

KOF Trade Model: Swiss Resilience, Trade Wars, and Geeconomics

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Uncertain Times

- ▶ Trump tariffs
- ▶ Availability of chips, rare earths
- ▶ Cold War 2.0?

Quantitative theoretical trade models offer rapid scenario analysis for policymakers facing unprecedented shocks

KOF Trade Model

- ▶ At KOF Lab, since 2022 we have been developing ...
 - ▶ a quantitative equilibrium model of global trade networks
 - ▶ a DSGE model of Switzerland (work in progress)

- ▶ Policy applications of trade model:
 - ▶ Resilience of Switzerland to trade disruptions
 - ▶ Real-time analysis of developments in Trump's trade war
 - ▶ Provide a reasonable benchmark for broader analysis

- ▶ Academic applications of trade model:
 - ▶ Source and extent of national economic power
 - ▶ Supply chain and network effects of climate shocks (in progress)

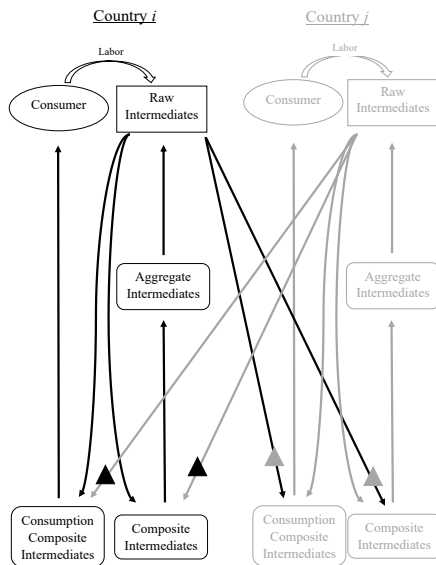
Today

1. Overview of model and approach
2. “Resilience of Small Open Economies to Geopolitical Shocks: The Case of Switzerland,” KOF Working Paper No. 523
3. Trump tariffs
4. “The Economic Value of Nations (for Others),” Discussion Paper 56593-1759868407, CEPR

Model and Approach: Overview

- ▶ C countries/regions (34 in current calibration)
- ▶ N industries/sectors in each country (38 in current calibration)
- ▶ Fixed supply of labor in each industry in each country
 - ▶ L^{kc} for all $k \in N, c \in C$
- ▶ Static general equilibrium Armington model
 - ▶ Comparative statics with respect to trade barriers and productivity shocks
- ▶ Each agent is represented by a CES function
 - ▶ C representative consumers (one for each country)
 - ▶ Consume composite intermediate bundles from each industry
 - ▶ Bundles created from foreign and domestic goods by intermediate firms
 - ▶ N raw producers in each country
 - ▶ Produce using local labor and bundles from each industry
 - ▶ Bundles created by industry-specific importers
 - ▶ $\mathcal{N} = C \times (1 + N + N + N^2 + N)$ CES agents in the world economy
- ▶ Weights on different sectors vary by country/industry, as in data
 - ▶ Accommodates quite specific trade barriers [▶ Details](#)

Model and Approach: Overview



Model and Approach: Quantification

Calibration of key CES parameters (from Baqaee and Farhi (2024))

- ▶ $\sigma = 0.9$ (consumption)
 - ▶ e.g., extent to which consumers trade off food and services
- ▶ $\theta = 0.5$ (elasticity between labor and intermediates)
 - ▶ Extent to which labor and intermediates are substitutable in production
- ▶ $\epsilon = 0.2$ (across industries within a country)
 - ▶ extent to which intermediates can be sourced from different sectors

Calibration of trade elasticities:

- ▶ Eppinger, Felbermayr, Krebs, and Kukharskyy (2023)
- ▶ Extent to which the same good from different countries is substitutable

Non-aggregated		
<u>ISIC Rev. 4 code</u>	<u>Description</u>	$\theta_k - 1$
A01_02	Agriculture, hunting, forestry	3.468
A03	Fishing and aquaculture	3.468
B05_06	Mining and quarrying, energy producing products	3.468
C10_C12	Food products, beverages and tobacco ("Food products")	3.468
C13_C15	Textiles, textile products, leather and footwear	3.468
C16	Wood and products of wood and cork	3.468
C17_18	Paper products and printing	3.468
C19	Coke and refined petroleum products	6.027
C20	Chemical and chemical products ("Chemicals")	3.543
C21	Pharmaceuticals, medicinal chemical and botanical products ("Pharma")	11.479
C22	Rubber and plastics products	2.27
C23	Other non-metallic mineral products	1.375
C24	Basic metals	3.206
C25	Fabricated metal products	1.558
C26	Computer, electronic and optical equipment ("Precision devices")	7.771
C27	Electrical equipment	6.012
C28	Machinery and equipment, n.e.c. ("Machinery")	7.868
C29	Motor vehicles, trailers and semi-trailers	4.61
C30	Other transport equipment	2.915
C31_C33	Manufacturing n.e.c.; repair and installation of machinery and equipment	3.714
D	Electricity, gas, steam and air conditioning supply	1.442
E	Water supply; sewerage, waste management and remediation activities	1.442
F	Construction	1.442
G	Wholesale and retail trade; repair of motor vehicles	1.442
H49	Land transport and transport via pipelines	1.442
H50	Water transport	1.442
H51	Air transport	1.442
H52	Warehousing and support activities for transportation	1.442
H53	Postal and courier activities	1.442
I	Accommodation and food service activities	1.442
K	Financial and insurance activities ("Finance")	1.442
L	Real estate activities	1.442
Q	Human health and social work activities	1.442
Aggregated		
<u>Included ISIC codes</u>	<u>Description</u>	$\theta_k - 1$
B07_08, B09	Mining, non-energy and support services	3.468
J58.60, J61, J62.63	Telecomm, IT, publishing and media	1.442
M, P	Science and education	1.442
N, O	Administrative services and defence; compulsory social security	1.442
R, S, T	Other services	1.442

Model and Approach: Algorithm

Solving the model for the effects of shocks:

- ▶ Follow the approach of Baqaee and Farhi (2024)
 - ▶ Bachmann, Baqaee, Bayer, Kuhn, Loeschel, Moll, Peichl, Pittel, and Schularkick (2024)
- ▶ Analytically characterize effect of small trade barriers
 - ▶ Yields a big linear system
- ▶ Get a global solution with numerical integration (add up small changes)
 - ▶ Requires no numerical optimization
 - ▶ Perform procedure on ETH's Euler Cluster

Model and Approach: Quantification

- ▶ But there are many more parameters of the model ...
 - ▶ Initial labor supplies
 - ▶ Preference/production weights on different sectors/countries
 - ▶ Initial productivities

- ▶ Baqaee and Farhi (2024) show that you don't need to know these parameters to study changes in the model
 - ▶ Input/output tables provide "sufficient statistics"
 - ▶ Expenditure shares and Domar weights

- ▶ Last input to the model: 2019 OECD input/output table
 - ▶ e.g., how much Swiss chemical industry sells to German plastics industry
 - ▶ Also gives sales to final uses (consumption and investment)

Resilience of Switzerland

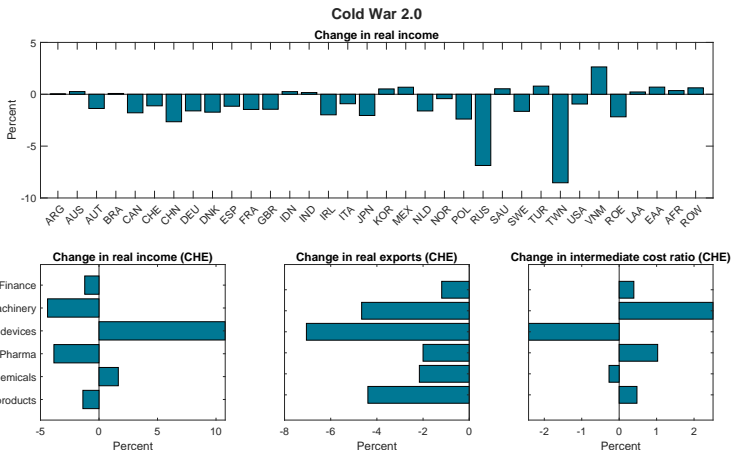
“Resilience of Small Open Economies to Geopolitical Shocks: The Case of Switzerland”

- ▶ We first built our model to stress test Switzerland in many extreme geopolitical scenarios

- ▶ Examples:
 - ▶ US/China trade wars
 - ▶ Trump tariffs
 - ▶ Cold War 2.0
 - ▶ Critical input disruptions
 - ▶ Various more Swiss-specific shocks

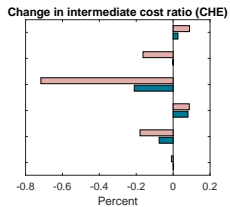
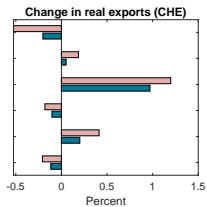
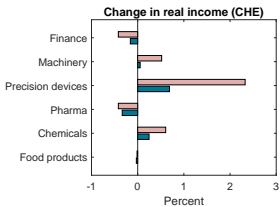
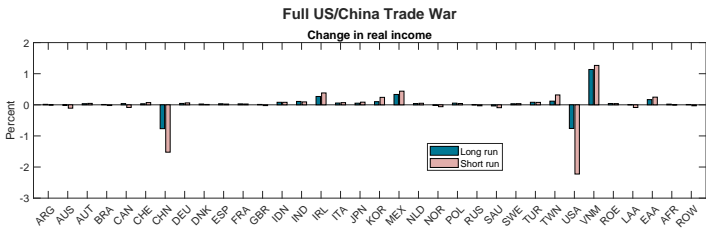
- ▶ Three examples here
 1. Cold War 2.0: breakdown of trade between China/Russia/Taiwan and G7/EU/Norway/Switzerland
 2. Breakdown of trade between US and China
 3. China stops exporting mining, non-metallic minerals, chemicals, and precision devices

Resilience of Switzerland: Cold War 2.0



Switzerland (-1.12%), Austria (-1.37%), Germany (-1.60%), France (-1.46%), Italy (-0.91%), Ireland (-2%), Japan (-2%), China (-2.65%)

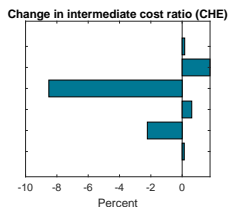
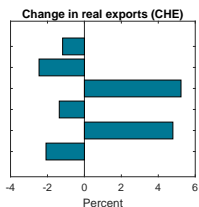
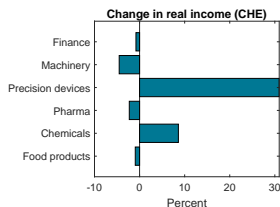
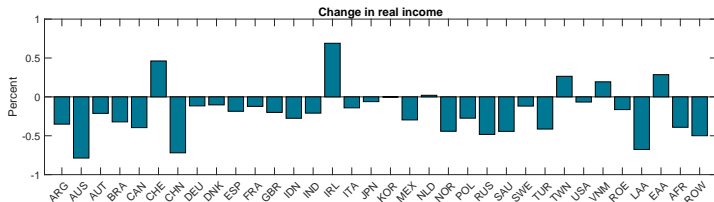
Resilience of Switzerland: Spillover from China/US Decoupling



Short run: assume very low trade elasticities

Resilience of Switzerland: Restriction of Chinese Exports

Restriction of Critical Chinese Inputs



Resilience of Switzerland: Takeaways

Attempting to generalize across scenarios . . .

- ▶ Swiss economy is relatively resilient
 - ▶ Have never found catastrophic losses
- ▶ Swiss pharma and machinery seem exposed to global shocks
- ▶ Swiss precision devices and chemicals can gain from external trade wars

Trump Tariffs

- ▶ We run the model after each major Trump trade war change
 - ▶ Liberation Day, April 2025
 - ▶ Immediate “pause”
 - ▶ August 2025 increases (Switzerland 39% !?)
 - ▶ Recent Swiss deal (15%)
 - ▶ Retaliation (China, Canada, ...)
 - ▶ Chinese rare earth restrictions
 - ▶ We read the announcements and try to map them into the model ...
 - ▶ Country and industry specific exemptions
 - ▶ Special rates for metals and vehicles

- ▶ Here I will show the raw results from the model for illustration

- ▶ But when our team is doing formal assessments at KOF, we ...
 - ▶ Get results from the trade model
 - ▶ Do extrapolations to account for recent trends for Switzerland
 - ▶ Adjust for “second-layer” effects

Trump Tariffs: Two Examples

	Real Income % Changes			
	<u>Aug. 3 run</u>		<u>Nov. 13 run</u>	
	SR	LR	SR	LR
USA	-1.35	-0.94	-1.24	-0.87
CHN	-0.11	-0.12	-0.07	-0.08
DEU	-0.03	-0.07	-0.02	-0.07
FRA	-0.05	-0.07	-0.04	-0.06
ITA	-0.03	-0.05	-0.02	-0.05
GBR	-0.03	0.00	-0.03	-0.01
JPN	-0.10	-0.14	-0.04	-0.12
MEX	-0.42	-1.10	-0.45	-1.14
CAN	-0.62	-0.94	-0.71	-1.06
CHE	-0.22	-0.33	-0.05	-0.08
EU	-0.04	-0.08	-0.03	-0.07
EZ	-0.04	-0.09	-0.04	-0.08
World	-0.34	-0.30	-0.31	-0.27

Short run: low trade elasticities

Trump Tariffs: Takeaways

Attempting to generalize . . .

- ▶ US, Canada, and Mexico hit quite hard
- ▶ Swiss losses not catastrophic, but on high end of Europe
 - ▶ Depends on pharma exemptions and 15% vs. 39%
- ▶ Total real income losses mask a lot of heterogeneity by sector

The Economic Value of Nations (for Others)

- ▶ Against the backdrop of the increasing weaponization of trade, there has recently been a resurgence of academic work studying geoeconomics
 - ▶ Mohr and Trebesch (2025)
- ▶ A recurrent theme in geoeconomics: economic asymmetries
 - ▶ Hirschman (1945), Keohane and Nye (1977)
 - ▶ Capacity to inflict harm vs. extent of self-harm
 - ▶ Countries that can inflict disproportionate damage are positioned to exert geopolitical pressure
- ▶ But how can we measure coercive capacity, vulnerability to coercion, and potential to escape coercion?

The Economic Value of Nations (for Others)

- ▶ In “The Economic Value of Nations (for Others)” we introduce a new metric:
- ▶ **Trade Benefit Ratio (TBR)**
 - ▶ Measures the geoeconomic significance of nations through their trade relationships
- ▶ In our model, we put countries into autarky, one at a time

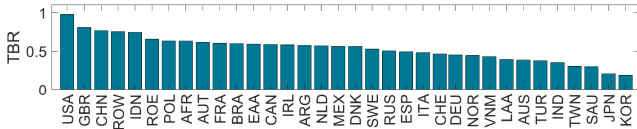
$$\text{TBR} = \frac{\textit{Total Foreign Welfare Losses}}{\textit{Domestic Welfare Loss}}$$

- ▶ Measure of how much systemic value a country provides to others via international trade, relative to how much it receives

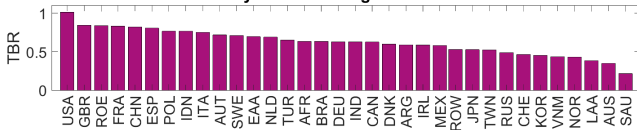
The Economic Value of Nations (for Others): Rankings

Trade Benefit Ratios

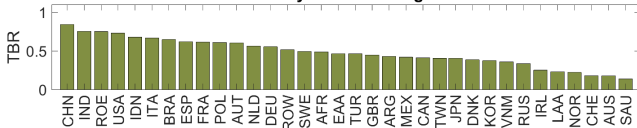
All Sectors



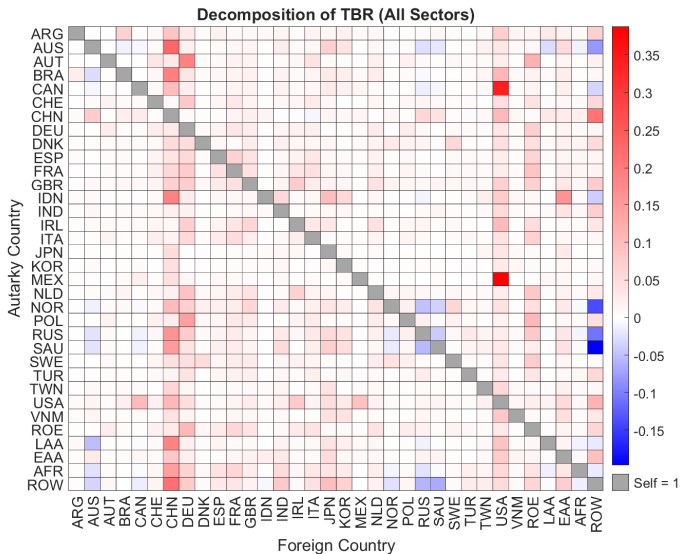
Only Manufacturing and Services



Only Manufacturing



The Economic Value of Nations (for Others): Decomposition



The Economic Value of Nations (for Others): Takeaways

- ▶ High all sectors TBRs: US, UK, China, and Indonesia
 - ▶ Lowest: Japan and Korea
- ▶ Leverage from services: US, UK, Switzerland
 - ▶ Leverage from manufacturing: India
 - ▶ Evenly distributed TBRs (w.r.t industries): China and Indonesia
- ▶ Exposed to many countries: China, Germany, US
- ▶ Highly concentrated effect on others: Mexico and Canada
 - ▶ Dispersed effect on others: Denmark and UK
- ▶ “Substitute” countries: Australia, Canada, Norway, Russia, and Saudi Arabia
 - ▶ Harm each other by engaging in trade

Caveats, Discussion, and Future Work

- ▶ Cross-border trade in assets, the role of reserve currencies, foreign direct investments, and financial markets
- ▶ Intertemporal dynamics
- ▶ Revenues from tariffs
- ▶ Amplification of shocks
- ▶ More recent, less coarse trade data
 - ▶ Swiss trade with US has increased since 2019
- ▶ Extensive margins from specific, critical inputs
 - ▶ Precision devices
 - ▶ Minerals

Conclusion

- ▶ Quantitative trade models are a useful starting point for evaluating policy in an uncertain world with unprecedented shocks
- ▶ At KOF, we are using trade models for:
 - ▶ Stress testing Switzerland
 - ▶ Quickly analyzing the ongoing trade war
 - ▶ Trying to understand economic power
 - ▶ Studying the network effects of climate shocks

Representative Consumers

Each $c \in C$ solves

$$U^c = \max_{x_k^c} \left(\sum_{k \in N} (b_k^c)^{\frac{1}{\sigma}} (x_k^c)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \text{ subject to}$$
$$\sum_{k \in N} P_k^c x_k^c = \underbrace{\sum_{k \in N} w^{kc} L^{kc}}_{I^c}$$

yields demands

$$\frac{P_k^c x_k^c}{I^c} = b_k^c \left(\frac{P_k^c}{P^c} \right)^{1-\sigma}$$

with price index

$$P^c = \left(\sum_{k \in N} b_k^c (P_k^c)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Classic result:

$$U^c = I^c / P^c$$

Composite Consumption Intermediate Firms

Each firm $c \in C$, $k \in N$ has the production function

$$x_k^c = \left(\sum_{c' \in C} (\delta_{kc'}^c)^{\frac{1}{\theta_k}} (y_{kc'}^c)^{\frac{\theta_k - 1}{\theta_k}} \right)^{\frac{\theta_k}{\theta_k - 1}}$$

- ▶ Face sales prices $p_{kc'}$ domestically and around the world
- ▶ Desire international variety according to elasticity θ_k
- ▶ 1 unit of an input requires purchase of $\tau_{kc'}^c$, and $\tau_{kc'}^c - 1$ units are destroyed
 - ▶ icebergs at entry port

Assume cost minimization and marginal cost pricing:

$$P_k^c = \left(\sum_{c' \in C} \delta_{kc'}^c (\tau_{kc'}^c p_{kc'})^{1 - \theta_k} \right)^{\frac{1}{1 - \theta_k}}$$

$$\frac{\tau_{kc'}^c p_{kc'} y_{kc'}^c}{P_k^c x_k^c} = \delta_{kc'}^c \left(\frac{\tau_{kc'}^c p_{kc'}}{P_k^c} \right)^{1 - \theta_k}$$

Raw Intermediate “Value-Added” Firms

Production function:

$$y_{kc} = A^{kc} \left((\alpha^{kc})^{\frac{1}{\theta}} (I^{kc})^{\frac{\theta-1}{\theta}} + (1 - \alpha^{kc})^{\frac{1}{\theta}} (X^{kc})^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}$$

- ▶ Use labor and an industry-specific aggregate intermediate
- ▶ A^{kc} is productivity

Cost minimization and marginal cost pricing yield

$$p_{kc} = \frac{1}{A^{kc}} \left(\alpha^{kc} (w^{kc})^{1-\theta} + (1 - \alpha^{kc}) (P^{kc})^{1-\theta} \right)^{\frac{1}{1-\theta}}$$

$$\frac{w^{kc} I^{kc}}{p_{kc} y_{kc}} = \alpha^{kc} \left(\frac{w^{kc}}{(\alpha^{kc} (w^{kc})^{1-\theta} + (1 - \alpha^{kc}) (P^{kc})^{1-\theta})^{\frac{1}{1-\theta}}} \right)^{1-\theta}$$

$$\frac{P^{kc} X^{kc}}{p_{kc} y_{kc}} = (1 - \alpha^{kc}) \left(\frac{P^{kc}}{(\alpha^{kc} (w^{kc})^{1-\theta} + (1 - \alpha^{kc}) (P^{kc})^{1-\theta})^{\frac{1}{1-\theta}}} \right)^{1-\theta}$$

Aggregate Intermediate Firms

Production function:

$$X^{kc} = \left(\sum_{j \in N} (\omega_j^{kc})^{\frac{1}{\epsilon}} (x_j^{kc})^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}}$$

Cost minimization and marginal cost pricing:

$$P^{kc} = \left(\sum_{j \in N} \omega_j^{kc} (P_j^{kc})^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}}$$

$$\frac{P_j^{kc} x_j^{kc}}{P^{kc} X^{kc}} = \omega_j^{kc} \left(\frac{P_j^{kc}}{P^{kc}} \right)^{1-\epsilon}$$

Composite Intermediate Firms

Production function:

$$x_j^{kc} = \left(\sum_{c' \in C} \left(\delta_{jc'}^{kc} \right)^{\frac{1}{\theta_j}} \left(y_{jc'}^{kc} \right)^{\frac{\theta_j - 1}{\theta_j}} \right)^{\frac{\theta_j}{\theta_j - 1}}$$

- ▶ Same cross-country import elasticity as in consumption sector
- ▶ Face icebergs different from consumption sector

Cost minimization and marginal cost pricing:

$$P_j^{kc} = \left(\sum_{c' \in C} \delta_{jc'}^{kc} \left(\tau_{jc'}^{kc} p_{jc'} \right)^{1 - \theta_j} \right)^{\frac{1}{1 - \theta_j}}$$

$$\frac{\tau_{jc'}^{kc} p_{jc'} y_{jc'}^{kc}}{P_j^{kc} x_j^{kc}} = \delta_{jc'}^{kc} \left(\frac{\tau_{jc'}^{kc} p_{jc'}}{P_j^{kc}} \right)^{1 - \theta_j}$$

Equilibrium

▶ Go Back

Given labor supplies, productivities, utility and production parameters, and icebergs, competitive equilibrium consists of

1. Wages w^{kc}
2. Raw intermediates prices p_{kc}
3. Aggregate intermediate prices P^c and P^{kc}
4. Composite intermediate prices P_k^c and P_j^{kc}
5. Labor demands l^{kc}
6. Raw intermediate outputs y_{kc}
7. Raw intermediate inputs $y_{kc}^{c'}$ and $y_{kc}^{j c'}$
8. Aggregate intermediate inputs X^{kc}
9. Composite intermediate inputs x_k^c and x_j^{kc}

such that

1. Consumers maximize utility, and raw intermediate inputs, aggregate intermediate inputs, and composite intermediate inputs minimize production costs
2. Prices equal marginal costs, satisfying the price indexes
3. Labor markets clear: $L^{kc} = l^{kc}$
4. Raw intermediate markets clear: $y_{kc} = \sum_{c' \in C} \tau_{kc}^{c'} y_{kc}^{c'} + \sum_{j c' \in N \times C} \tau_{kc}^{j c'} y_{kc}^{j c'}$