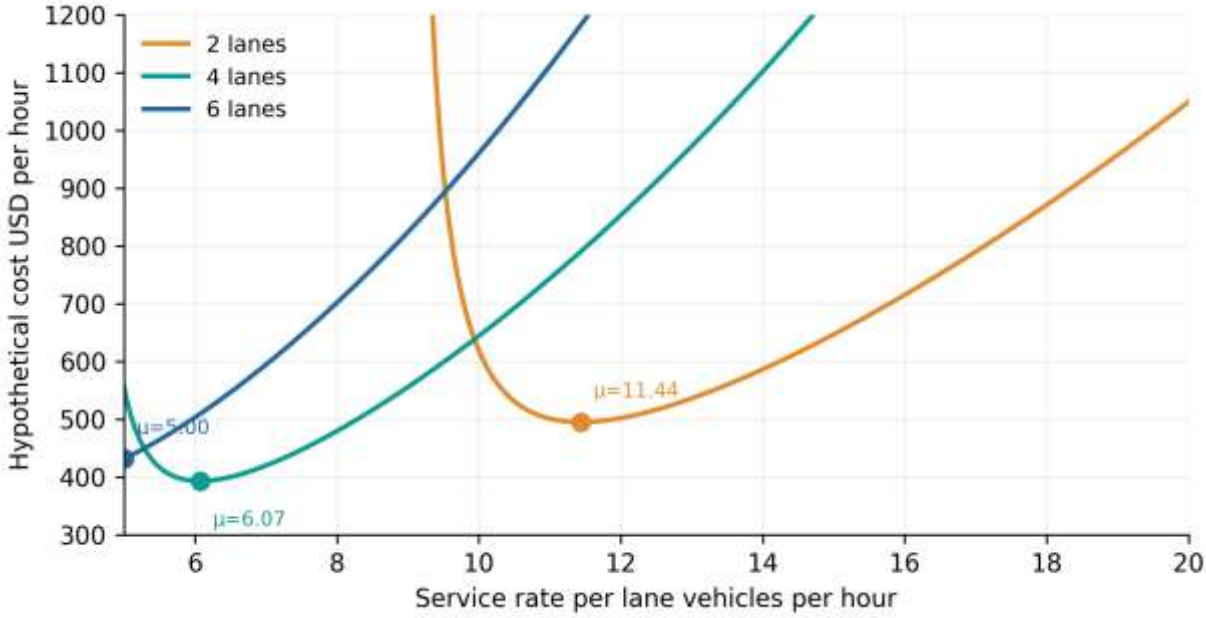



**Figure 2.** Hourly cost curves under the hypothetical assumptions. Dots identify the minimum for each lane count. Four lanes yield the lowest cost among the specified alternatives. Only stable configurations are shown; curve segments above the plotting limit are omitted. Source: reproducible scenario calculations.

The example shows how capacity decisions can be evaluated once suitable operational data are available. Applying it to a checkpoint would require observed arrival and service-time distributions, shift schedules, route composition, minimum processing times, storage conditions and losses. Group arrivals, priority classes or linked agency queues may call for another queueing model or a discrete-event simulation. Any proposed time target must respect laboratory methods and the competent authority's safety requirements.

**Coordinating clearance across agencies**

The proposed mechanism connects information across agencies while preserving each authority's legal responsibility. A common consignment identifier links declarations, certificate references, risk assessments, samples and release events.

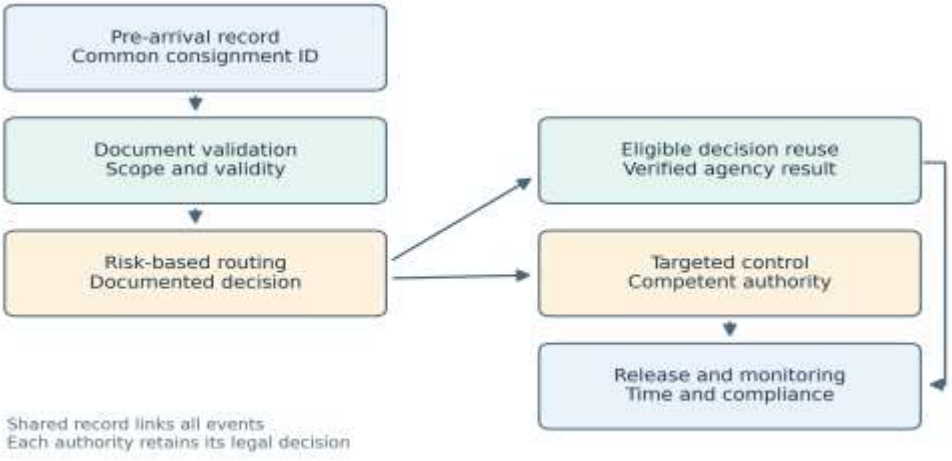



**Figure 3.** Proposed coordination of clearance through a shared consignment record, documented risk routing and decisions by the competent authorities. Arrows represent information flows; they do not imply automatic legal recognition or exemption from control. Source: author's design, informed by [2][3][4][5].

Each authority validates its own decision and records what it covers and how long it remains valid. Customs may reuse that verified result when it applies to the consignment and the legal conditions are met. Where further evidence is required, a reason code records the basis for the request. This allows the coordinator to distinguish necessary additional checks from duplication. Figure 3 sets out the proposed workflow; it does not describe an operational national system.

A public laboratory service catalogue could support this arrangement by stating accredited scopes, test methods, sample requirements, prices and the turnaround time for each method. These times would need to reflect the tests involved; the proposal does not rely on an unverified universal two-hour standard attributed to Latvia's BIOR institute. Nor does it assume direct interoperability with EU TRACES. Access rights, technical interfaces, data protection and certificate acceptance would require separate verification and agreement. A national pilot could first assess the reuse of agency decisions before international integration is considered.

The pilot should initially be assessed through separate, clearly defined indicators. Table 5 sets out measures of duplicate requests, decision reuse, agency handoff time, total release time and independently audited non-compliance. Baselines, eligibility criteria and targets should be specified before evaluation begins. If a BMSI composite index is developed later, its normalization, weights, treatment of missing data and sensitivity to alternative choices must be reported and externally validated. This study estimates neither a historical BMSI series nor a score for 2030.

**Table 5.** Proposed pilot indicators and data requirements

| Indicator | Definition | Data source |
|---|---|---|
| Duplicate requests | Unnecessary repeat requests / eligible consignments × 100 | Reason-coded request log |
| Decision reuse | Eligible verified decisions reused / eligible consignments × 100 | Linked agency decision log |
| Agency handoff time | Hours from complete referral to agency decision; median and P90 | Referral and decision timestamps |
| Complete release time | Arrival to physical release; median and P90 by risk and product | Arrival and release events |
| Verified non-compliance | Non-compliant cases / independently audited cases | Stable random audit sample |

These are proposed pilot measures, not observed outcomes or validated components of a composite index. P90 denotes the 90th percentile. Eligibility, unnecessary duplication and the audit sampling design must be defined before data collection.

## 4. Discussion

The analysis has different implications for fiscal policy and operational management. The regression results show where measurement and specification need to be clarified before fiscal associations can guide policy. The queueing example and coordination proposal identify the operational data needed to assess changes in staffing, routing and agency handoffs. Neither analysis establishes that tariff relief reduces import dependence or that faster clearance lowers consumer food prices by a given percentage. A negative import coefficient may reflect omitted changes in demand or production, among other explanations; it cannot by itself justify restricting relief [15].

A prospective pilot should compare eligible consignments exposed to the new process with suitable comparison consignments, examine patterns before implementation and account for reforms introduced at the same time. Total release time should be broken down by agency and reported using the median and an upper percentile. Because targeted

inspections select consignments according to risk, their detection rates alone cannot establish control effectiveness. A stable independent audit sample, or known sampling probabilities, is needed for that assessment. Economic evaluation should distinguish savings in resources from tax transfers and avoid counting storage, financing or spoilage costs twice.

The main limitation is the lack of dated observation-level data and a complete measurement dictionary. Serial dependence, stationarity, omitted variables and the original covariance estimates therefore remain unresolved. The queueing example uses assumed parameters, and the coordination mechanism has yet to be evaluated. No SEM mediation result is reported because the measurement model, estimation output and uncertainty of the indirect effect are unavailable. The study also does not measure household access to food, nutritional outcomes or biological safety performance.

## 5. Conclusion

The study provides a reproducible reassessment of reported estimates and a way to connect future operational measurement with capacity planning and agency coordination. The most consistent food-trade association is between customs value and imports; the evidence concerning fiscal relief remains sensitive to reported precision. A monitored pilot at consignment level is therefore the next defensible step. By linking verified decisions and retaining technical safety requirements, such a pilot could establish whether coordination improves the movement of food, what it costs and whether compliance is maintained.

### Declarations

Data and code: The accompanying supplement contains the 24 transcribed slope coefficients, model summaries, scenario parameters, calculations and figures. It does not contain the original dated observations, predictor matrix or residuals. The hypothetical scenario uses no confidential transaction records.

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