# Digital Customs Transformation and Economic Welfare

*A Computable General Equilibrium Analysis of Kazakhstan's 2030 Reform Vision*

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THE IDENTIFICATION PROBLEM

# What actually drives welfare gains from digital customs reform?

**Time saved at the border** vs. **administrative fees reduced** — the trade-facilitation literature rarely identifies which mechanism dominates.

## Iceberg view

*Samuelson 1954; Hummels 2001*

Border delays are real resource waste — goods "melt away" in transit. Time reduction is productivity enhancement: it expands effective endowments and shifts the production frontier outward.

***First-order efficiency gain***

## Phantom-tax view

*Zaki 2010*

Administrative fees are pure rent extraction — tariff-equivalent costs generating no output. Reform redistributes surplus from traders to intermediaries. No frontier shift.

***Redistribution, not expansion***

**The gap:** theory alone cannot adjudicate — especially in landlocked transition economies where both channels operate at scale. This paper provides the first clean welfare comparison of both, calibrated from primary survey data.

A NATURAL EXPERIMENT

# Kazakhstan: three reform phases toward “Digital by Default” 2030

**1** 1995–2017

## Foundational automation

TAIS database; Single Window (2017); WTO accession (2015)

**2** 2018–2023

## ASTANA-1 era

UNCTAD / ASYCUDA platform; Green Corridor. Rail transit: 3 hrs → 30 min

**3** 2024–present

## Keden + AI integration

AI/ML risk management; 16 of 20 modules live. Transit: 30 → 10 min

## Why Kazakhstan sharpens the identification problem

Landlocked penalty (Pomfret 2013): container costs up to **70% higher** than coastal peers.

If time dominates → transit-corridor digitalization (atm) is the priority. If rent dominates → institutional fee reform takes precedence. Active reform enables forward-looking calibration, not retrospective benchmarking.

MECHANISM

# Three GTAP variables, three distinct transmission pathways

## *ams*

**Import-augmenting technical change**

```
M_eff = (1 + ams) × M
```

Iceberg: time savings stop goods “melting away” during clearance. Expands effective endowment, shifts frontier outward.

***Efficiency gain · positive-sum***

## *atm*

**Transit-augmenting technical change**

```
T_margin → T_margin / (1 + atm)
```

Cuts the FOB–CIF transport wedge for multi-border transit. Specific to the landlocked penalty; independent of border processing.

***Conflating with ams hides transit value***

## *tms*

**Trade cost equivalent (admin rent)**

```
P_CIF_eff = P_CIF × (1 + tms)
```

No fiscal revenue: pure deadweight consumed as rents / compliance cost. Moves agents along the existing frontier.

***Redistribution · zero- or negative-sum***

**Methodological point:** ams and atm shift the frontier; tms moves agents along it. Prior studies rarely test both simultaneously, which is exactly what prevents identifying the dominant mechanism.

DATA

# Primary survey data enabling clean channel identification

**n = 165**

respondent companies

Customs brokers, logistics providers, traders

Structured questionnaire, late 2025

Stratified across 5 GTAP sector clusters

Exceeds CGE threshold (40–60)

**MODULE A · TIME**

Current and expected clearance / transit duration: baseline vs. 2030 Keden scenario.

`feeds ams + atm`

**MODULE B · COST**

Current admin cost as % of shipment value, plus expected % reduction by 2030.

`feeds tms`

**Why this matters:** respondents reported time burdens and fee burdens through **separate sections** — respondent-level channel separation, not post-hoc decomposition of aggregate data. Validation: higher % cost reductions matched proportionally larger absolute savings.

CALIBRATION

# From survey responses to shocks: calibration mechanics

## Time savings → ams, atm

$$ams_i = \Delta Days_i \times 0.5\%$$

Hummels (2001) conservative benchmark: 1 day = 0.5% ad valorem equivalent.

Worked: Heavy Mfg 1.5 → 0.03 days, ΔDays = 1.47 → ams = 0.74%.

## Cost reduction → tms

$$tms_i = -(Reduction\% \times Cost\text{-}share\%)$$

Scaling by baseline cost share isolates admin friction from factory-gate prices.

Worked: Agri-Food −(10% × 12.5%) = −1.25%.

| Sector | ams | atm | tms | Dominant |
|---|---|---|---|---|
| **Agriculture & Food** | 0.00% | 0.01% | −1.25% | Rent |
| **Heavy Manufacturing** | **0.74%** | 0.02% | **−2.25%** | **Mixed** |
| **Light Manufacturing** | **1.24%** | **0.50%** | −0.60% | **Efficiency** |
| **Textiles & Apparel** | 0.01% | 0.00% | −1.13% | Rent |
| **Logistics & Services** | 0.03% | 0.01% | −0.69% | Rent |

**Carry forward:** 3 of 5 sectors are rent-dominated. Aggregate efficiency dominance will be driven by Manufacturing's weight in trade, not a uniform economy-wide mechanism.

DESIGN

# Three scenarios for direct hypothesis testing

Scenario 1

## Cost-Only

`tms only`

Isolates administrative rent reduction.

Scenario 2

## Efficiency-Only

`ams + atm`

Isolates productivity enhancement.

Scenario 3

## Combined Reform

`ams + atm + tms`

Full 2030 Digital by Default.

**S1 vs. S2 = direct test of Hypothesis 1 (efficiency dominance)**

**Standard GTAP closure:** factors mobile across sectors, immobile internationally; Kazakhstan as small open economy; static comparative-statics appropriate for medium-term projections.

# Efficiency generates 99.4% of welfare gains — but the story is sector-specific

**99.4%**

of total welfare gains come from the efficiency channel (ams + atm)

S2 efficiency: **$292.99M**

S1 rent-only: **$1.69M (0.6%)**

| Indicator | S1 Cost | S2 Effic. | S3 Combined |
|---|---|---|---|
| **Real GDP (qgdp), %** | 0.00 | **+0.18** | **+0.18** |
| **Welfare EV, USD M** | 1.69 | **292.99** | **294.68** |
| **Terms of trade, %** | 0.00 | −0.04 | −0.04 |

**Sign asymmetry (Appendix A.1):** rent-only (S1) imposes **negative** spillovers on partners (ROW −$1.07M, EAEU −$1.08M); efficiency (S2) is positive-sum for all. Rent redistributes existing surplus; efficiency expands the global frontier.

**Efficiency paradox:** +0.18% real GDP despite −0.04% terms of trade — output expansion offsets the unit price decline; EV is the correct welfare metric. **Recall:** the 99.4% is Manufacturing-driven; for 3 of 5 sectors efficiency shocks are near zero.

# Channel heterogeneity predicts the restructuring pattern

| Sector | Δ Output (qo) | Δ Exports (qxw) | Channel |
|---|---|---|---|
| **Agri-Food** | +0.06% | +0.01% | Rent |
| **Heavy Mfg** | −0.15% | **+0.36%** | **Mixed** |
| **Textiles** | −0.03% | +0.18% | Rent |
| **Light Mfg** | **−1.14%** | **+0.49%** | **Efficiency** |
| **Log Services** | +0.07% | −0.03% | Rent |

*Kazakhstan, Scenario 3. Source: Appendix A.3, A.4.*

**Light Mfg** (efficiency-dominated): deepest restructuring — output −1.14%, exports +0.49%. ams cuts trade costs; comparative advantage shifts to exports. Classic Heckscher-Ohlin.

**Heavy Mfg** (mixed): moderated version — ams improves input access; large tms adds cost pressure.

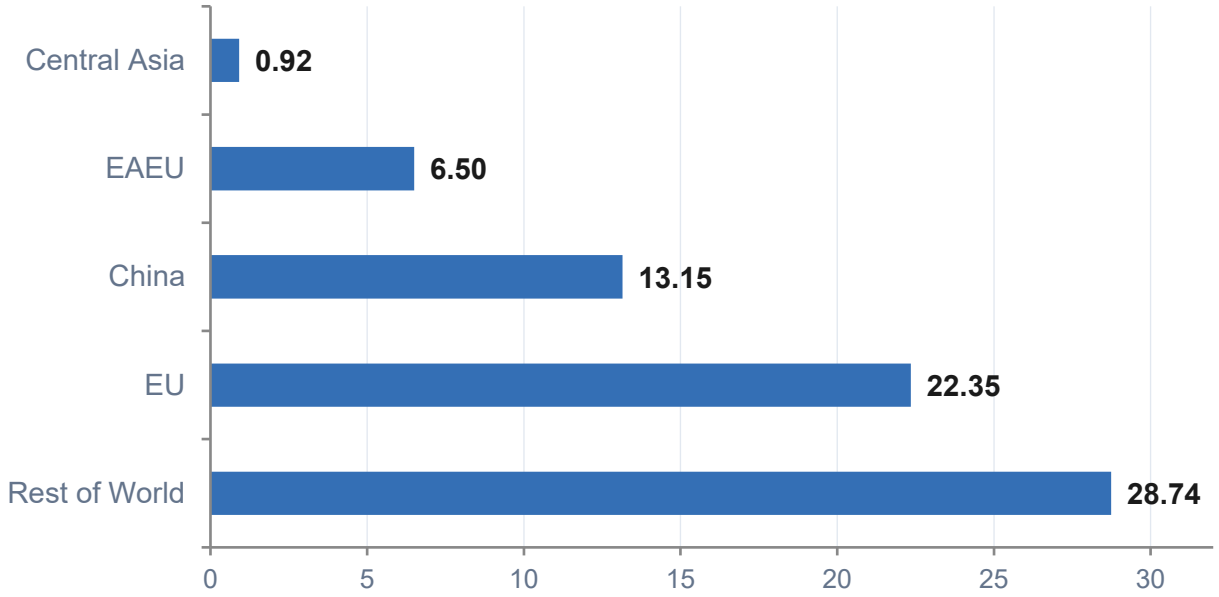
**Rent-dominated sectors** (Agri, Textiles, Log): near-zero ams → no frontier shift; tms yields marginal redistribution, minimal restructuring.

**Policy:** sector-calibrated, not uniform. Manufacturing → time-minimizing platform investment. Agriculture, Textiles, Logistics → targeted administrative fee reduction.

RESULTS · HYPOTHESIS 2

# Kazakhstan as corridor facilitator: $71.67M accrues to partners

**External welfare gains (EV, USD M) — Scenario 3**




**$294.68M** (80.4%) to Kazakhstan; **$71.67M** (19.6%) to partners. Total global gain $366.35M.

**EU largest external winner** ($22.35M): primary Trans-Caspian transit destination; atm lowers Middle Corridor transport costs.

**China** ($13.15M): rail-cargo origin; Tez Customs pilot benefits Chinese exporters.

**Central Asia smallest** ($0.92M): competes with, rather than routes through, Kazakhstan.

**H2 partial support:** atm generates positive-sum corridor spillovers, but Scenario 2 cannot fully separate ams from atm — separate runs are a direct extension. Externalities justify coordinated EAEU Trusted Digital Space investment.

THREE FINDINGS AS A CONCLUSION

# What the evidence establishes

**H1** Efficiency dominates at 99.4% — but this is Manufacturing-driven. 3 of 5 sectors are rent-dominated. The aggregate is correct; the universal prescription is not.

**H2** The atm transit channel is analytically essential for landlocked economies. $71.67M positive corridor spillovers; EU is the largest external beneficiary.

**H3** Digital customs reform is structural transformation, not just modernization. Efficiency-dominated sectors restructure deeply; rent-dominated sectors adjust marginally.

EXTENSIONS

- Separate ams / atm runs to isolate the transit channel
- Dynamic CGE: capital accumulation, technology diffusion
- Distributional analysis across deciles and regions
- Game-theoretic regional coordination / cost-sharing

**Policy hierarchy:** Manufacturing → platform investment (Keden, Smart Borders). Agriculture, Textiles, Logistics → administrative fee reduction and transparency.

# THANK YOU

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