HUMBOLDT-UNIVERSITÄT ZU BERLIN

SUSTAINABLE FOOD SYSTEM: AN EMPIRICAL CGE ANALYSIS ON THE PROCESSING OF CASHEW BYPRODUCTS IN BENIN

Agossoussi Thierry Kinkpe, Harald Grethe & Jonas Luckmann

International Agricultural Trade and Development Group

Humboldt-Universität zu Berlin

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Outline (1/1)

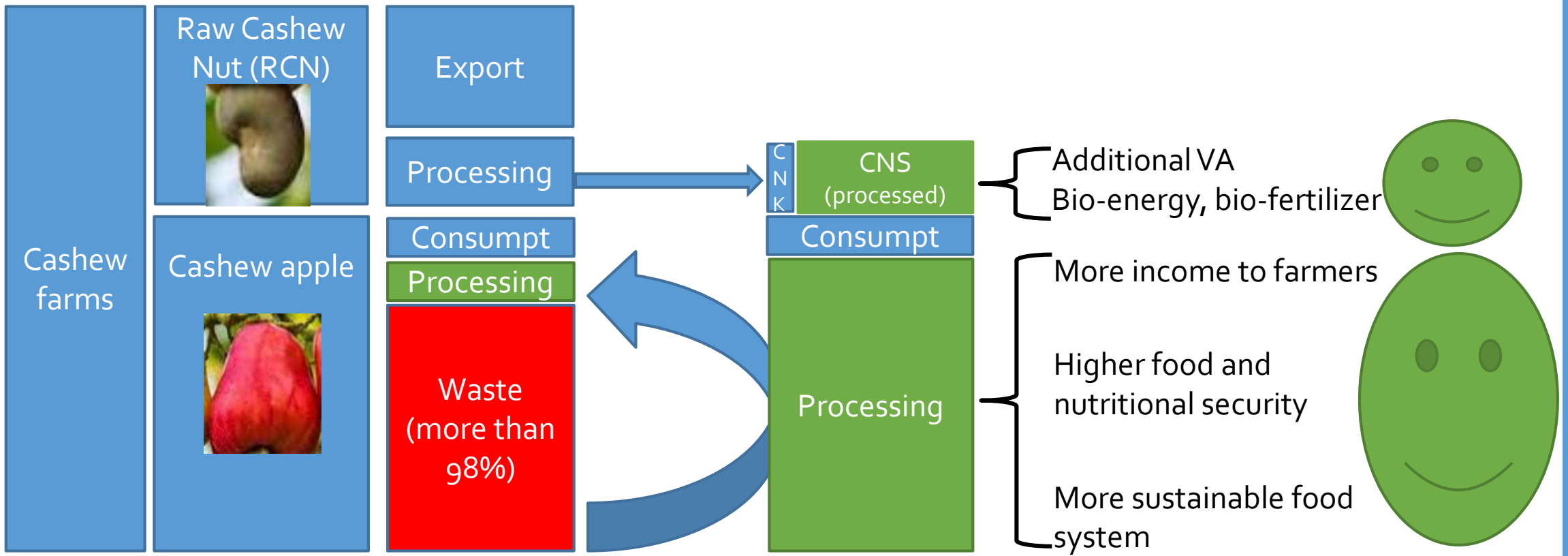
- Background
- Methodology
  - SAM
  - Scenario design: empirical study
  - Model
  - Novel welfare calculation
- Results
- Conclusion and implications

Background (1/2)

- In African agriculture-based economies, post-harvest losses are relatively high
- 30-50% of food produced in Africa for human consumption is lost or wasted (Jones *et al.*, 2015)
- **Fruits and vegetables are most affected** (Gustavsson *et al.*, 2011)
- The losses estimated at 1.3 billion tons could feed 1.6 billion people (Jones *et al.*, 2015)
- In a continent heavily dependent on food imports, this is a major problem
- Processing development is a way to decrease these losses

Background (2/2)

- Cashew example in Benin (inspired by Houssou *et al.*, 2018; Benin Caju, 2017; Zoumarou Wallis *et al.*, 2016; ACi, 2010)

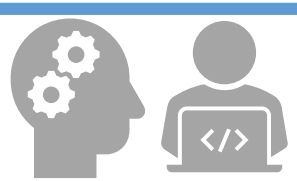


Social Accounting Matrix (SAM) (1/1)

- **2019 Social Accounting Matrix (SAM) for Benin (Kinkpe *et al.*, 2022)**
  - 10 household groups (5 rural, 5 urban: Q1-Q5)
  - 45 activities,
    - 2 cashew activities: only nut (wasting the apple), both nut and apple (without wasting the apple)
    - Cashew apple processing activity
    - Cashew Nut Shell (CNS) processing activity (CNSL, bio-energy and bio-fertilizer)
    - 2 cashew nut processing activities: only cashew nut kernel (wasting the shell), both kernel and shell (without wasting the shell);
  - 9 production factors (2 unskilled and skilled labor; 2 non-agricultural and an agricultural capital; permanent crop, annual crop and husbandry land)
    - Unskilled seasonal labor for cashew farming
    - Non-agricultural unused capital for CNS

Scenario design: empirical study (1/1)

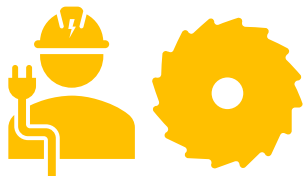
Ideas



Iterative **interactions** with actors

Farmers (41) Unstructured interviews

Processors (5): Unstructured interviews



Consumers (265): experimental auction

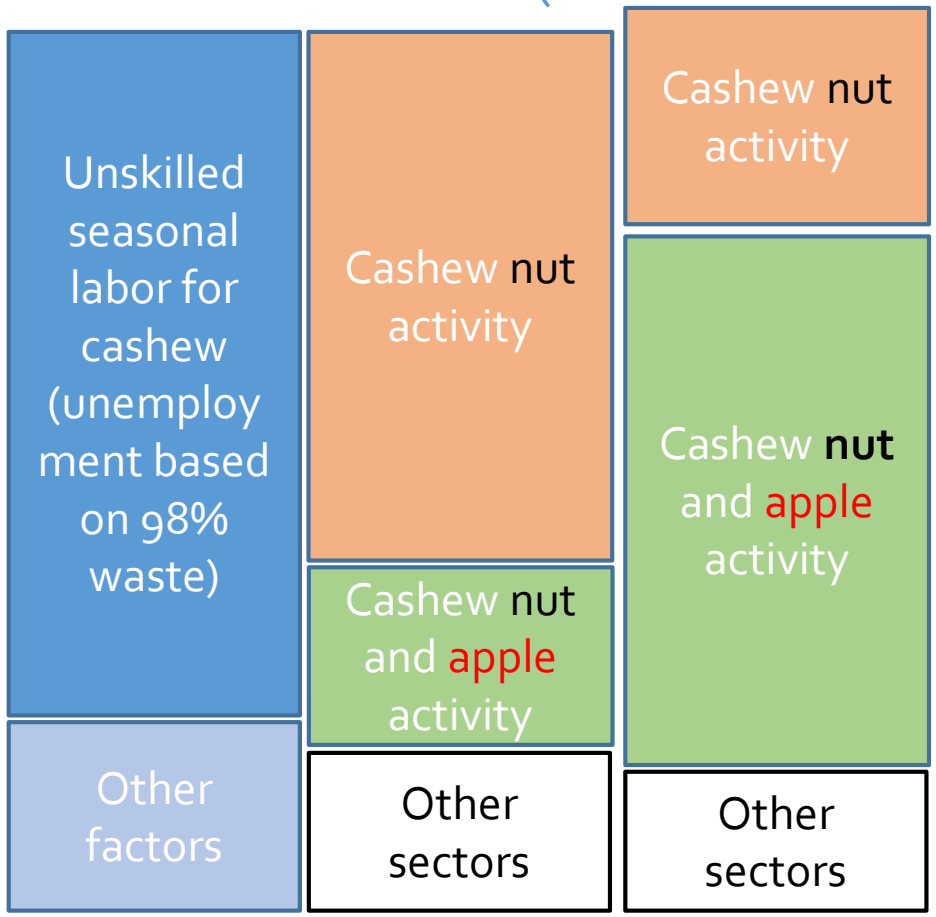
Outcomes

- CNS processing started and can develop
- Cashew juice types, cashew apple processing can grow with government support
- Cashew apple waste can be used (labor available)
- 3% consume cashew apple juice, 97% want to consume (after exposition)
- Quadruple per capita consumption and substitute some sodas and alcohol

Scenarios	Change in household demand for cashew apple juice (thousand tons)	Change in household demand for sodas (thousand tons)	Change in household demand for alcoholic drinks (thousand tons)	Production tax rate in cashew apple processing
BASE				00.0%
DEMAND	+318.1	-143.1	-15.9	-00.0%
SUPPORT	+318.1	-143.1	-15.9	-9.8%

Model (1/2)

- **STAGE model** (McDonald and Thierfelder, 2015)



Closures

- Factor fully mobile
- Fixed ER, flexible current account,
- Investment= share of total demand (investment-driven)
- Small country

Figure 1. Cashew production as depicted

Source: Own compilation

Model (2/2)

- **STAGE model** (McDonald and Thierfelder, 2015)

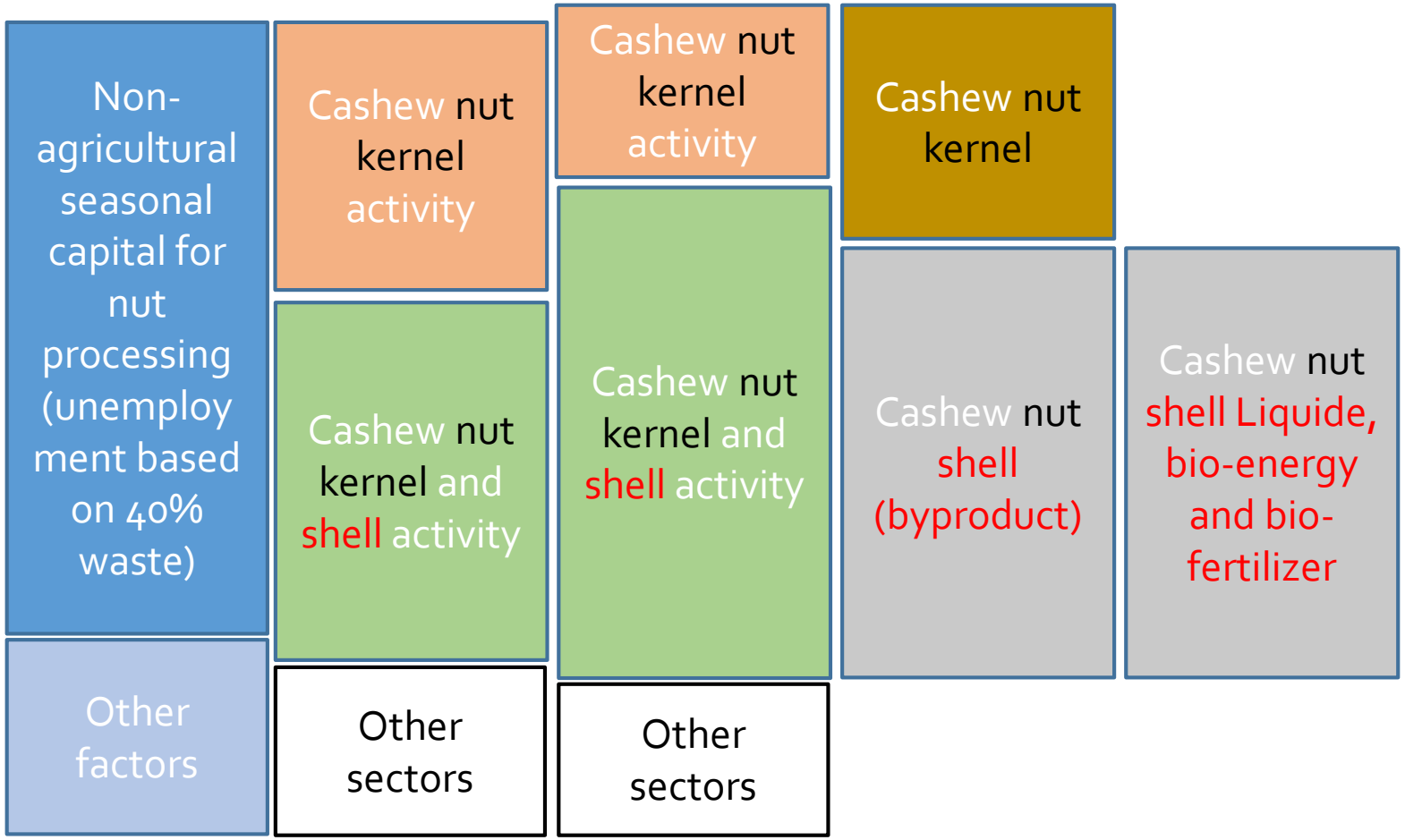


Figure 2. Cashew nut processing as depicted

Source: Own compilation

Novel welfare calculation: EVICS (1/1)

- Equivalent Variation (EV) based only on consumption
  - $EV_h = \prod_c \left[\left(\frac{P_{c0_c}}{P_{c_c}} \right)^{\beta_{c,h}} \right] * (C_{T_h} - C_{S_h}) - (C_{T0_h} - C_{S0_h})$
- Savings vary (even with savings-driven closure)
- Savings = welfare for future
- ➔ **EV I**ncluding **C**hange in **S**avings (EVICS)
  - $EVICS_h = \prod_c \left[\left(\frac{P_{c0_c}}{P_{c_c}} \right)^{\beta_{c,h}} \right] * (C_{T_h} + \boldsymbol{S_{T_h}} - C_{S_h}) - (C_{T0_h} + \boldsymbol{S_{T0_h}} - C_{S0_h})$

Results (1/7)

- **Production and price of targeted sectors**

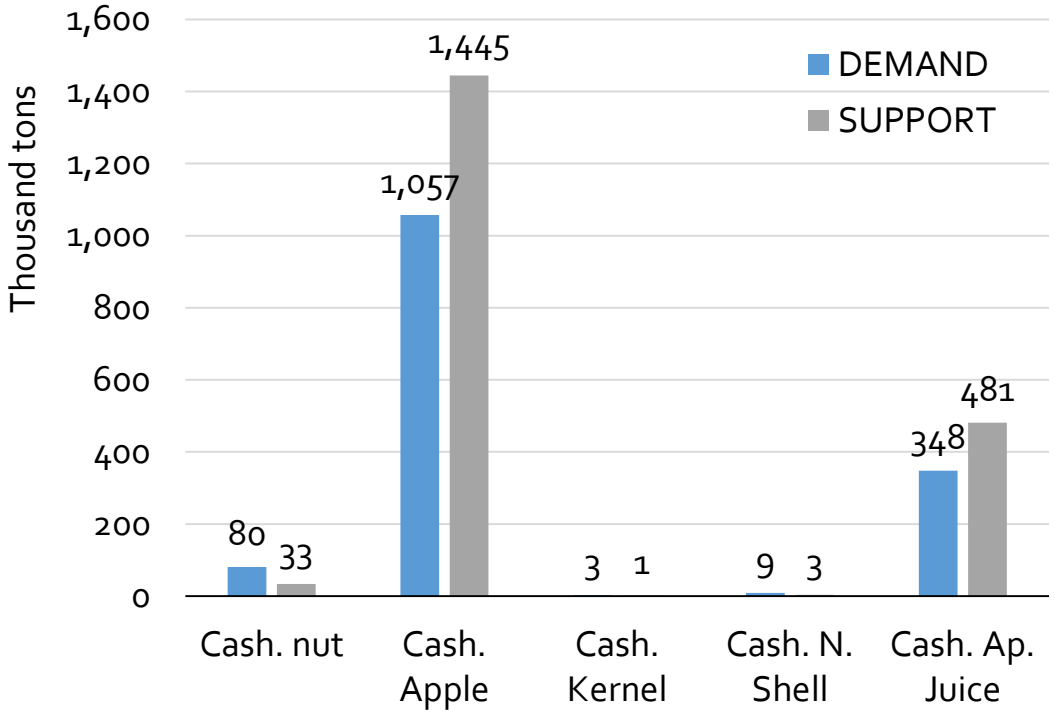


Figure 3. Production effect
Source: Own compilation

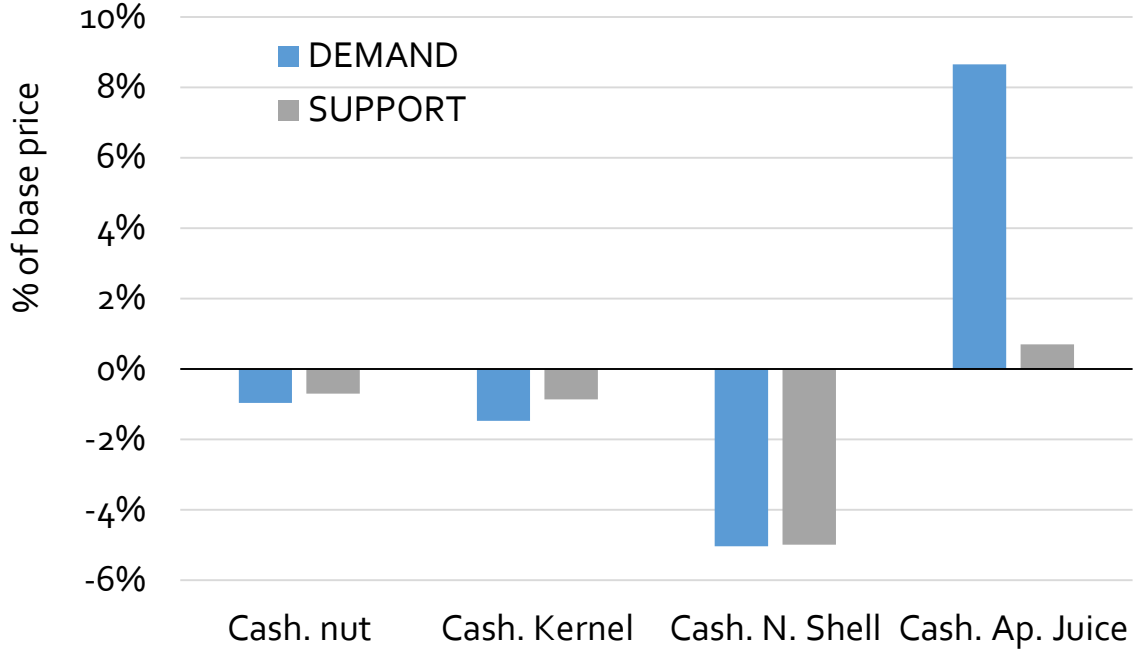


Figure 4. Produce price effect
Source: Own compilation

Results (2/7)

- **Production and price of other sectors**

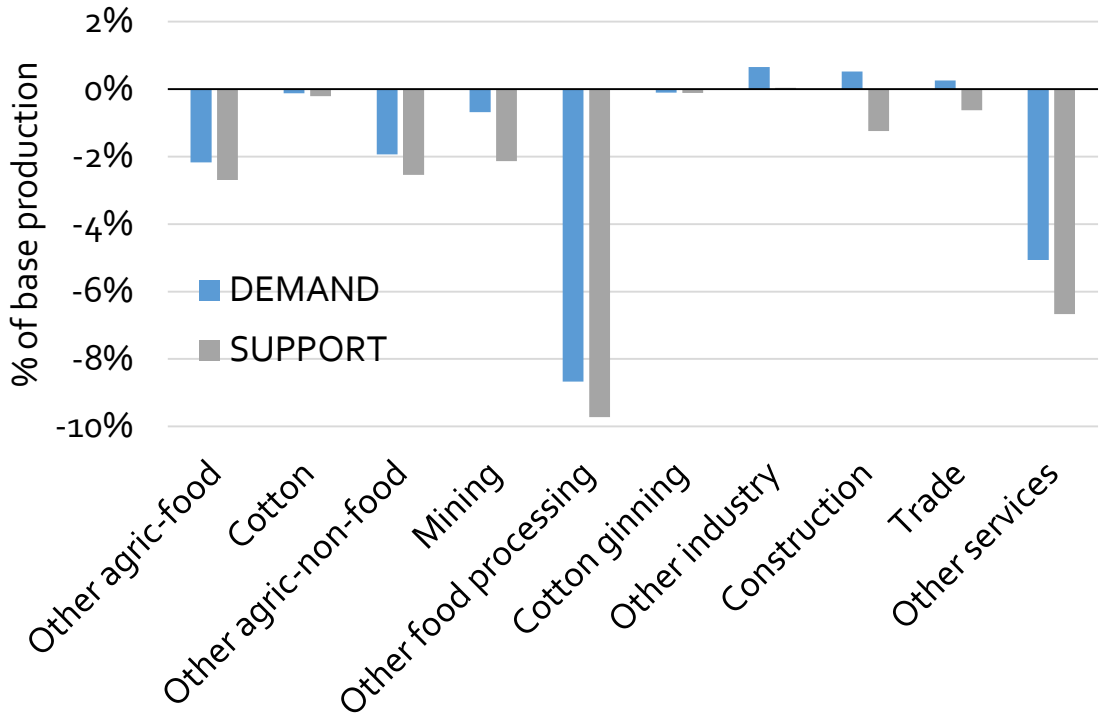


Figure 5. Production effect
Source: Own compilation

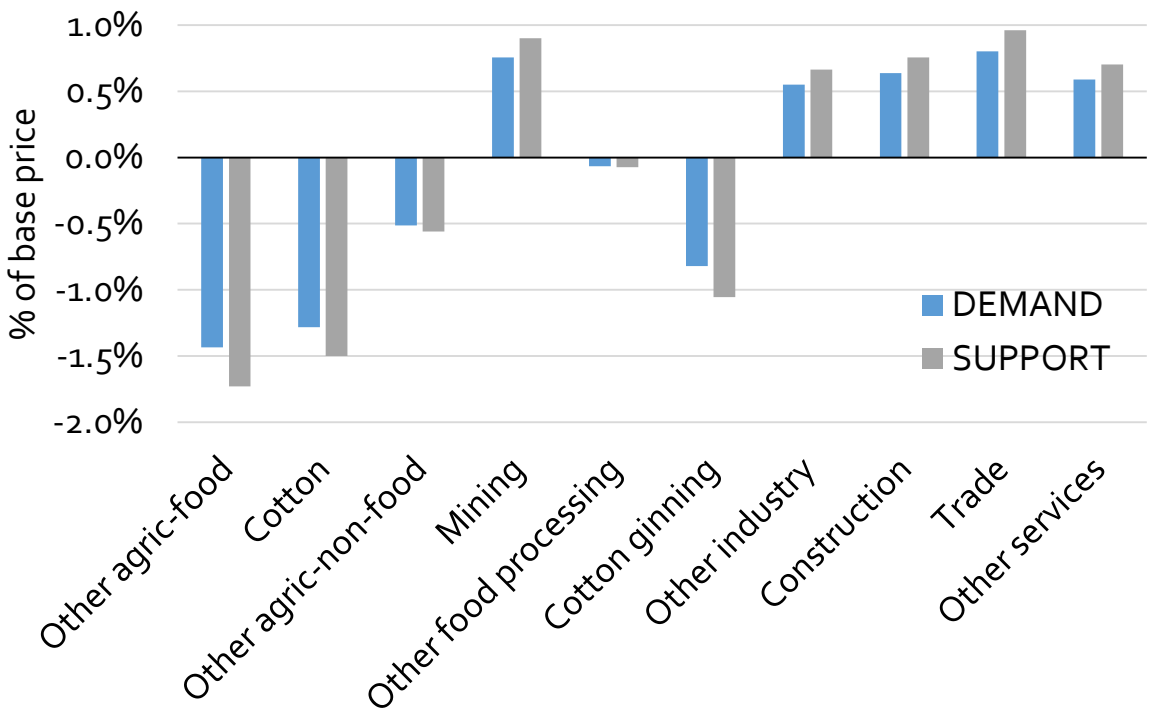


Figure 6. Producer price effect
Source: Own compilation

Results (3/7)

- **Factor price**

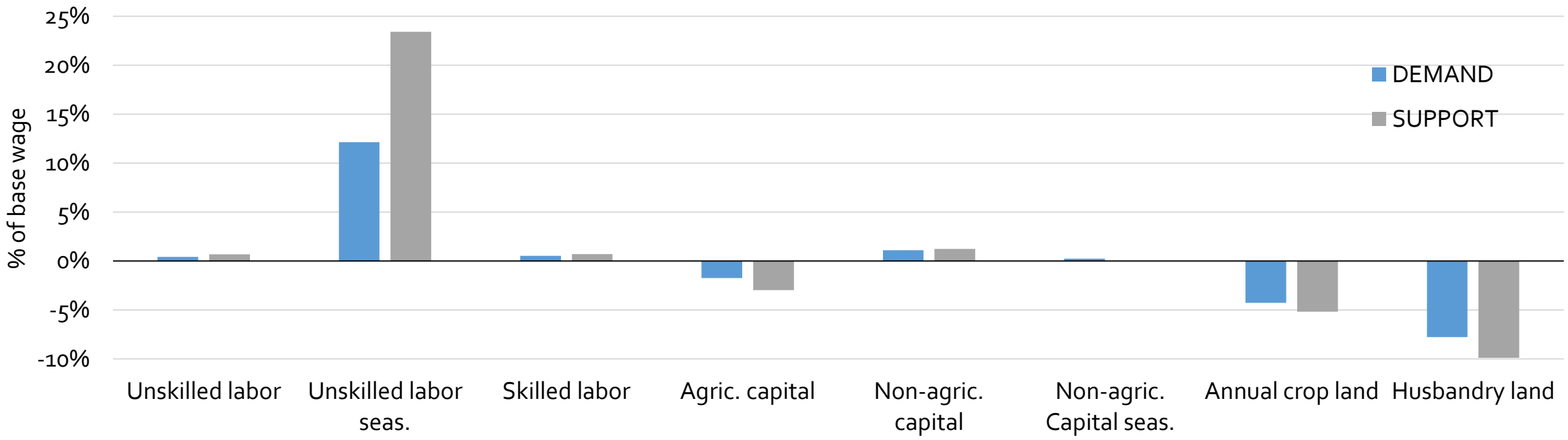


Figure 7. Factor price effect
Source: Own compilation

Results (4/7)

- **Income effect**

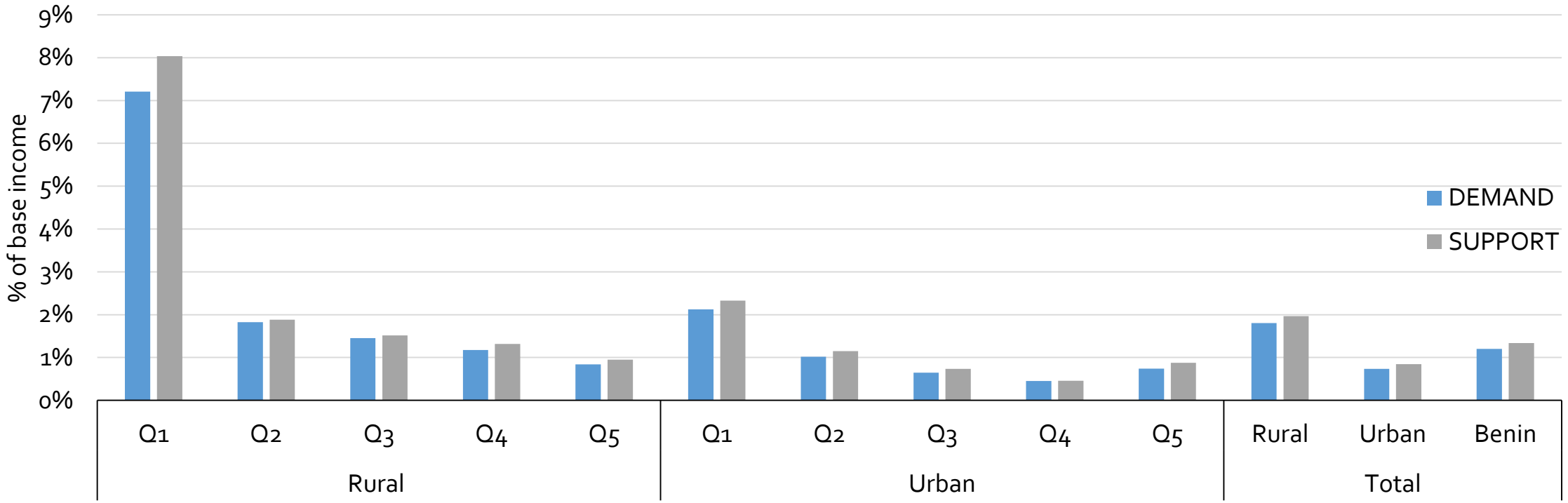


Figure 8. Income effect
Source: Own compilation

Results (5/7)

- **Poverty reduction effects**

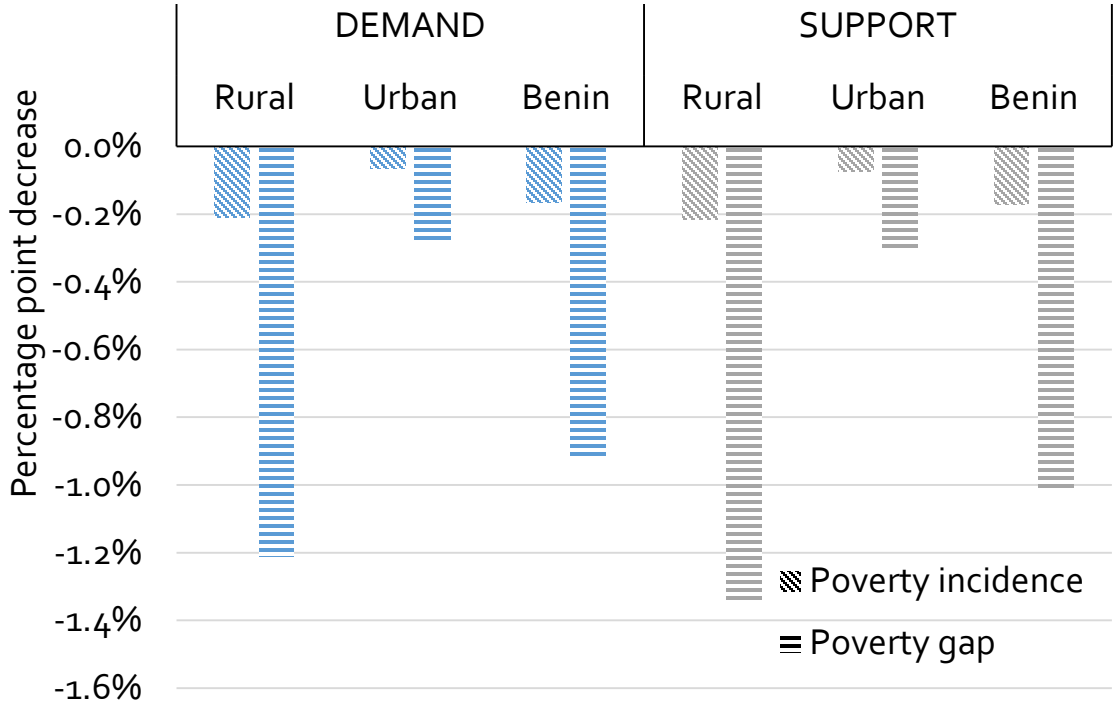


Figure 9. Poverty incidence and gap effect
Source: Own compilation

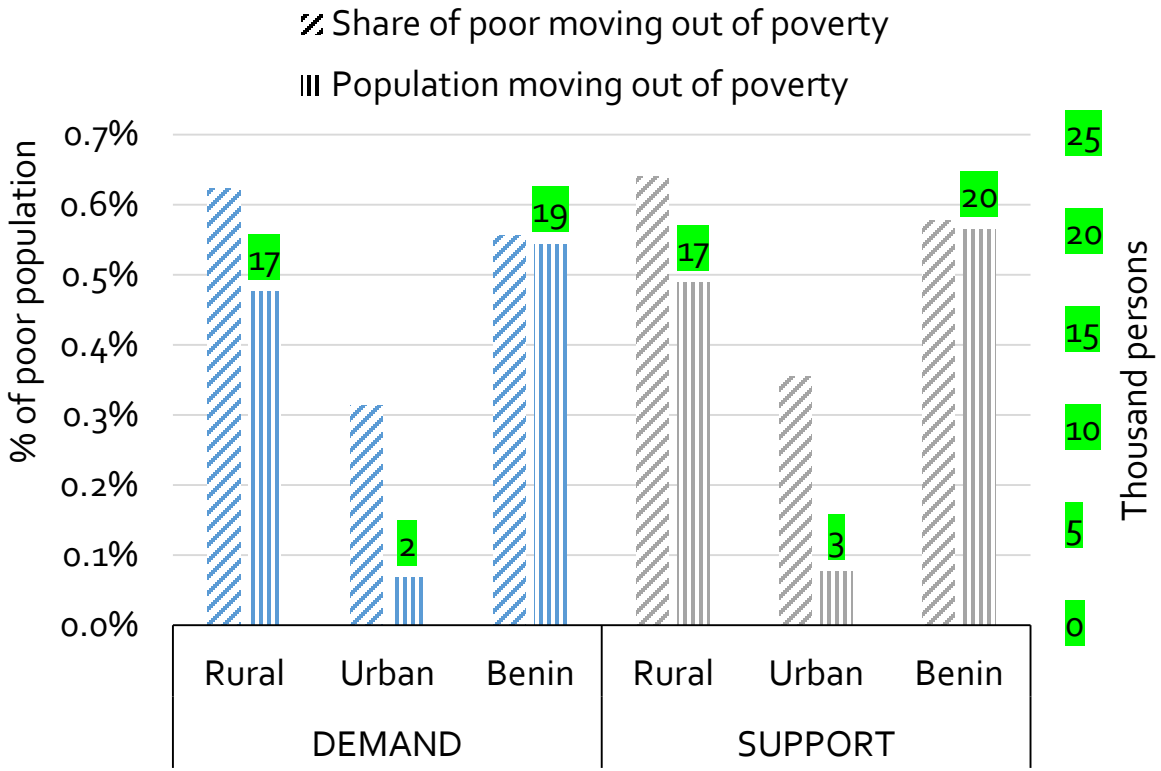


Figure 10. Population moving out of poverty
Source: Own compilation

Results (6/7)

- **Welfare effect: EV versus EVICS**

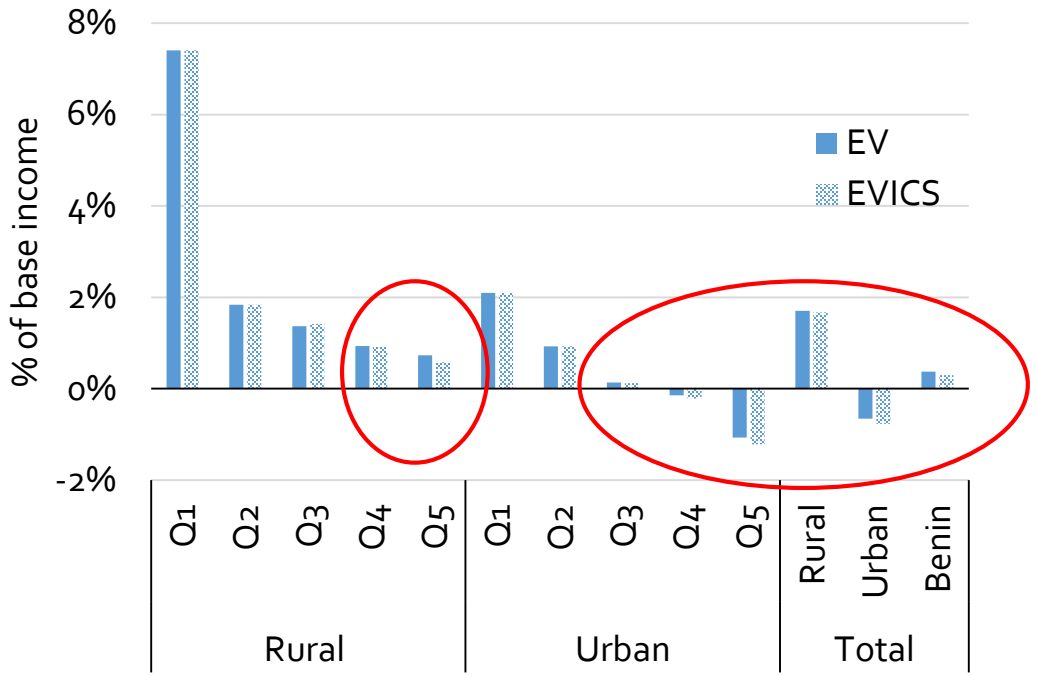


Figure 11A. Welfare effects: DEMAND scenario
Source: Own compilation

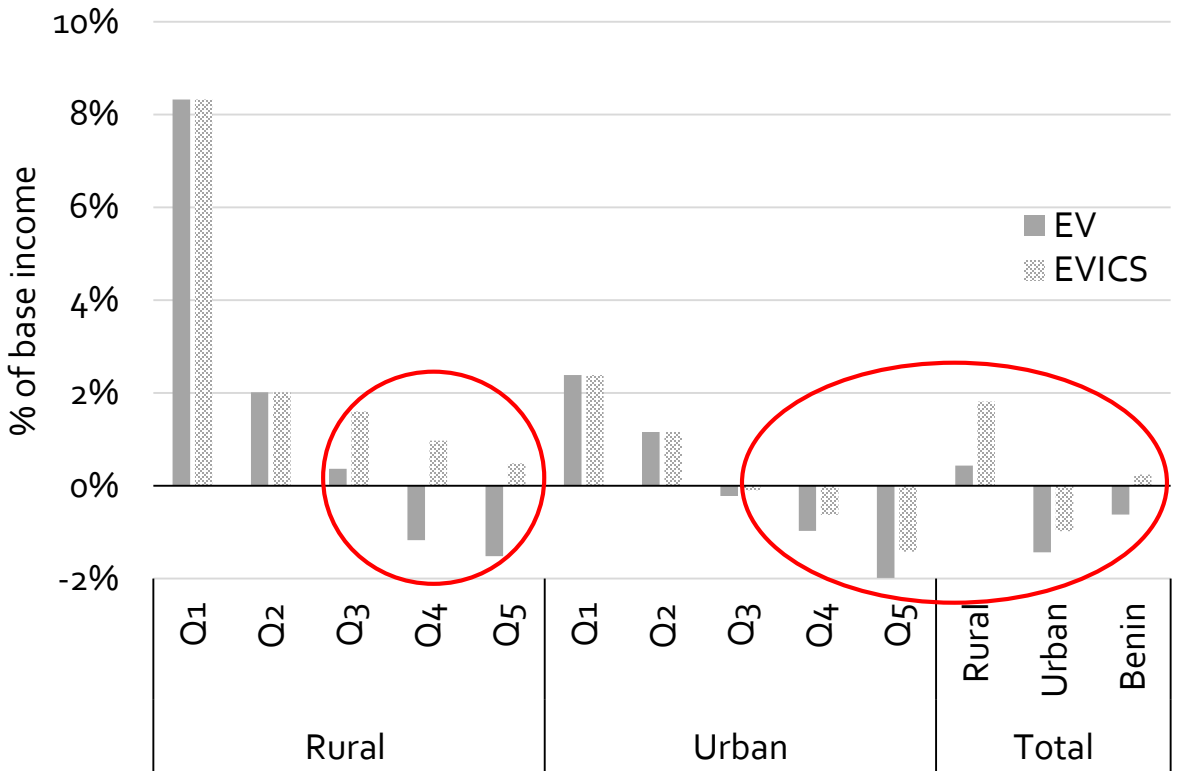


Figure 11B. Welfare effects: SUPPORT scenario
Source: Own compilation

Results (7/7)

- **Macroeconomic effect**

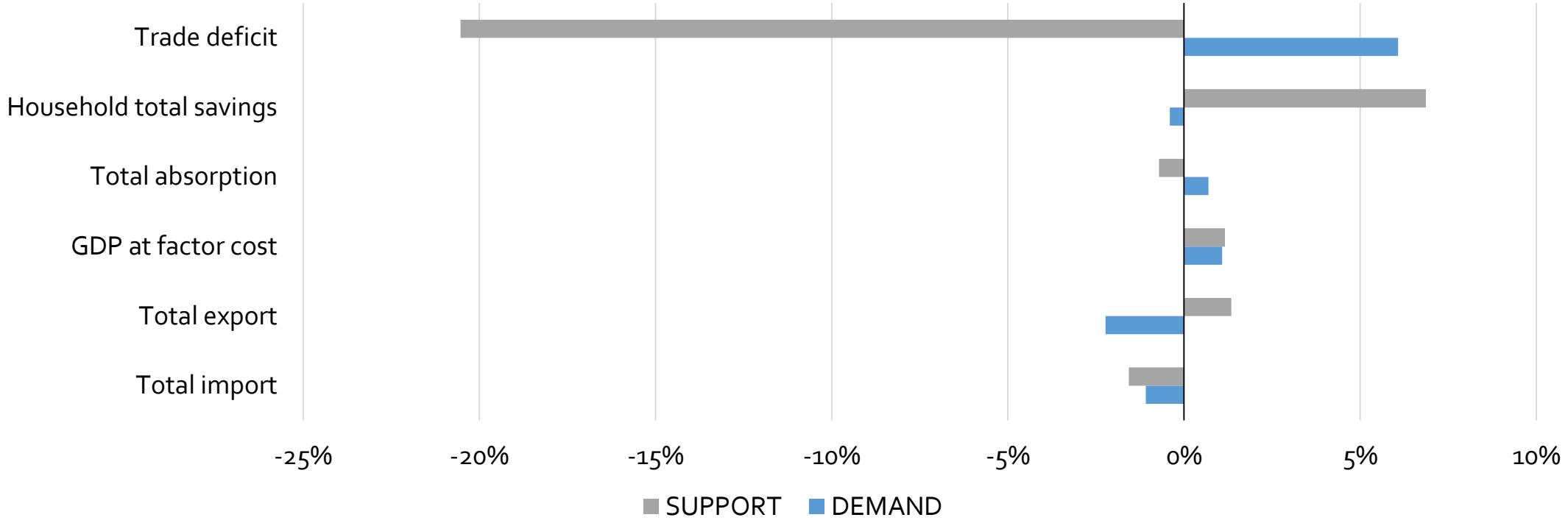


Figure 12. Macroeconomic effect
Source: Own compilation

Conclusion and implications (1/2)

- Cashew byproduct use increases agricultural production and provides additional income to farmers and processors as well as additional value-added
  - ➔ Economic sustainability
- Poverty decreases and households are better off; nutritional security is higher
  - ➔ Social sustainability
- Land use for nutrition decreases, cashew nut shell (CNS) processing removes a polluting byproduct from the environment
  - ➔ Environmental sustainability

Conclusion and implications (2/2)

- From 3% of consumers to 97% of consumers of cashew apple juice: marketing, tasting sections, promotion at national and international events in Benin
- How to support the cashew apple processing:
  - Subsidize farmers to acquire first step processing equipment to extract the pulp from the cashew apple at farm level
  - Training farmers for that extraction as well as good quality management
  - Processors in cities can collect pulp for further processing (more) easily
- Facilitate cashew product exports

THANKS FOR YOUR ATTENTION

Contact

Agossoussi Thierry Kinkpe

kinkpeth@hu-berlin.de

Sources (1/1)

- ACi (2010) Etude sur les Sous Produits de l'anacarde: Pommes et Coques de cajou. African Cashew Initiative (ACi).
- Benin Caju (2017) Sous Produits de l'anacarde: Sources importantes de valeur ajoutée, Cotonou, Bénin.
- Gustavsson, J., Cederber, C., Sonesson, U., van Otterdijk, R., & Meybeck, A. (2011) Global food losses and food waste. Food and Agriculture Organization (FAO) of the United Nations (UN). Available from: https://www.fao.org/3/mb060e/mb060e.pdf.
- Houssou, P., Dansou, V., Hotegni, A.B., Ahounou, J.-L. & Djivoh, H.Y. (2018) Catalogue des innovations technologiques et équipements développés par le PTAA. Porto-Novo, Benin.
- Jones, C., Bryce, J., Vink, J. & Behar, A. (2015) Reducing Food Loss Along African Agricultural Value Chains. Deloitte. Available from: https://www2.deloitte.com/content/dam/Deloitte/za/Documents/consumer-business/ZA_FL1_ReducingFoodLossAlongAfricanAgriculturalValueChains.pdf.
- Kinkpe, A.T., Luckmann, J., Grethe, H. & Siddig, K. (2022) A 2019 Social Accounting Matrix for Benin with detailed representation of agriculture and food processing sectors. Working Paper, No. 101/2022, Humboldt-Universität zu Berlin, Faculty of Life Sciences, Department of Agricultural Economics, Berlin. https://www.agrar.hu-berlin.de/de/institut/departments/daoe/publ/wp
- McDonald, S. & Thierfelder, K. (2015) A Static Applied General Equilibrium Model: Technical Documentation: STAGE Version 2. cgemod: http://www.cgemod.org.uk/stage2.pdf.
- Zoumarou Wallis, N., Bagnan, M.A., Akossou, A.Y.J. & Kanlindogbe, C.B. (2016) Caractérisation morphologique d'une collection de fruits d'anacardier provenant de la commune de Parakou (Bénin). International Journal of Biological and Chemical Sciences, 10(6), 2413–2422. Available from: https://doi.org/10.4314/ijbcs.v10i6.1.