Brain drain and the world economy

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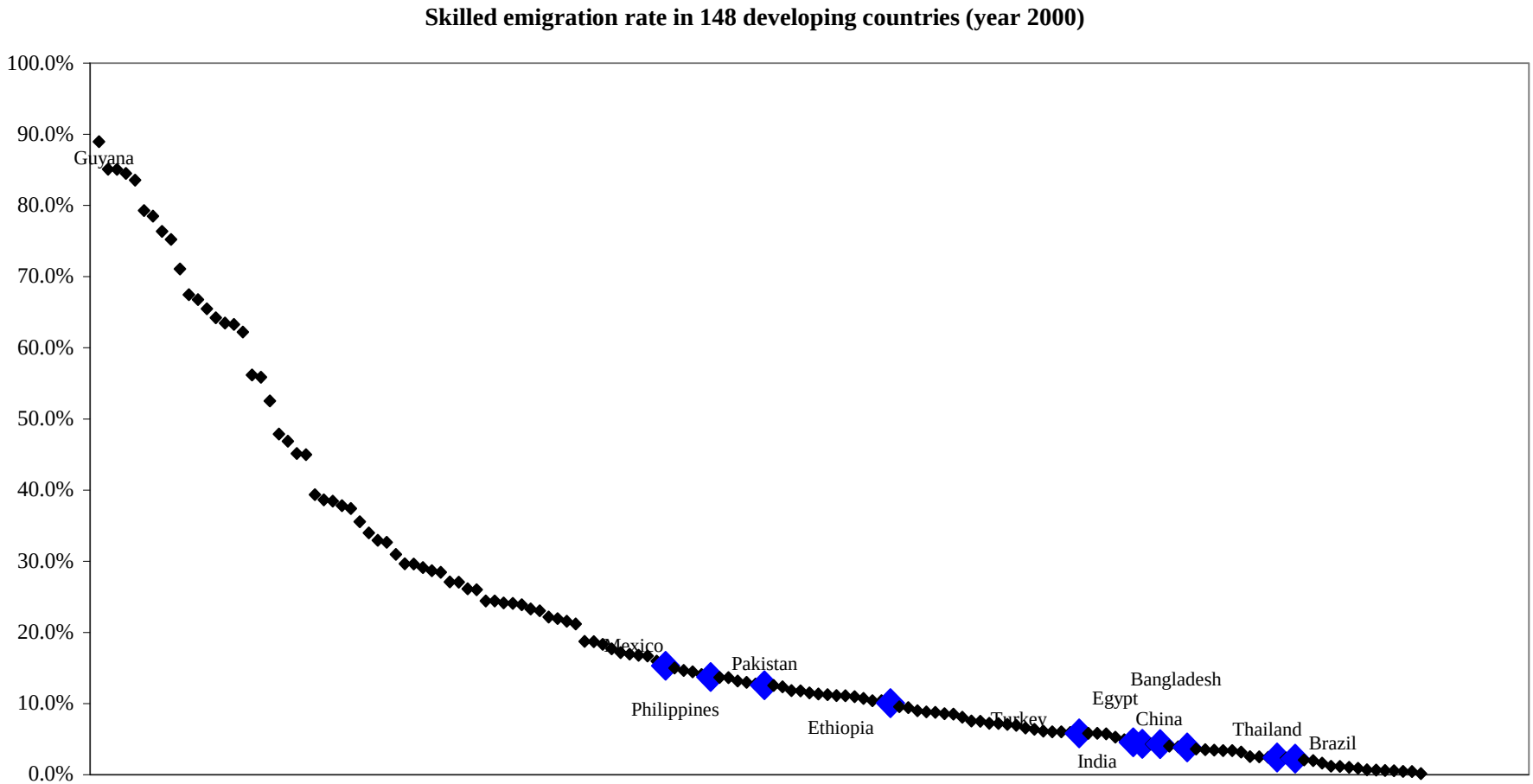
1. INTRODUCTION

1. Introduction - Context

- Assessment of the brain drain: stock of post-secondary educated adults born in country *i* and living in an(other) OECD country / stock of post-secondary educated adults born in country *i*
- Quantitatively, skilled migration is a major source of concern for some developing countries and regions
- Increasingly important issue if developed countries reinforce the selection of immigrants (German green cards, UK points-based system, European blue card, French immigration choisie, etc.)
- What if all developed regions increase their inflows of skilled immigrants? How would it affect developing regions?

1. Introduction - Stylized facts



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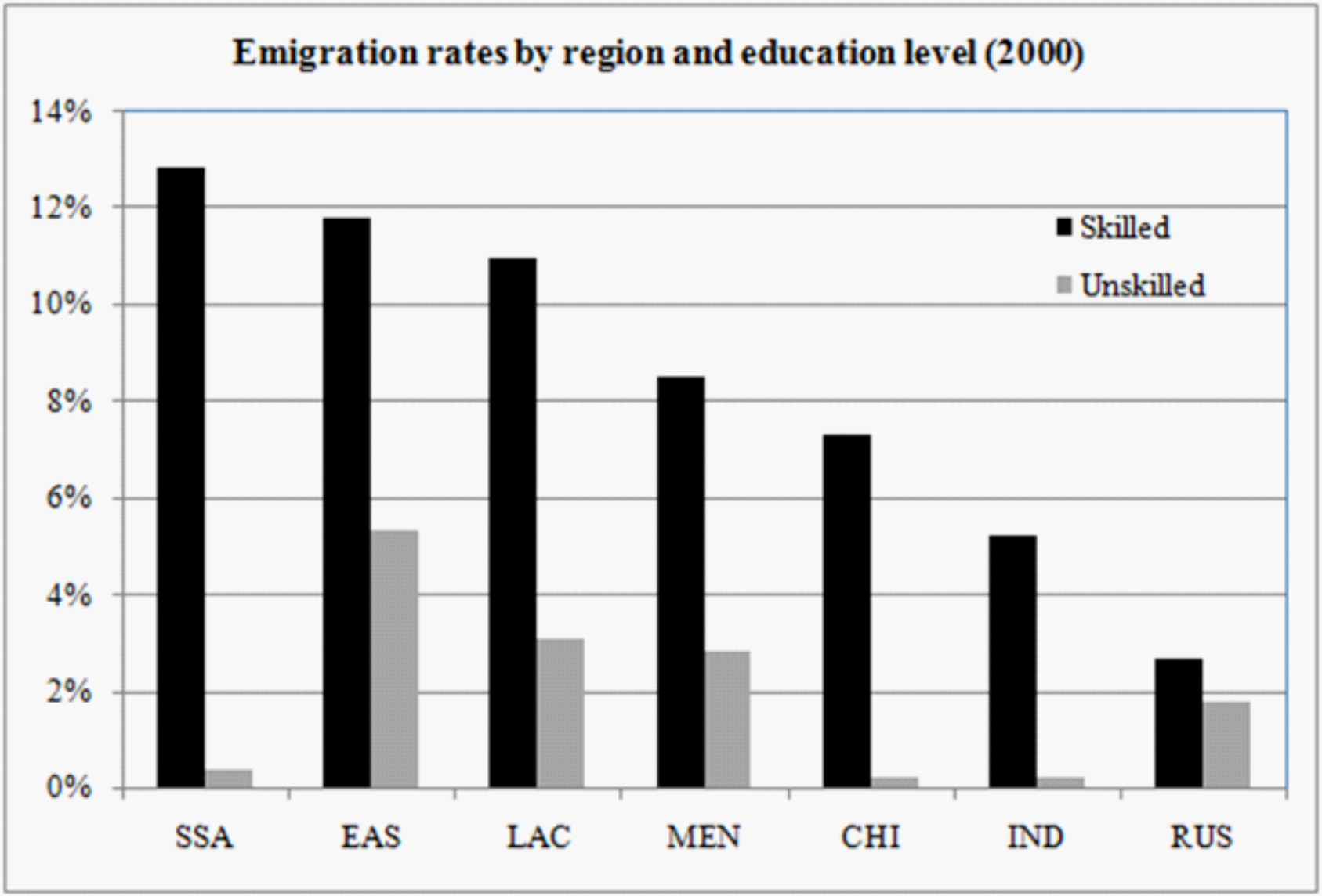

1. Introduction - Recent literature

Brain drain impacts on source countries through multiple channels:

- Reduces human capital ex-post + indirect effects (on MPK, on productivity growth, etc)
- Deteriorates the demographic dependency ratio
- Induces remittances
- Generates diaspora externalities (FDI, trade, knowledge diffusion, etc.)
- Stimulates human capital accumulation ex-ante (brain gain)

Many elasticities were estimated in recent empirical studies

But no global assessment, no decomposition of the total effect (what is dominant? what is minor?)

1. Introduction - Purpose

- Construction of a **GE-OLG model** of the world economy, which combines the most important effects in a unified framework

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- **Disadvantages**: the world is divided in regions; pure macro approach (what about specific occupational shortages?); identical behavioral forms for developed and developing regions

1. Introduction - Purpose

- Construction of a **GE-OLG model** of the world economy, which combines the most important effects in a unified framework
- **Disadvantages**: the world is divided in regions; pure macro approach (what about specific occupational shortages?); identical behavioral forms for developed and developing regions
- **Advantages**: first evaluation and decomposition of the global impact on economic activity, income, inequality in source and destination countries; back-solving calibration allows to exactly match world disparities; possibility to conduct various robustness checks on key assumptions

1. Introduction - Strategy

- What if all developed regions increase skilled immigration (in response to aging, occupational shortages, etc.)?
- Shock: 33% increase in migration flows to the North between 2010 and 2050 + 70% of skilled
- Implicit assumption: excess supply of (skilled) migrants, the magnitude of migration flows is determined by policy restrictions in the North.
- Focus on GDP per capita, GNI per capita, skilled/unskilled inequality

1. Introduction - Main results

- World GDP increases by 5.6%
- Ambiguous impact on regional GDP per capita (winners and losers)
- Positive impact on GNI per capita (except in EAS and the CHI)
- Increase in 'skilled/unskilled' inequality almost everywhere
- Results robust to remittance behavior and brain gain hypothesis
- More pessimistic results if lower diaspora externality

2. THE MODEL

2. Model - General structure

- World divided into 10 regions (3 North and 7 South regions)
- In each region: adult households, firms, government
- Adult population divided in 8 overlapping generations (from 15-24 to 85-94): age is denoted by $a = 0, ...7$
- In each generation, time-varying proportions of skilled (post-secondary) and unskilled
- Migration is permanent, occurs at the first period of life
- We only track migrants from South to North (other int'l migrants included in the demographic forecasts)

2. Model - General structure

- NAM = North America
- ADV = Other advanced OECD countries
- JAP = Japan
- EAS = Eastern Europe
- MEN = Middle East and Northern Africa
- LAC = Latin America and the Caribbean
- SSA = Sub-Saharan Africa
- RUS = Former Soviet Union
- CHI = Chinese world
- IND = Indian world

2. Model - General structure

Two main blocks:

- 'Upstream block' (calibrated outside the core of the model using data + empirical studies): predictions for demography, human capital, diaspora externalities
- 'Micro-founded CGE block': predictions for world output, prices, remittances, asset accumulation, geographical allocation of assets, international flows of capital income, etc.

2. THE MODEL

2.1. THE UPSTREAM BLOCK

2.1. 'Upstream' block - Methodology

- No micro-foundations
- Calibrated using data + empirical studies
- No interdependencies with the CGE block
- Customized to match the general structure
- Predictions for demography ($\frac{L}{POP}, M^S, M^U$), human capital ($\frac{L^S}{L^U}$), and diaspora externalities: technology adoption (A) + transaction/information costs affecting movements of capital (π)

2.1. 'Upstream' block - Demography

- Size of young generation: $N_{o,t} = N_{0,t-1} m_{t-1}$ (m_{t-1} affected by fertility and migration)
- Other cohorts: $N_{a,t+a} = N_{0,t} P_{a,t+a}$ ($P_{a,t+a}$ = probability to be alive at age a)
- Skill composition: $N^s_{o,t} = N_{o,t}\phi_t$ and $N^u_{o,t} = N_{o,t}(1-\phi_t)$ (ϕ_t affected by migration)
- Labor supply: $L^j_t = \sum_a \lambda^j_{a,t} N^j_{a,t}$ $(j = s, u)$
- In the baseline, $N_{a,t}, P_{a,t}, m_t$ calibrated using UN data and forecasts; ϕ_t calibrated using Barro-Lee (2001); $\lambda^j_{a,t}$ calibrated using observed participation rates

2.1. 'Upstream' block - Migration

- **Baseline history**: model matches UN data (immigrants/population in receiving countries) + matches Docquier-Marfouk sharing by age group, education level and region of origin.

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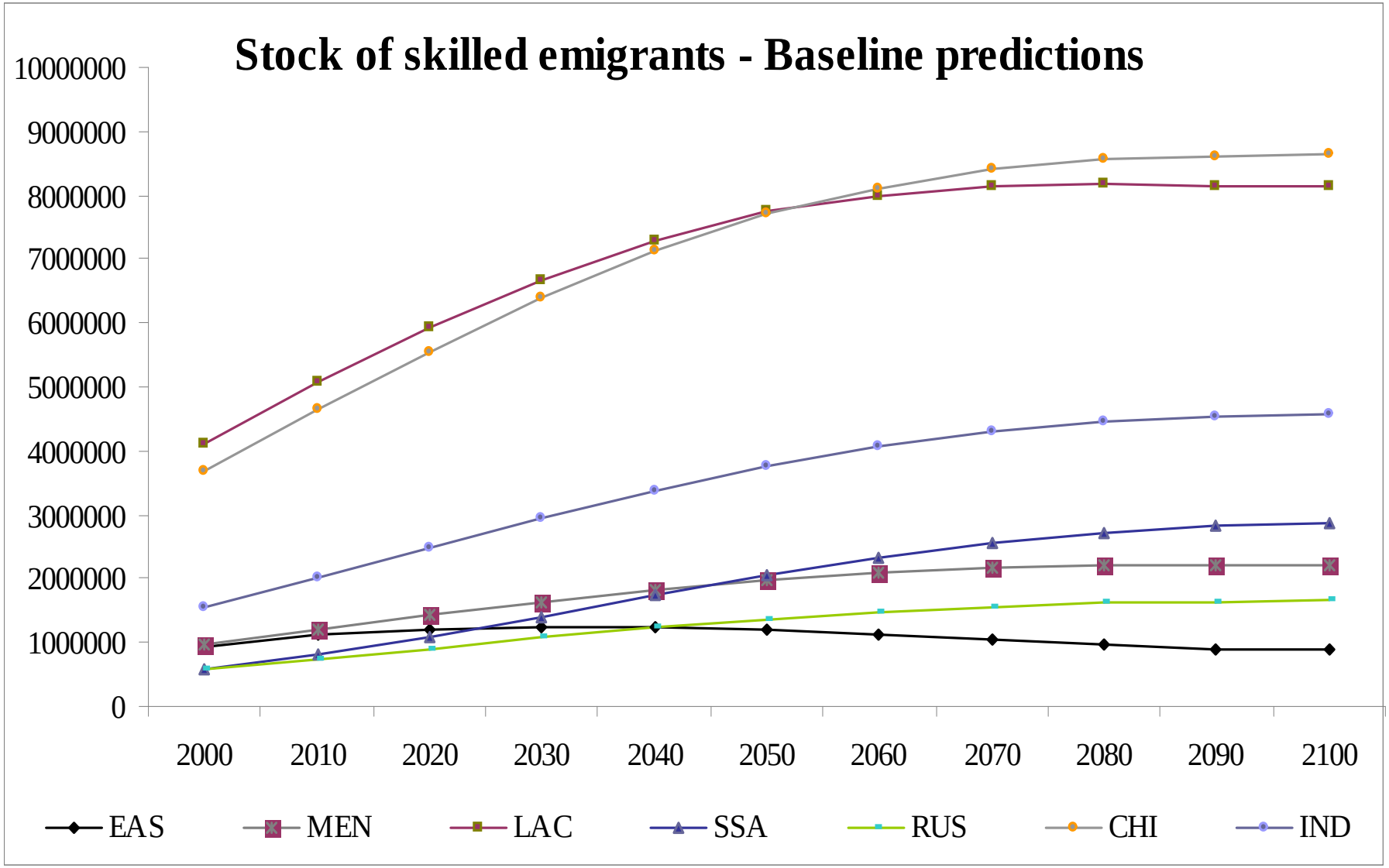
- **Shock (def)**: 33% increase in immigration flows in the North between 2010 and 2050 + same distribution by origin as in forecasts + 70% of skilled $\Rightarrow$ South-North skilled emigration stock increases by 15.8%. Strong increase in skilled emigration for LAC and EAS, lowest increase for SSA

2.1. 'Upstream' block - Skilled emigration stocks



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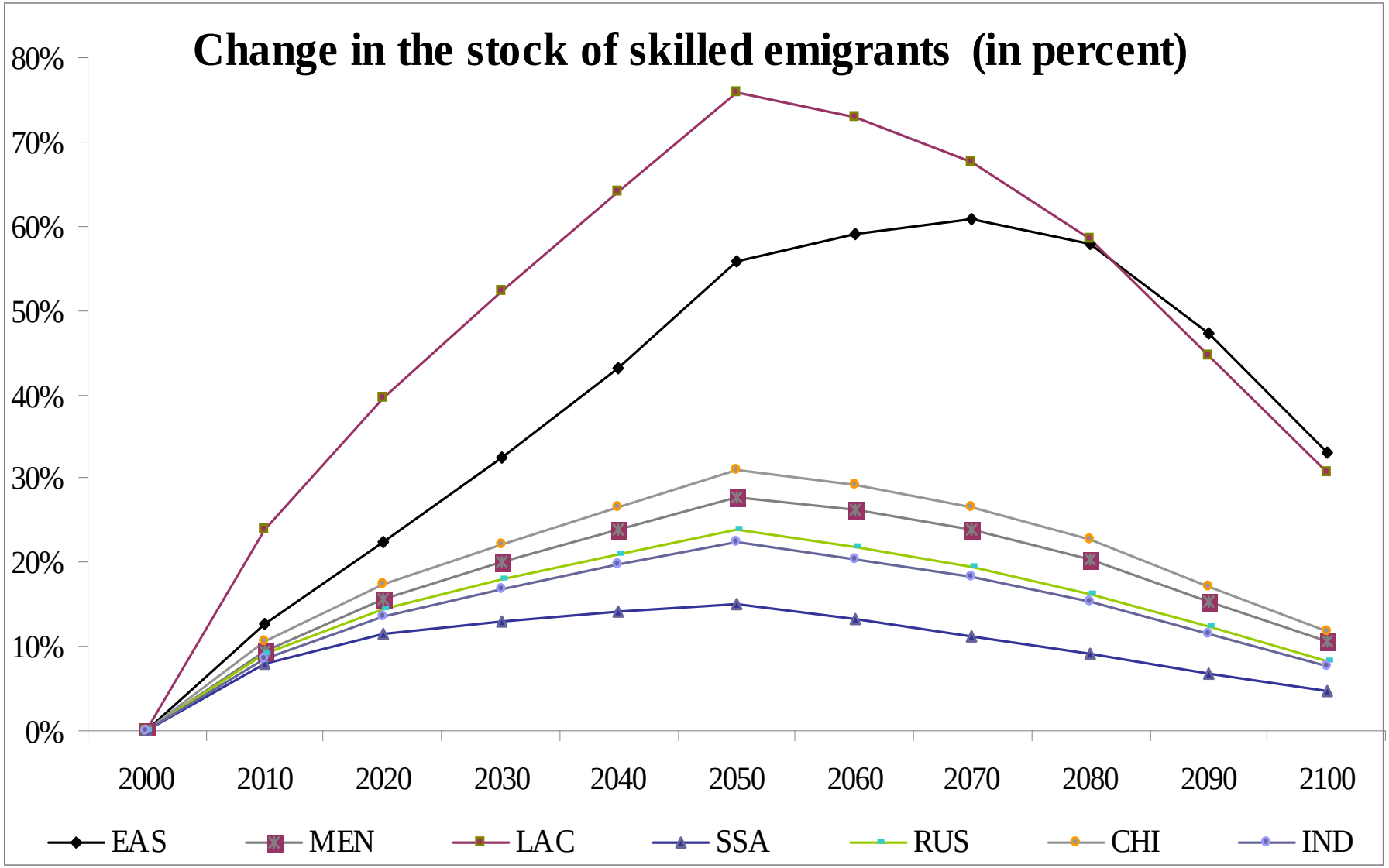

2.1. 'Upstream' block - Support ratio

- Support ratio = Labor Force / Population

$$SR = \frac{\sum_{a=0}^{7} \left[\lambda_{a,t}^{u} N_{a,t}^{u} + \lambda_{a,t}^{s} N_{a,t}^{s} \right]}{\sum_{a=0}^{7} \left[N_{a,t}^{u} + N_{a,t}^{s} \right]}$$

  where $\lambda_{a,t}^{e}$ is the participation rate of individuals aged a of education e (in number $N_{a,t}^{e}$)
- **Baseline**: aging in developing regions until 2060 (heterogeneous timing)
- **Shock**: strong deterioration in LAC and EAS

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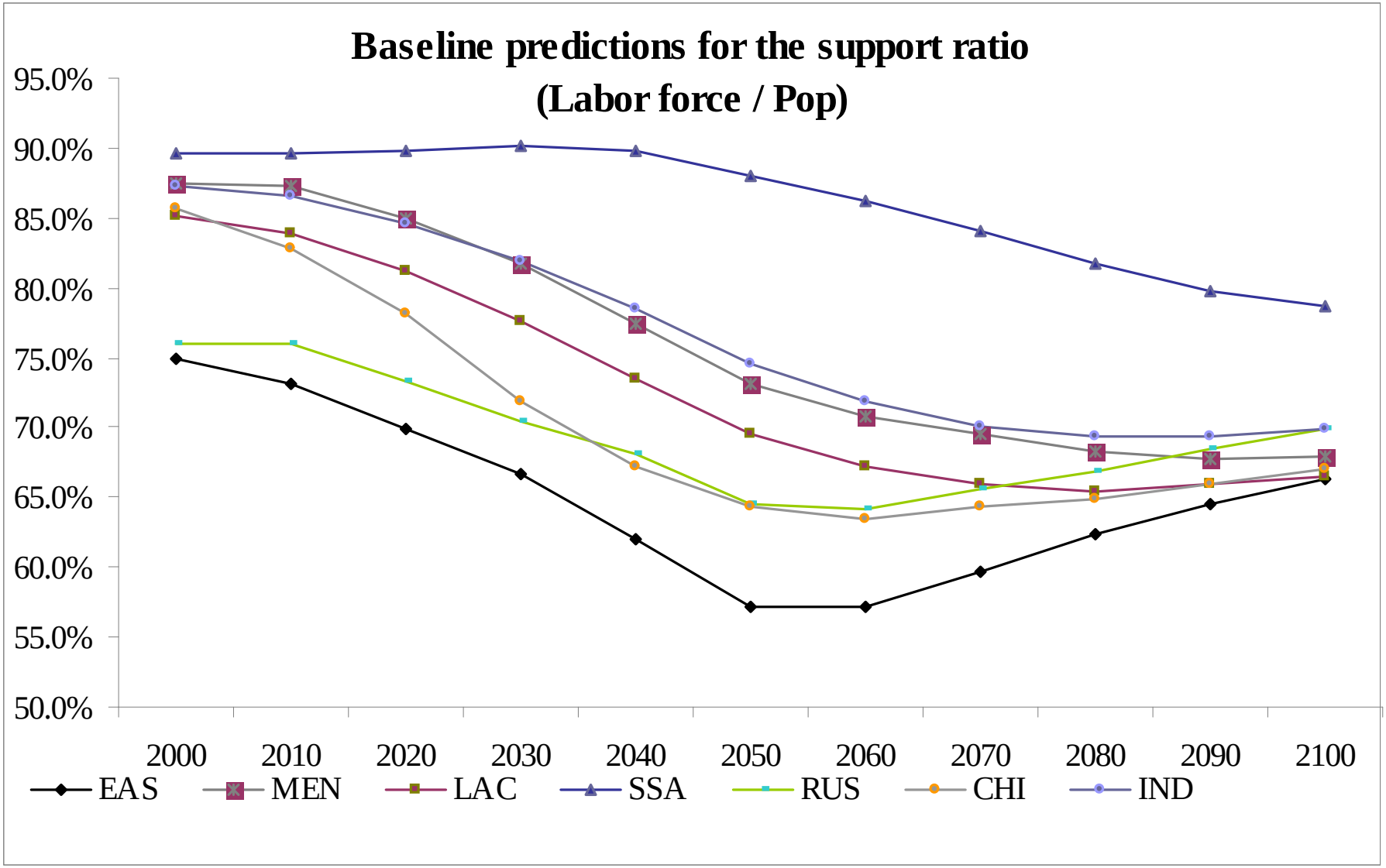

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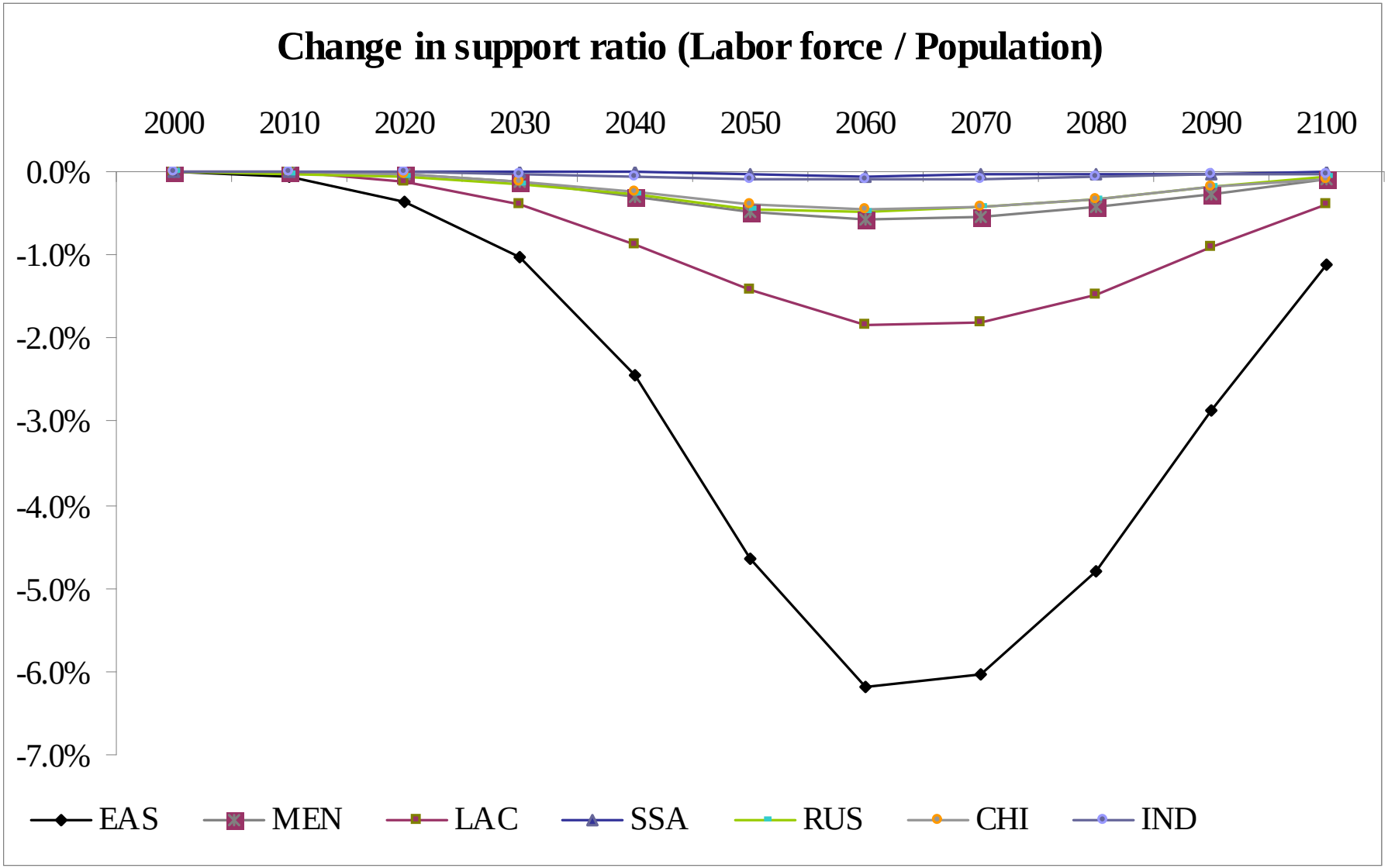

2.1. 'Upstream' block - Human capital

Human capital defined as the proportion of skilled in the resident labor force

$$HC = \frac{\sum_{a=0}^{7} \lambda_{a,t}^{s} N_{a,t}^{s}}{\sum_{a=0}^{7} \left[\lambda_{a,t}^{u} N_{a,t}^{u} + \lambda_{a,t}^{s} N_{a,t}^{s}\right]}$$

Baseline: future young cohorts educated like the 2000 young cohort
Shock: The global impact is ambiguous

- Ex-ante, higher brain drain increases human capital among natives. Long-run elasticity of human capital to skilled migration (Beine et al, 2007)
- Ex-post, higher number of emigrants
- Predictions by country + aggregation by region

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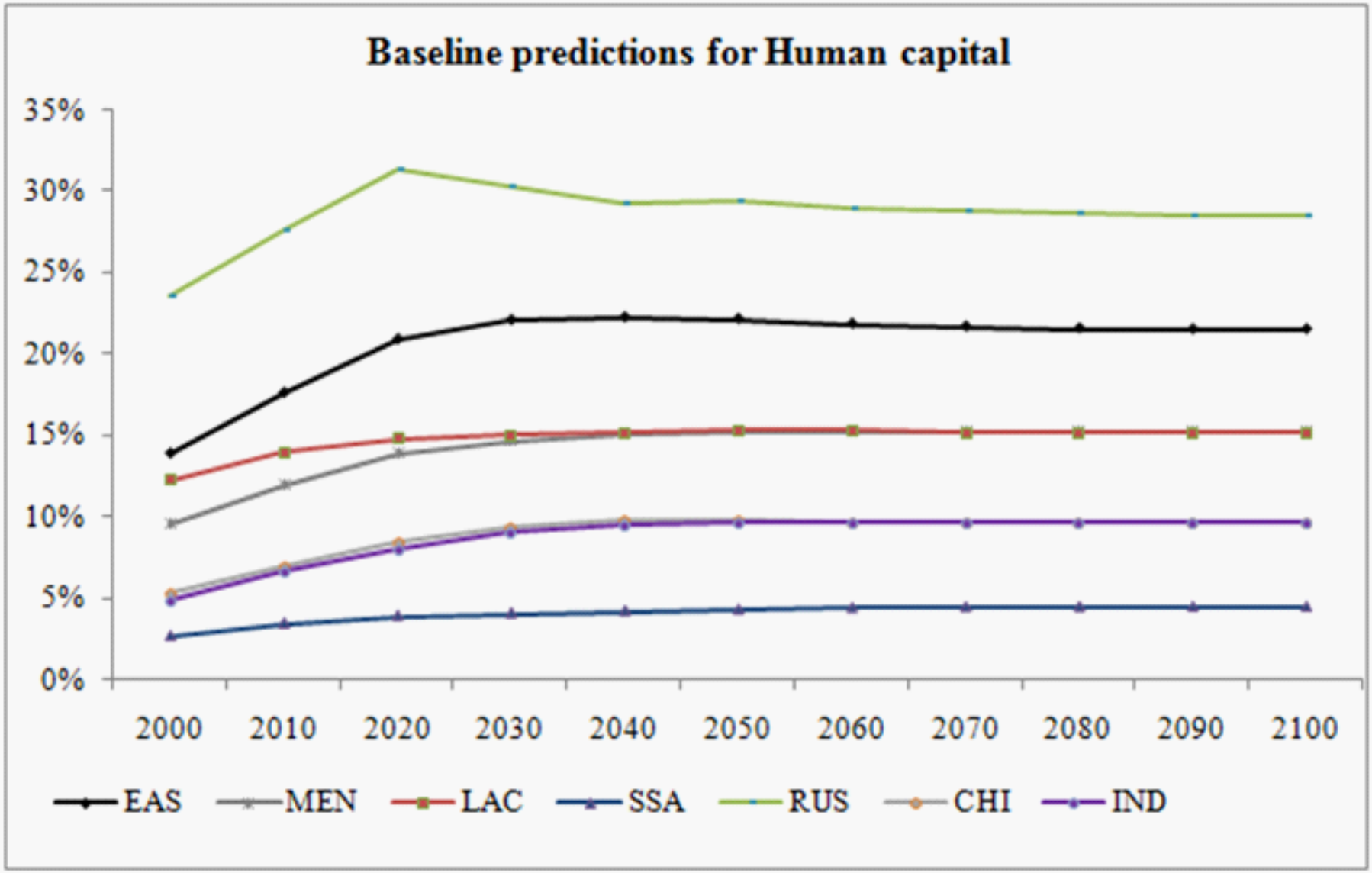

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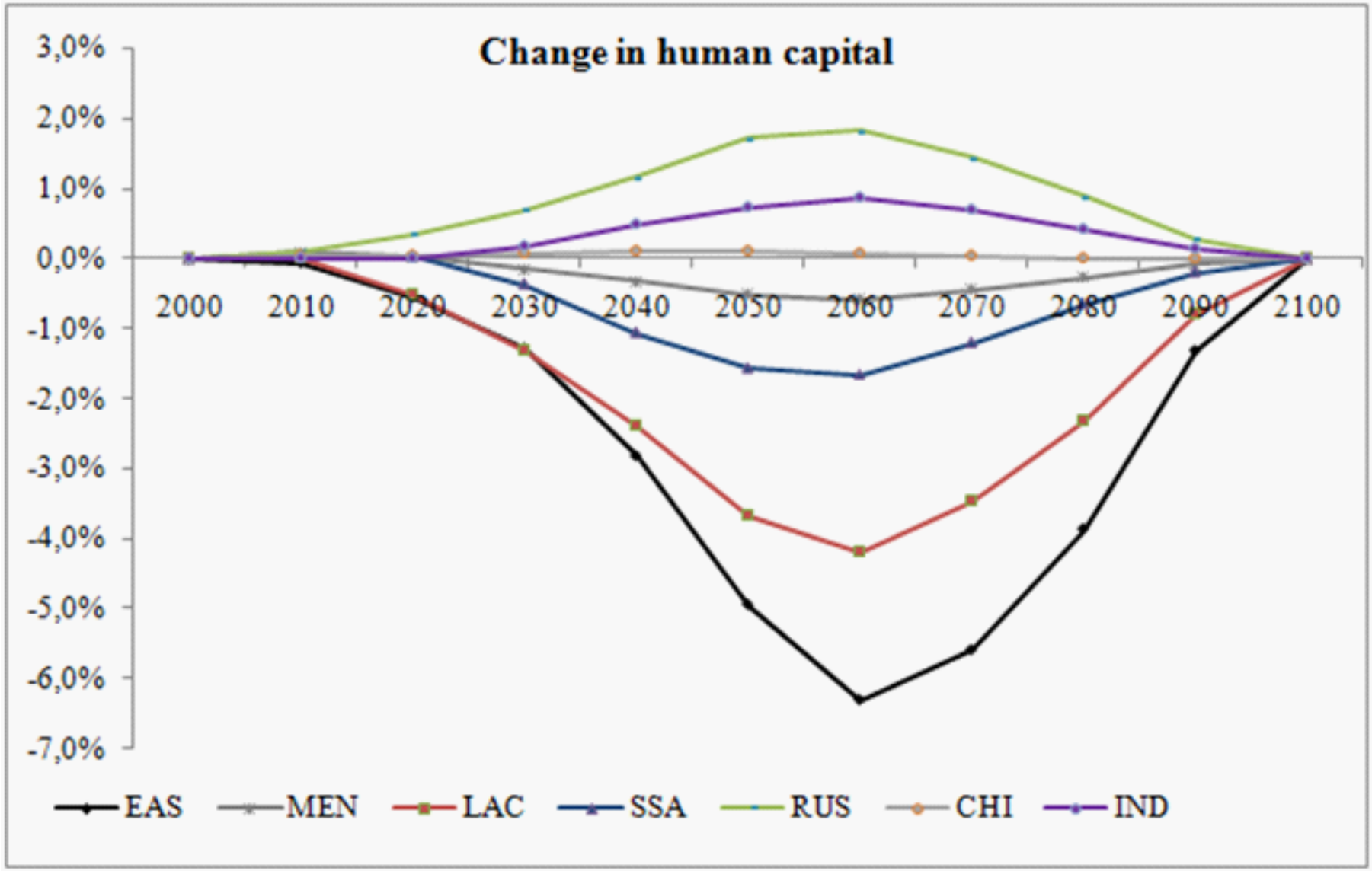


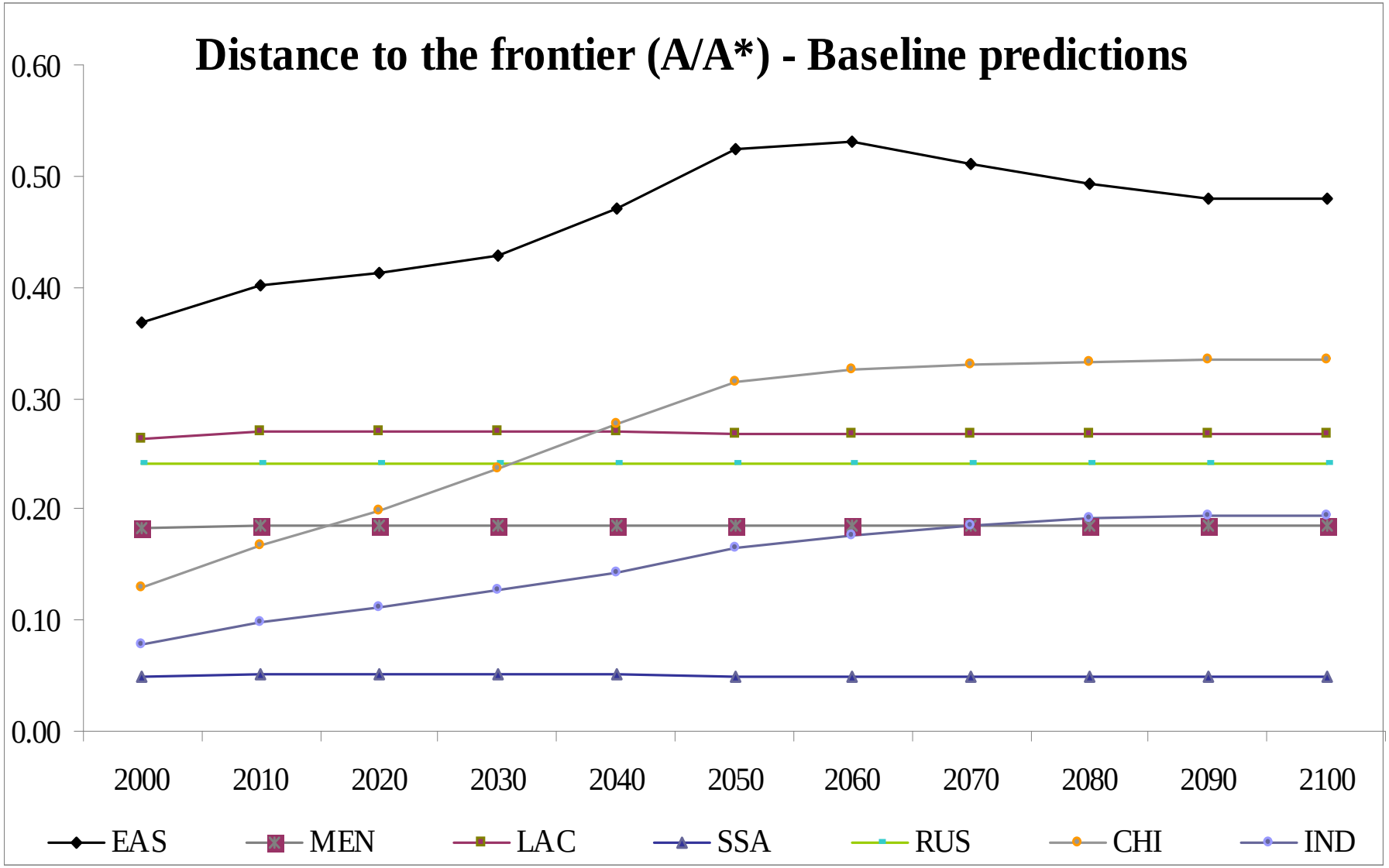
2.1. 'Upstream' block - Harrod-Neutral TP

- Production function: $Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}$
- Technology model with diaspora externality (Lodigiani, 2007, extending Vandenbussche, Aghion and Meghir, 2006):

$$\begin{aligned}\Delta \ln A_t &= .59 - .28 \ln\left(\frac{A_t}{A_t^*}\right) + 1.43 h_t - .10 \ln(M_t^s) \\ &\quad +0.87 \ln\left(\frac{A_t}{A_t^*}\right) h_t - .06 \ln\left(\frac{A_t}{A_t^*}\right) \ln(M_t^s)\end{aligned}$$

- Predictions by country (we incorporate a positive trend for IND, EAS and CHI) + Aggregation by region

2.1. 'Upstream' block - Harrod-Neutral TP

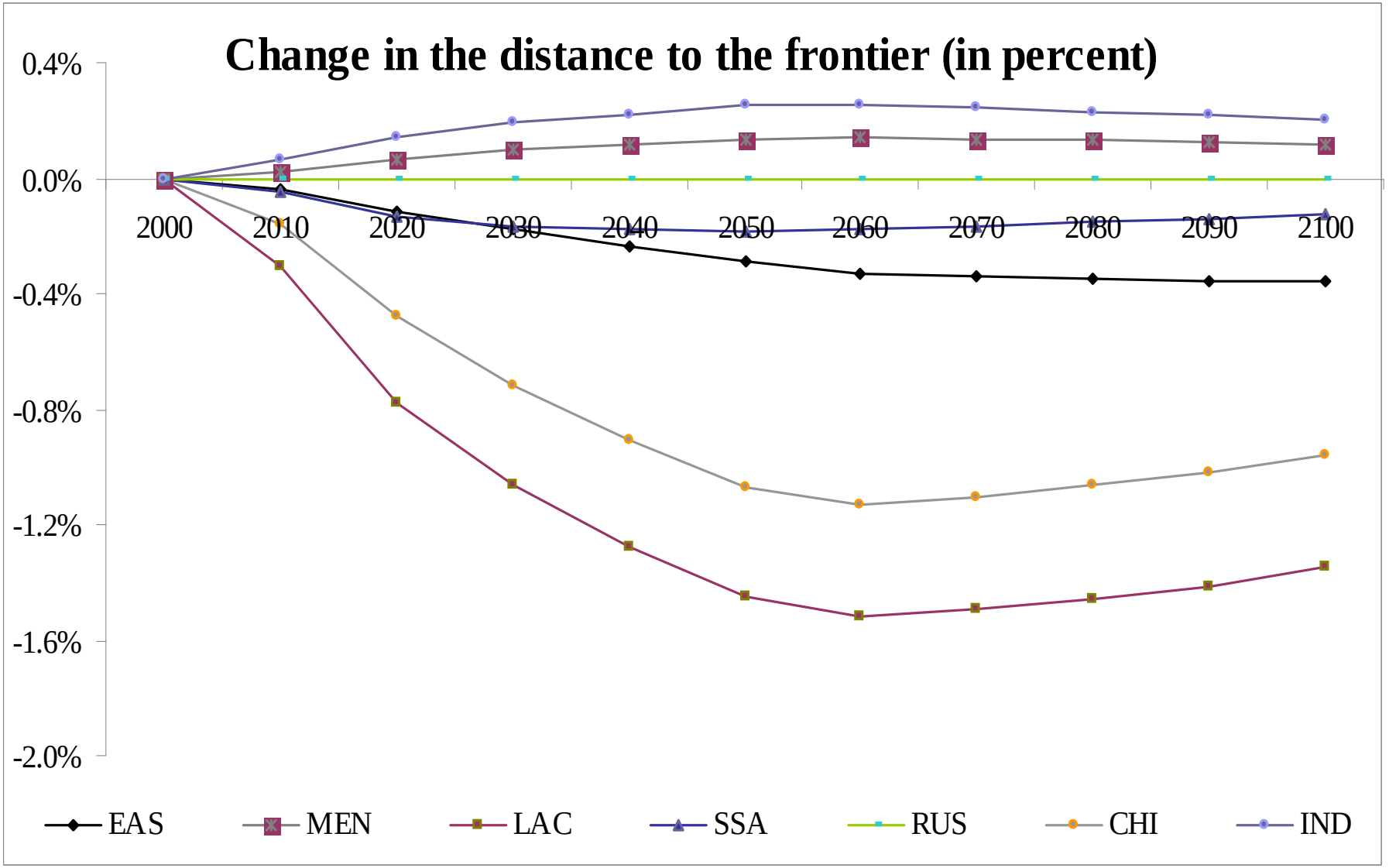


2.1. 'Upstream' block - Harrod-Neutral TP

What if skilled emigration increases?

- **Effect of human capital:** $\Delta \ln A_t$ increases in h_t if $ln\frac{A_t}{A_t^*} \succ -1.64$ (LAC, CHI)
- **Effect of skilled diaspora:** $\Delta \ln A_t$ increases in M_t^s if $ln\frac{A_t}{A_t^*} \prec -1.67$ (EAS, MEN, SSA, IND)
- **Shock**: Gain for IND, MEN. Status quo for RUS. Loss for LAC, CHI, EAS, SSA

'Upstream' block - Harrod-Neutral TP



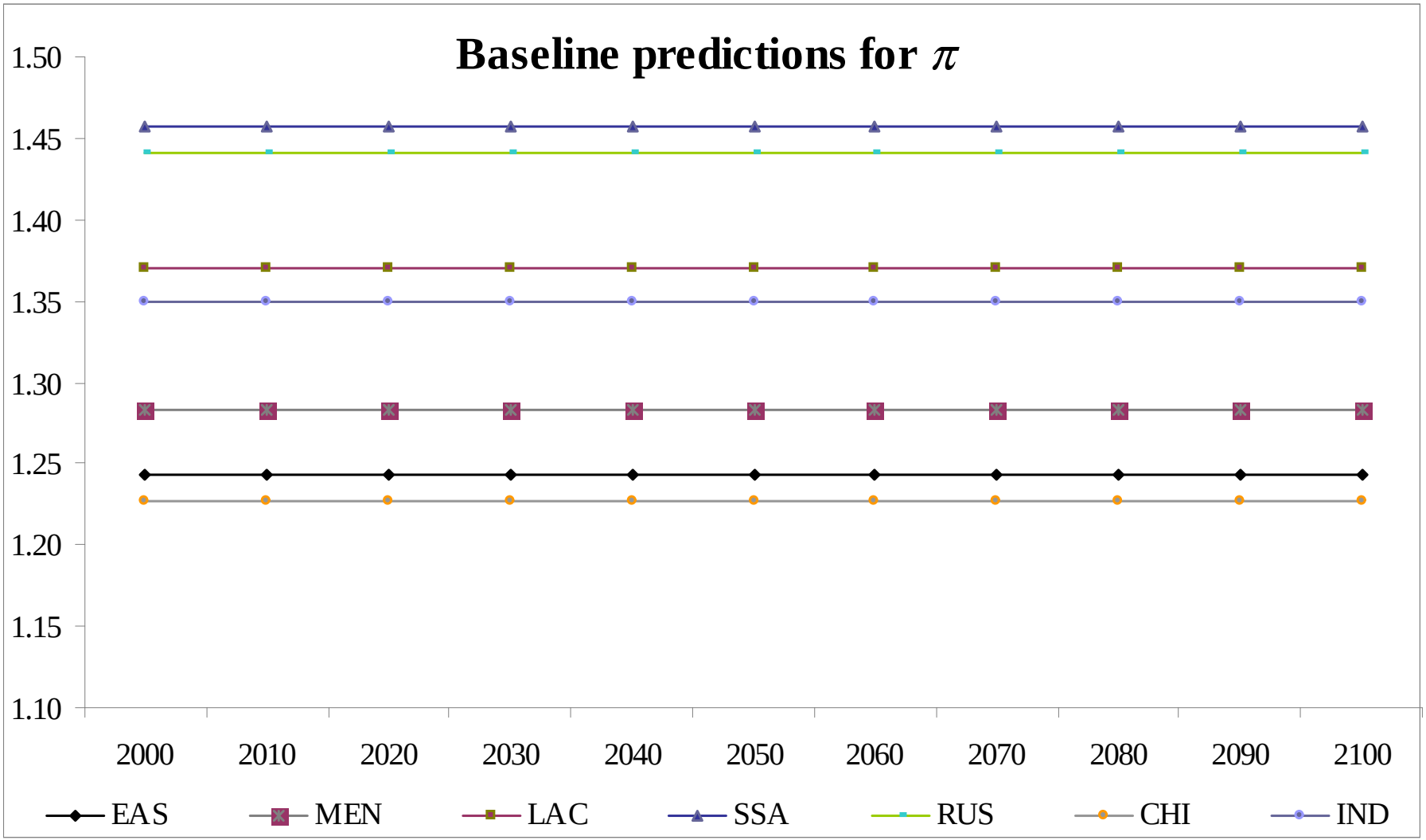
2.1. 'Upstream' block - Risk premium

- International mobility of capital with information costs/risk premia π:

$$\begin{aligned} r^*(1+\pi_t) &= \alpha K_t^{\alpha-1}(A_t L_t)^{1-\alpha} - d \\ 1+\pi_t &= (1+\pi_{0,t})\left(M_t^s\right)^{-\psi} \end{aligned}$$

- Effect of skilled diaspora on $1+\pi_t$ calibrated using elasticity of FDI to diaspora (Docquier and Lodigiani, 2007) and assuming that FDIs represent 12.5% of total investments
- Panel regression: long-run elasticity = 0.75 (central variant)
- **Baseline**: $1+\pi_t$ is constant over time; calibrated using country risk rating in 2000 (Knaepen package)
- **Shock**: Decrease in π_t (important for LAC and EAS)

2.1. 'Upstream' block - Risk premium



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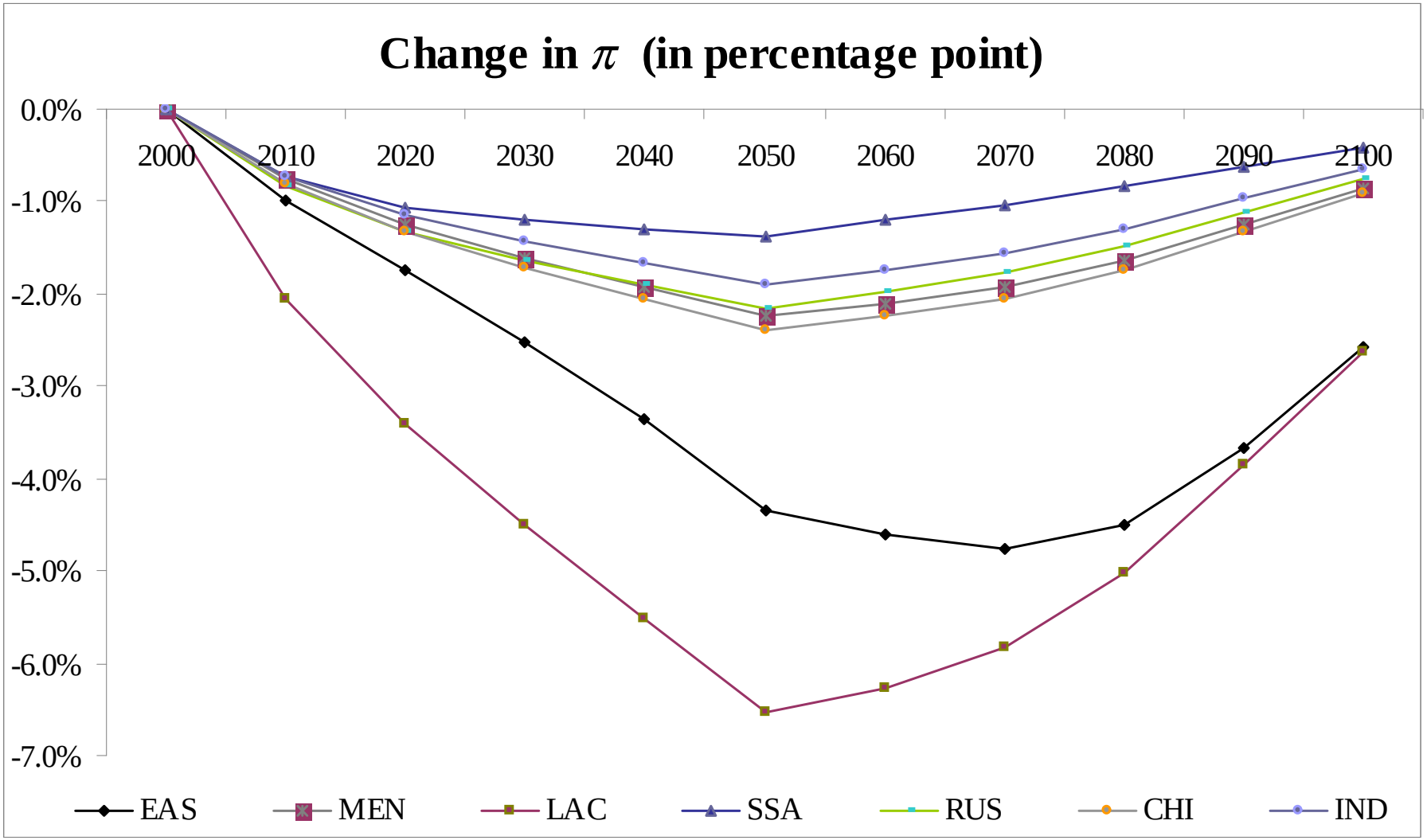


2. THE MODEL

2.2. THE CGE BLOCK

2.2. CGE block - Methodology

- Global impact of the brain drain on key indicators depends on changes in labor and capital income, taxation, asset accumulation by region, geographical allocation of assets, remittances (level and distribution), etc.
- This requires a micro-founded model depicting firms', state's and individuals' behaviors
- Backward-forward model with 1750 equations by period (could be reduced to 350 'long' equations). Simulated on 40 periods. Hence, 70,000 simultaneous equations (could be reduced to 14,000 equations)

2.2. CGE block - Households

- Expected utility function: $E(U_t^j) = \sum_{a=0}^{7} P_{a,t+a} \ln(c_{a,t+a}^j)$
- For migrants only, consumption of goods versus remittances: $c_{a,t+a}^j = (c_{a,t+a}^{M,j})^{1-\gamma^j} (RM_{a,t+a}^{M,j})^{\gamma^j}$ (γ^j = propensity to remit, varies by region and education level)
- Budget constraint with Arrow-Debreu contingent prices: expected discounted lifetime income (wages, capital income, welfare transfers, pension benefits) = expected discounted amount of expenditures
- This determines age profiles for consumption, remittances, saving and asset accumulation

2.2. CGE block - Households

- We arbitrarily set γ^s/γ^u and calibrate γ^u so as to match REM/GDP in recipient countries (given income disparities between skilled and unskilled and between regions). If $\gamma^s/\gamma^u \prec 0.7$, γ^u becomes irrealistically high (more than 80% in MEN, more than 60% in IND and more than 50% in SSA)

- Scenario 1 (central): $\gamma^s = 0.7\gamma^u$ and equal sharing abroad
- Scenario 2: $\gamma^s = \gamma^u$ and equal sharing abroad
- Scenario 3: $\gamma^s = 0.7\gamma^u$ and (un)skilled$\rightarrow$(un)skilled abroad

2.2. CGE block - Production

- Production function: $Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}$
- Labor in efficiency units: $L_t = \left[\nu_t \left(L_t^s\right)^{\sigma} + (1-\nu_t)\left(L_t^u\right)^{\sigma}\right]^{1/\sigma}$
- ν_t calibrated to match observed skill premia; σ calibrated to match elasticity of substitution of 1.4 (Acemoglu, 2002)
- Harrod-neutral TP (A_t) calibrated outside the model (see above)

2.2. CGE block - Government

- Levies taxes on labor income and consumption, issues bonds and pays interests
- Finance public consumption, pension benefits and welfare transfers
- Pension benefits partly Bismarckian and partly Beveridgian (depending on the region)
- Public debt and public consumption calibrated using WDI or OECD database. Pension benefits calibrated using World Bank study.

2.2. CGE block - Competitive equilibrium

- Households' and firms' first order conditions
- Market clearing on the goods and labor markets
- Budget balance for the governments (adjusted labor income tax)
- World assets = World capital stock
- Arbitrage condition of the rates of return to capital (given risk premia)

3. SIMULATION RESULTS

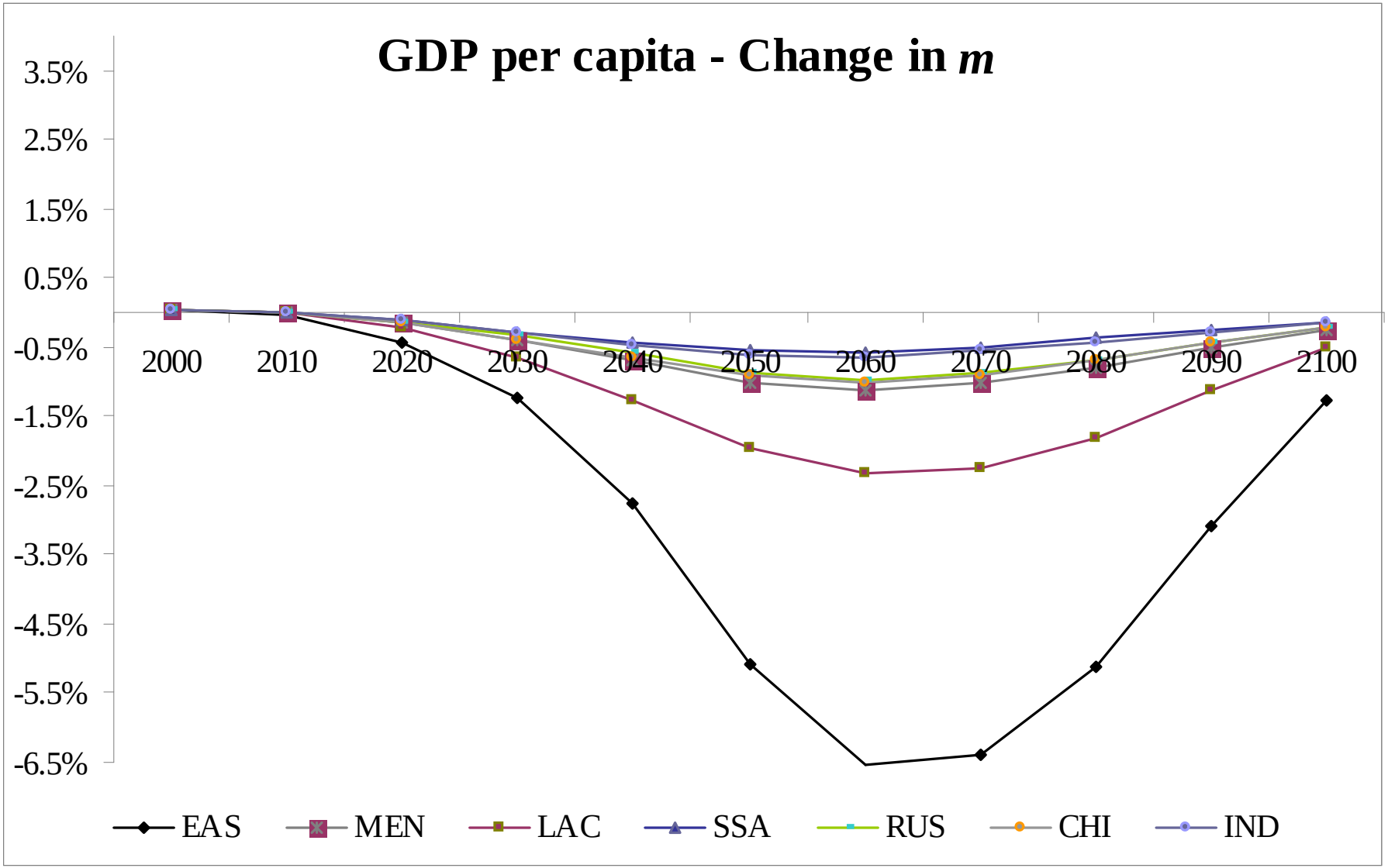
3. Results - multiple shocks

Global effect = response to simultaneous 'upstream' shocks

- Impact through demography
- Impact through human capital
- Impact through total Harrod neutral TP
- Impact through risk premium

Disentangling the endogenous change in GDP per capita.

3. Results - Disentangling the effect on GDP per capita



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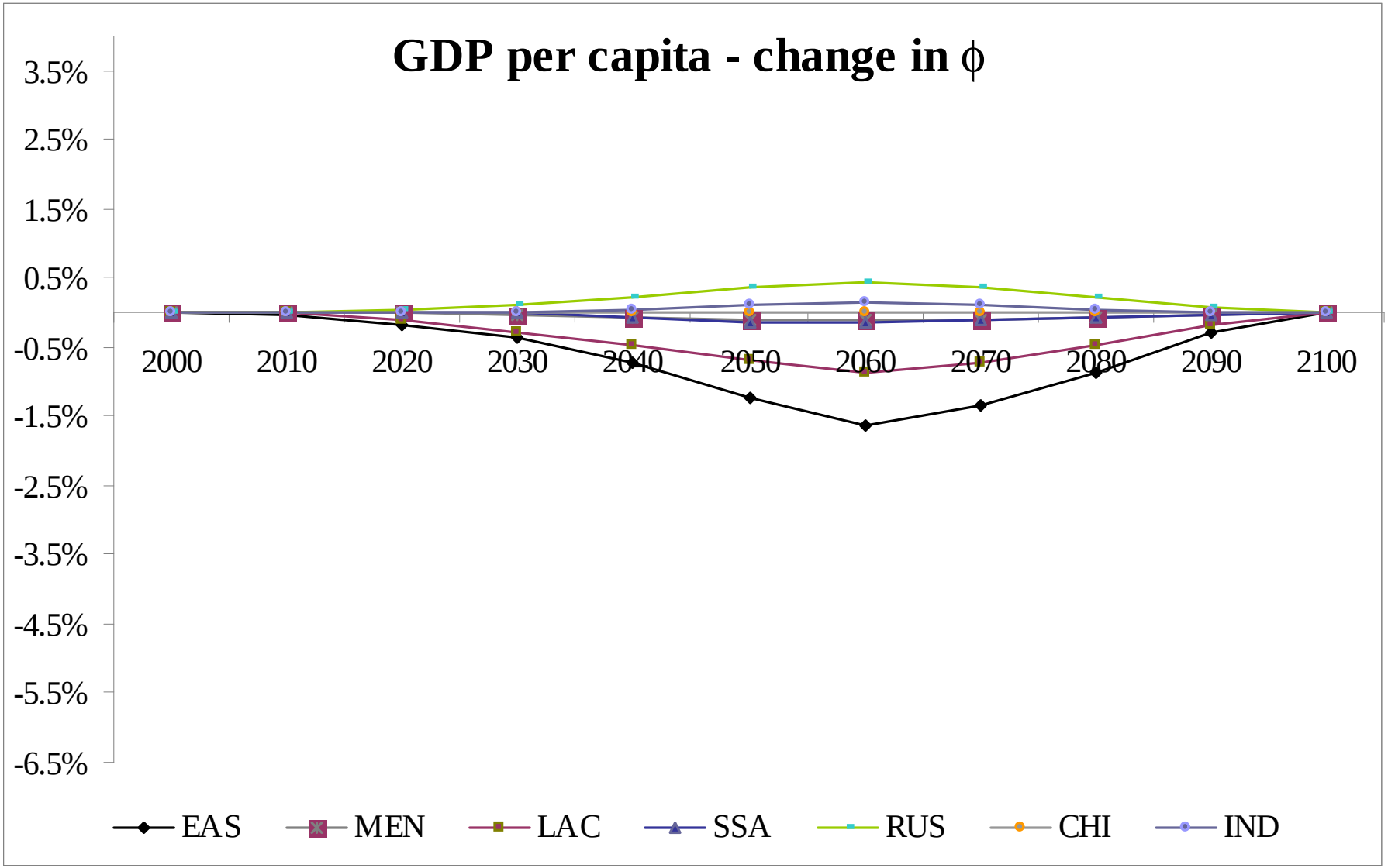

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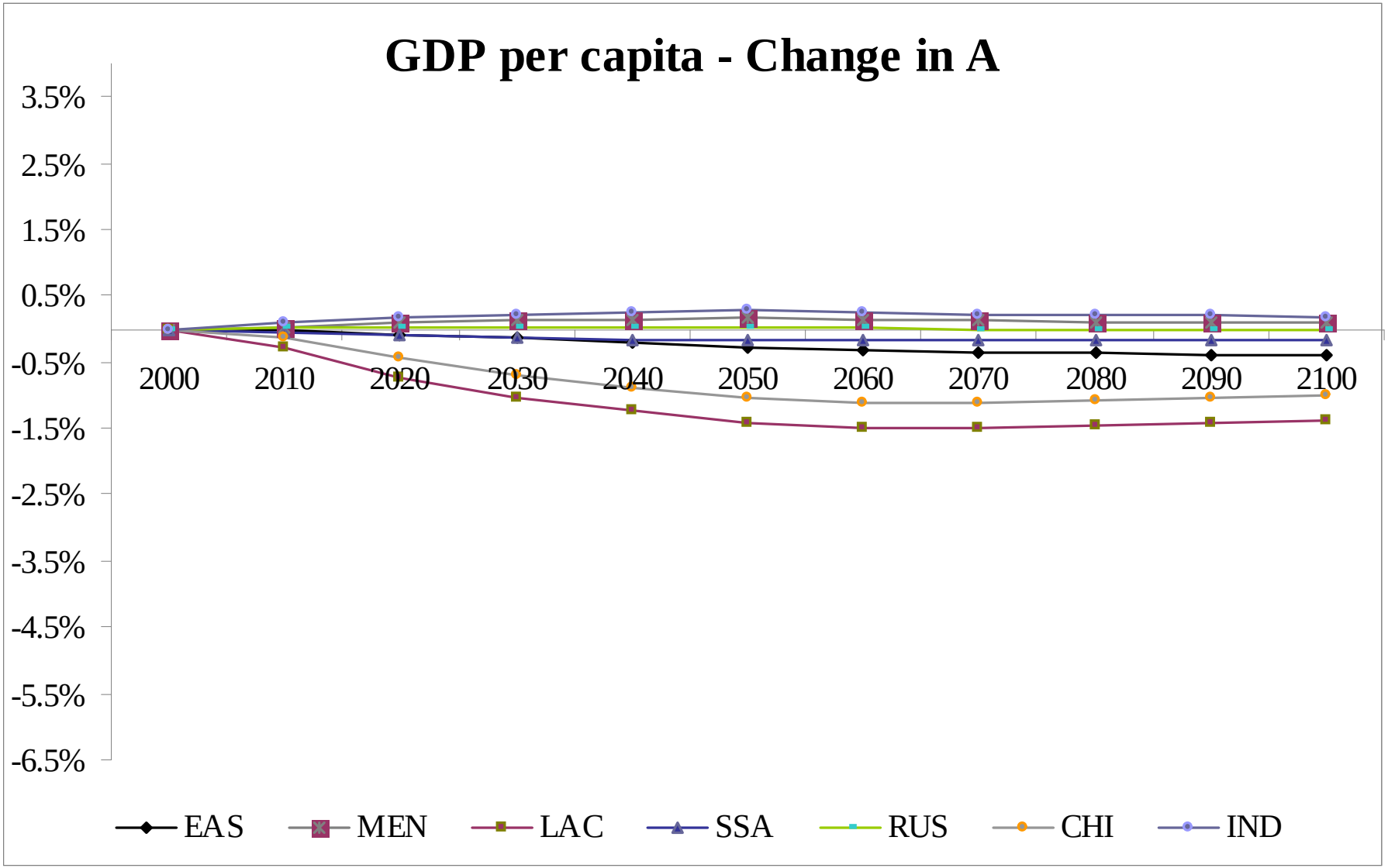

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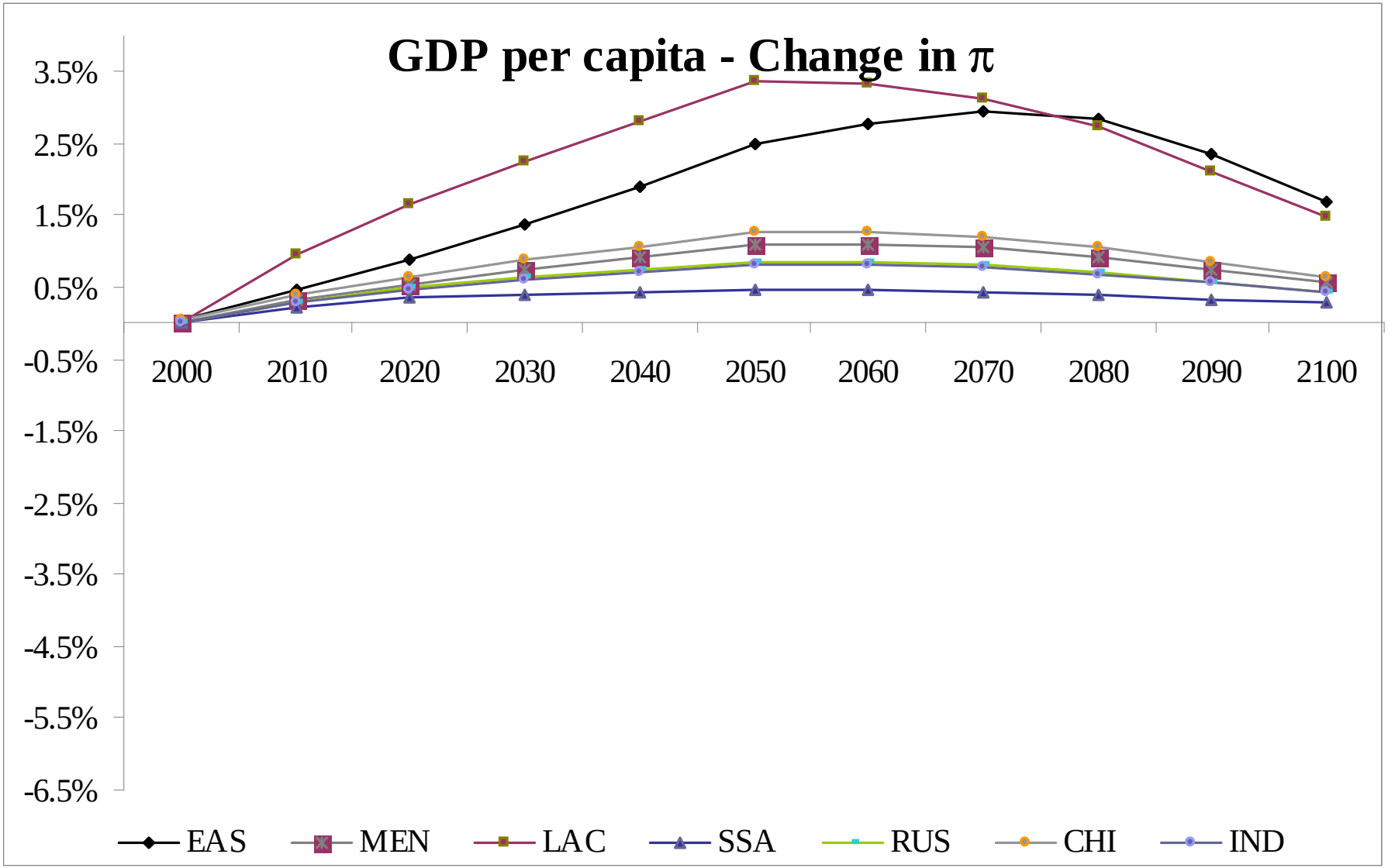

3. Results - Total effect on GDP per capita

- Demography: negative effect (strong for EAS, LAC)
- Skill composition and Harrod neutral TP: negative or positive - relatively small effect
- Risk premium: positive and strong
- Total effect: Negative for EAS, LAC, CHI, SSA. Positive but small for MEN, RUS, IND
- World GDP increases by 5.6% (elasticity to S-N 'skilled' migration = 0.36). Winters and Walsmley found an elasticity of 0.16 to S-N 'unskilled' migration.

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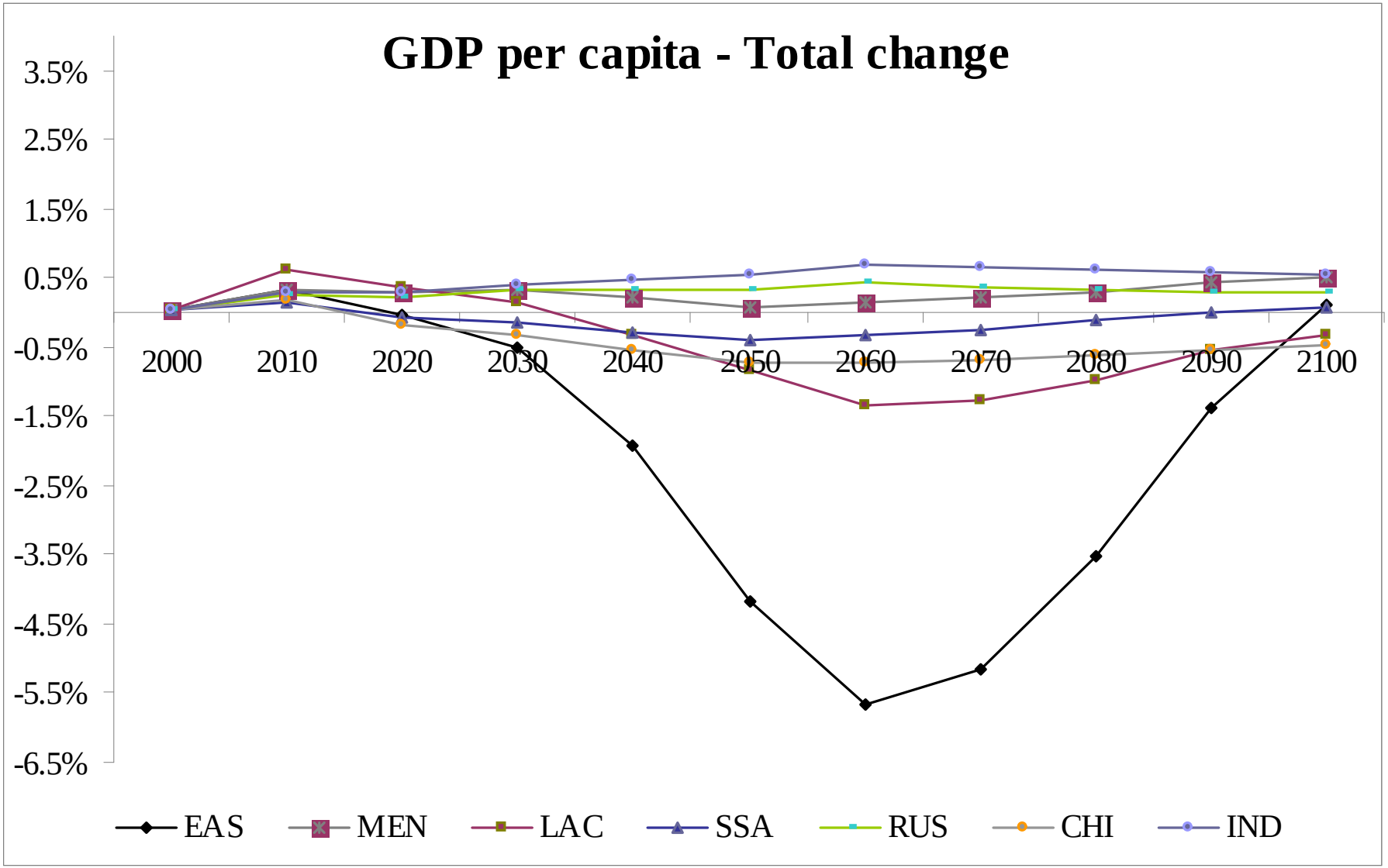
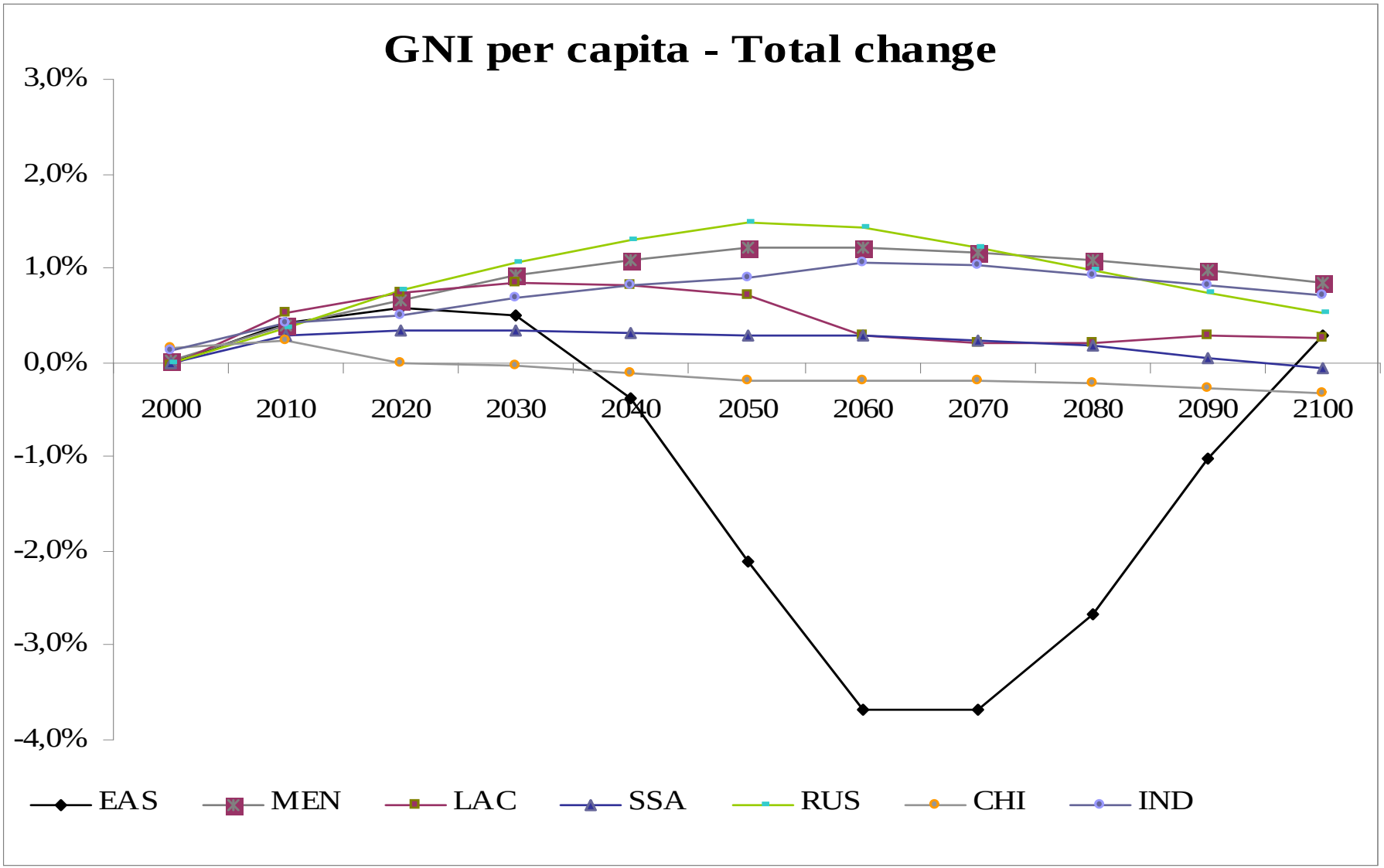


3. Results - Total effect on GNI per capita

- **GNI = GDP - Indirect taxes + Foreign aid + Remittances + Net inflows of capital income**
- Ambiguous changes in GDP per capita
- Insignificant changes in indirect taxes and foreign aid
- Lower outflows of capital income (more investments in the North despite decrease in π)
- Higher inflows of remittances in the South (increase asset accumulation after 2020)
- Increased interest rates

3. Results - Total effect on GNI per capita



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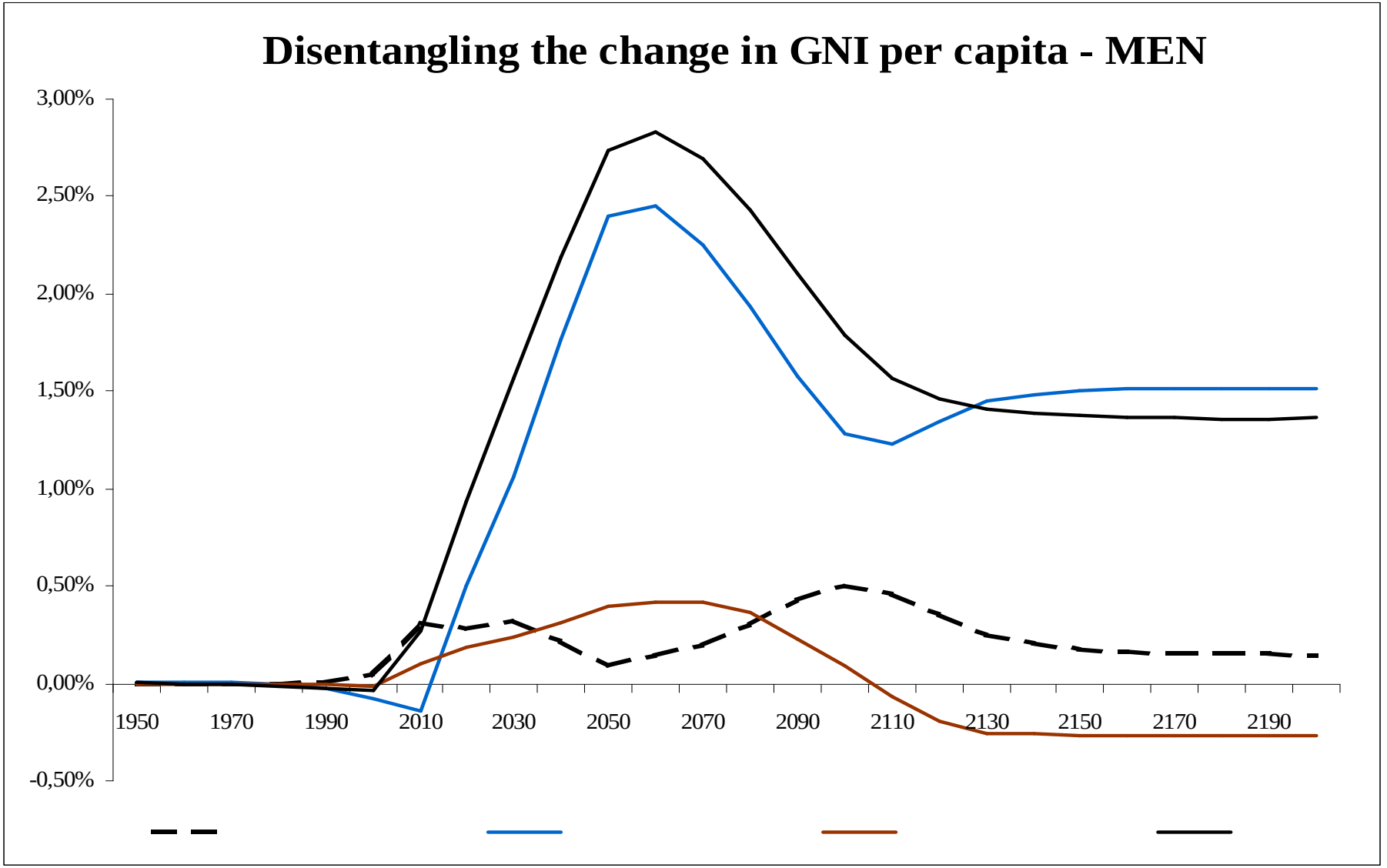
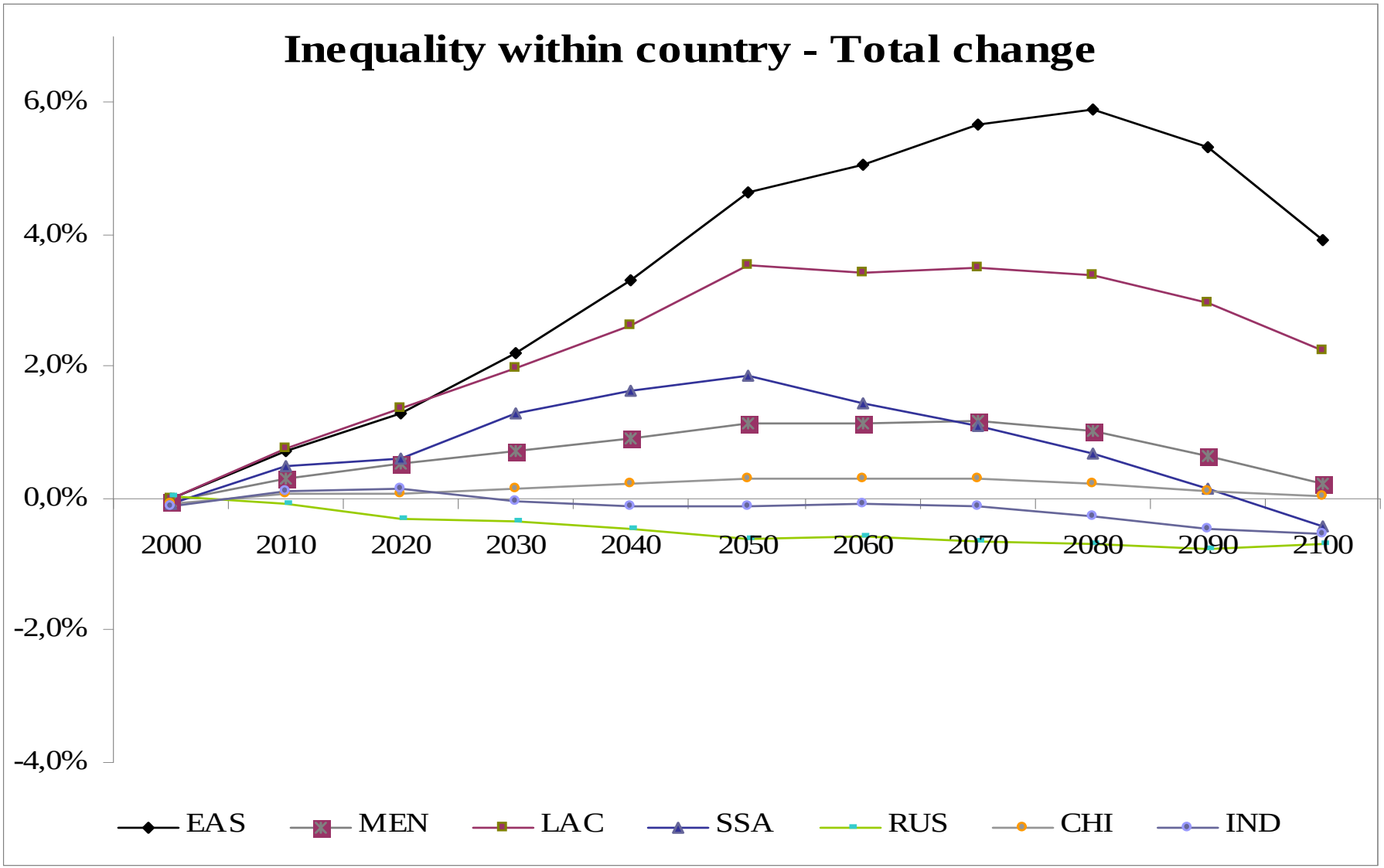


3. Results - Total effect on inequality

- 'Skilled/unskilled inequality' = GNI per capita of the skilled / GNI per capita of the unskilled
- Demography: less young educated workers (higher inequality)
- Skill composition: if no brain gain, less educated workers (higher inequality)
- Remittances: equal sharing reduces inequality but the effect is small (except SSA, RUS)
- Total effect: increase in inequality, except in IND and RUS (brain gain)

3. Results - Total effect on inequality



4. ROBUSTNESS ANALYSIS

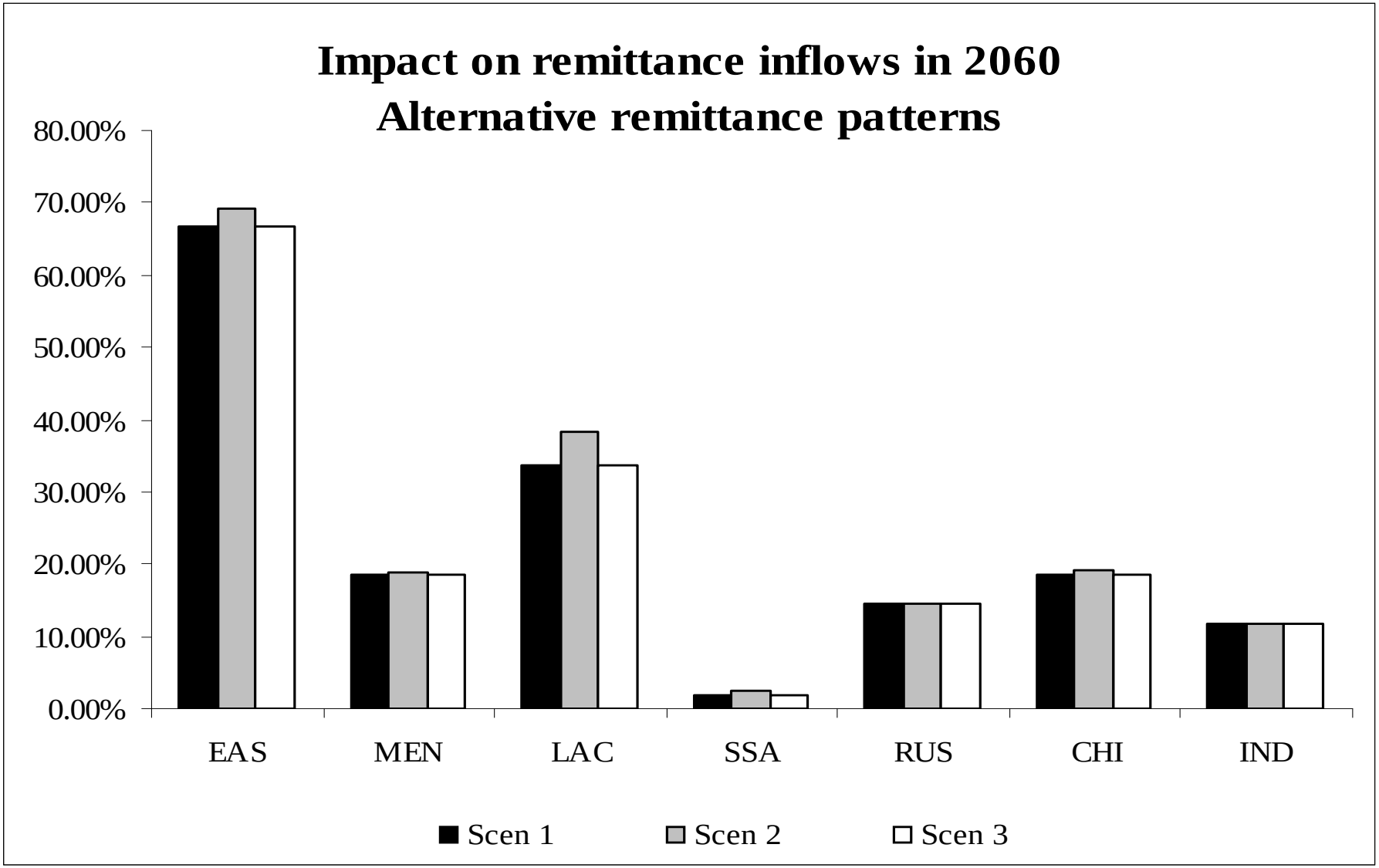
4.1. Robustness - Alternative remittance behaviors

Alternative remittance behaviors - reminder:

- Scenario 1 (central): $\gamma^s = 0.7\gamma^u$ and equal sharing abroad
- Scenario 2: $\gamma^s = \gamma^u$ and equal sharing abroad
- Scenario 3: $\gamma^s = 0.7\gamma^u$ and (un)skilled$\rightarrow$(un)skilled abroad

- Same time-path than in scenario 1 $\Rightarrow$ focus on the effect in 2060 (except for inequality)
- Slight increase in remittances in scenario 2 (after re-calibration of the baseline)
- Negligible effect on GDP and GNI per capita

4.1. Robustness - Alternative remittance behaviors



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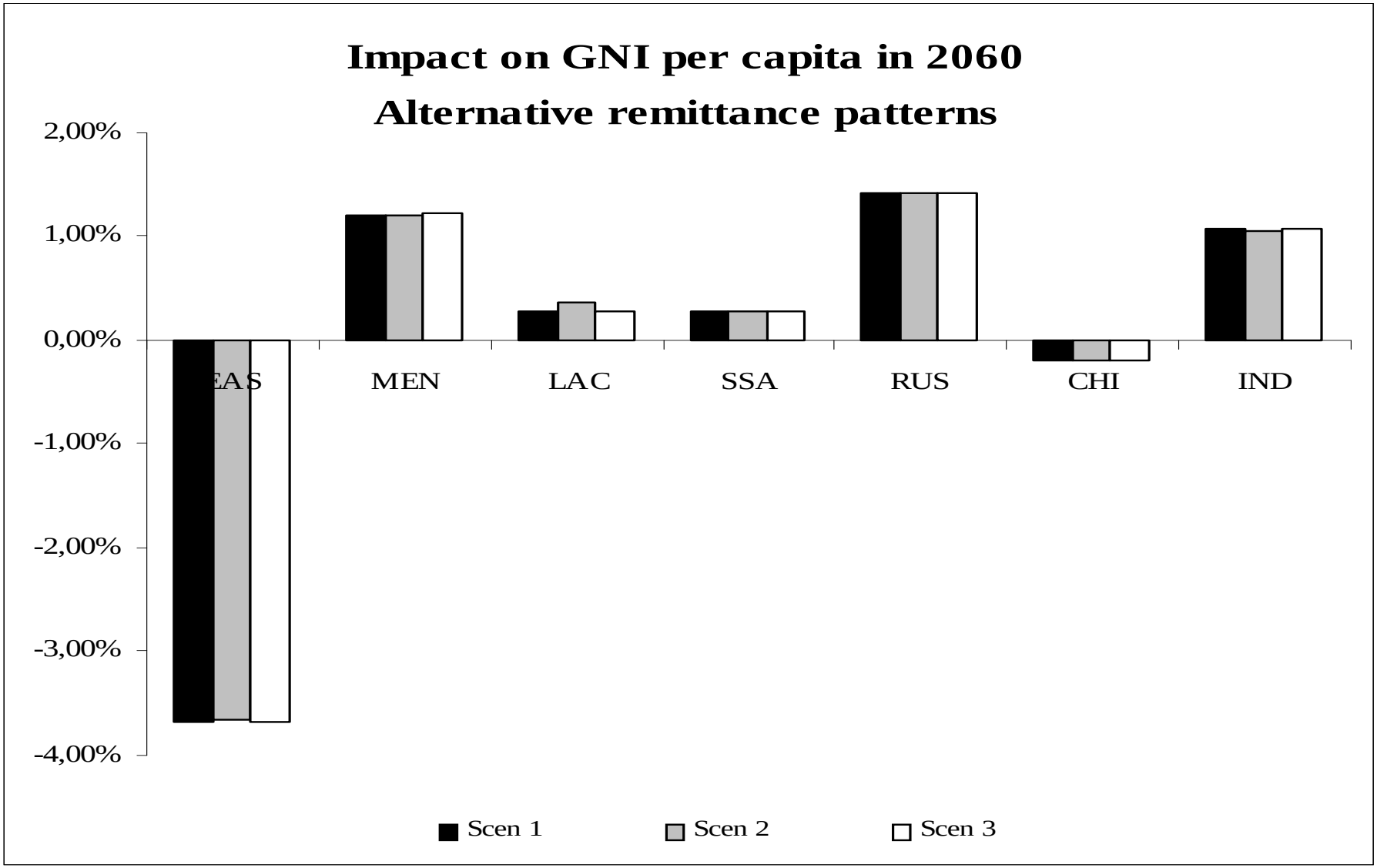


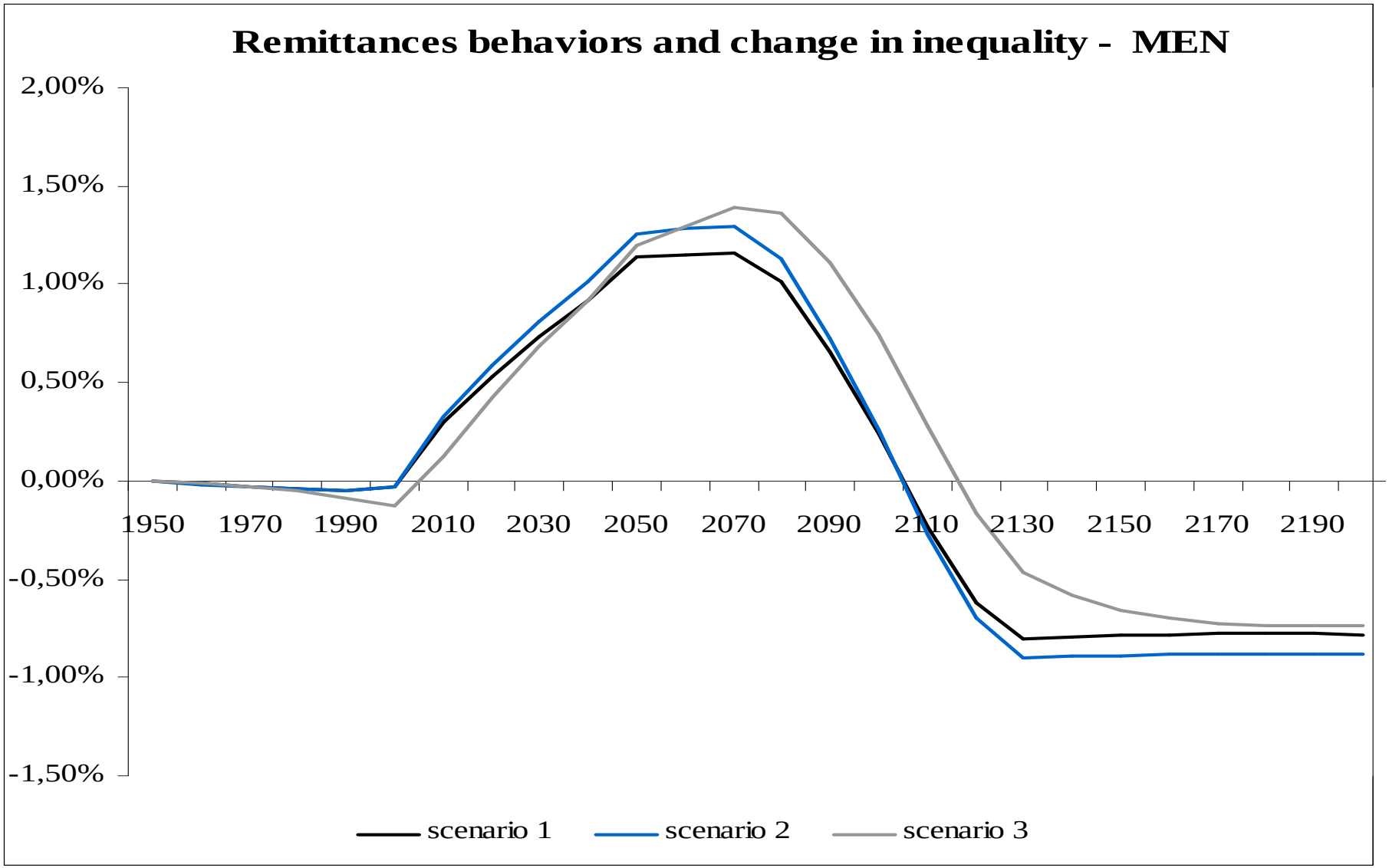
4.1. Robustness - Alternative remittance behaviors

- Scenarios 1 and 2 generate identical relative changes in inequality
- Scenario 3 usually generates higher relative changes in inequality in the long-run

In scenario 3, unskilled recipients receive less than skilled recipients (in the baseline and after the shock)

- In the "medium term" (2000-2050), lower relative changes in remittances for the skilled compared to the baseline (because the baseline level of inequality is high)
- In the long-run, more inequality
- Example of the MENA region

4.1. Robustness - Alternative remittance behaviors



4.2. Robustness - Brain drain versus brain gain

Brain drain = No ex-ante effect on education; Only ex-post loss of human capital

- Same time path than in scenario 1 $\Rightarrow$ focus on the effect in 2060
- More pessimistic predictions for GDP and GNI per capita
- More pessimistic predictions for inequality (skilled labor is more scarce)

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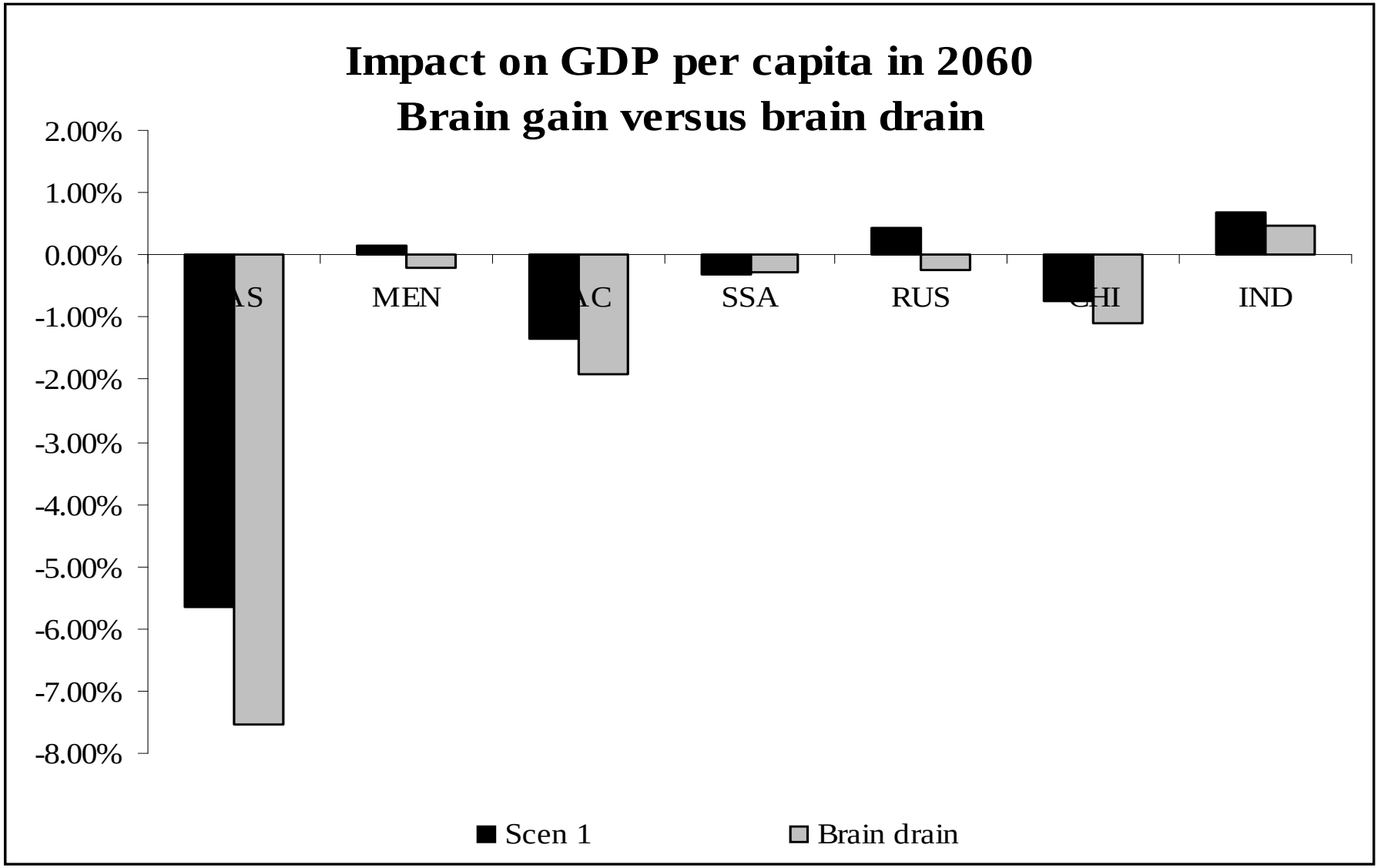

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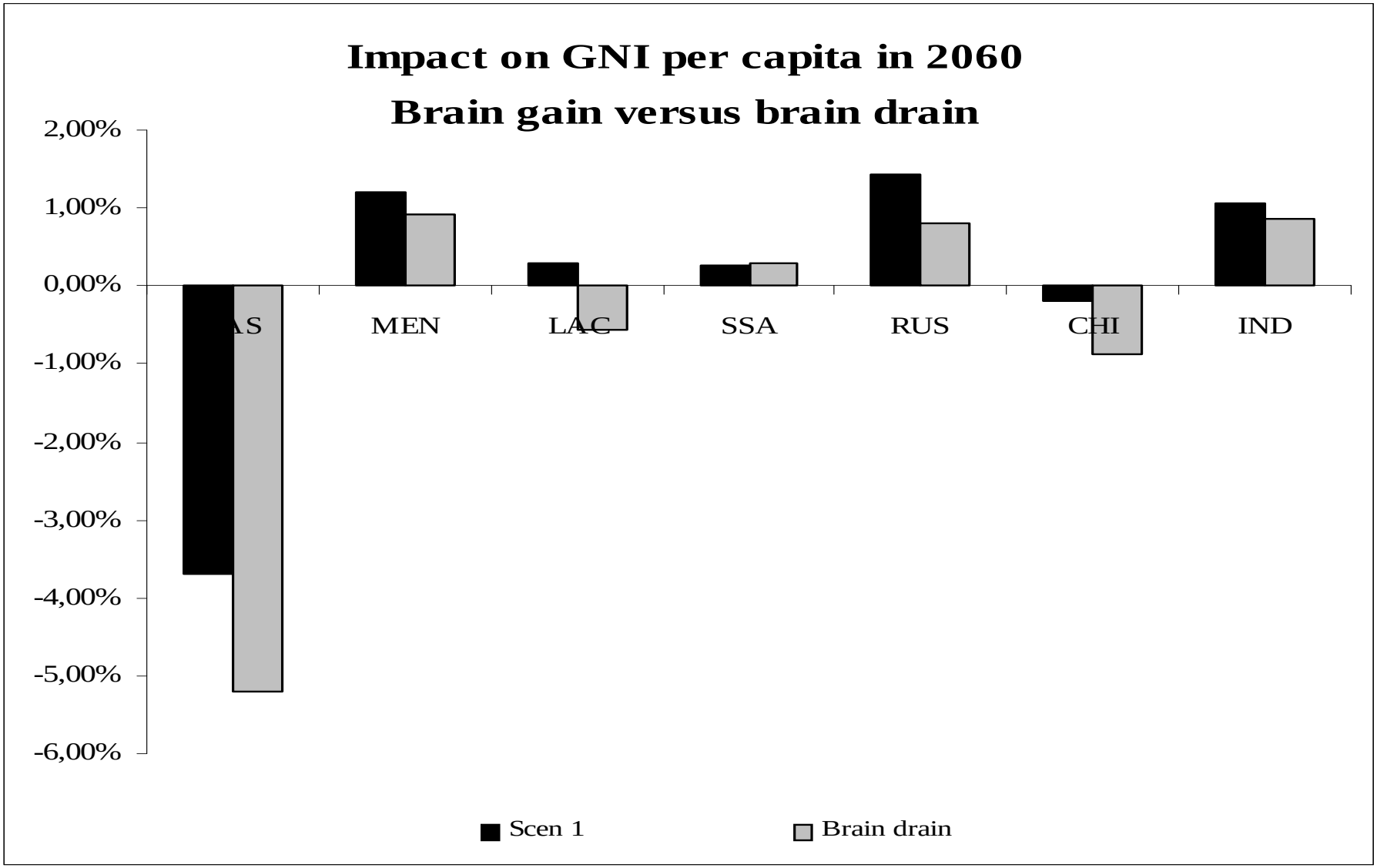

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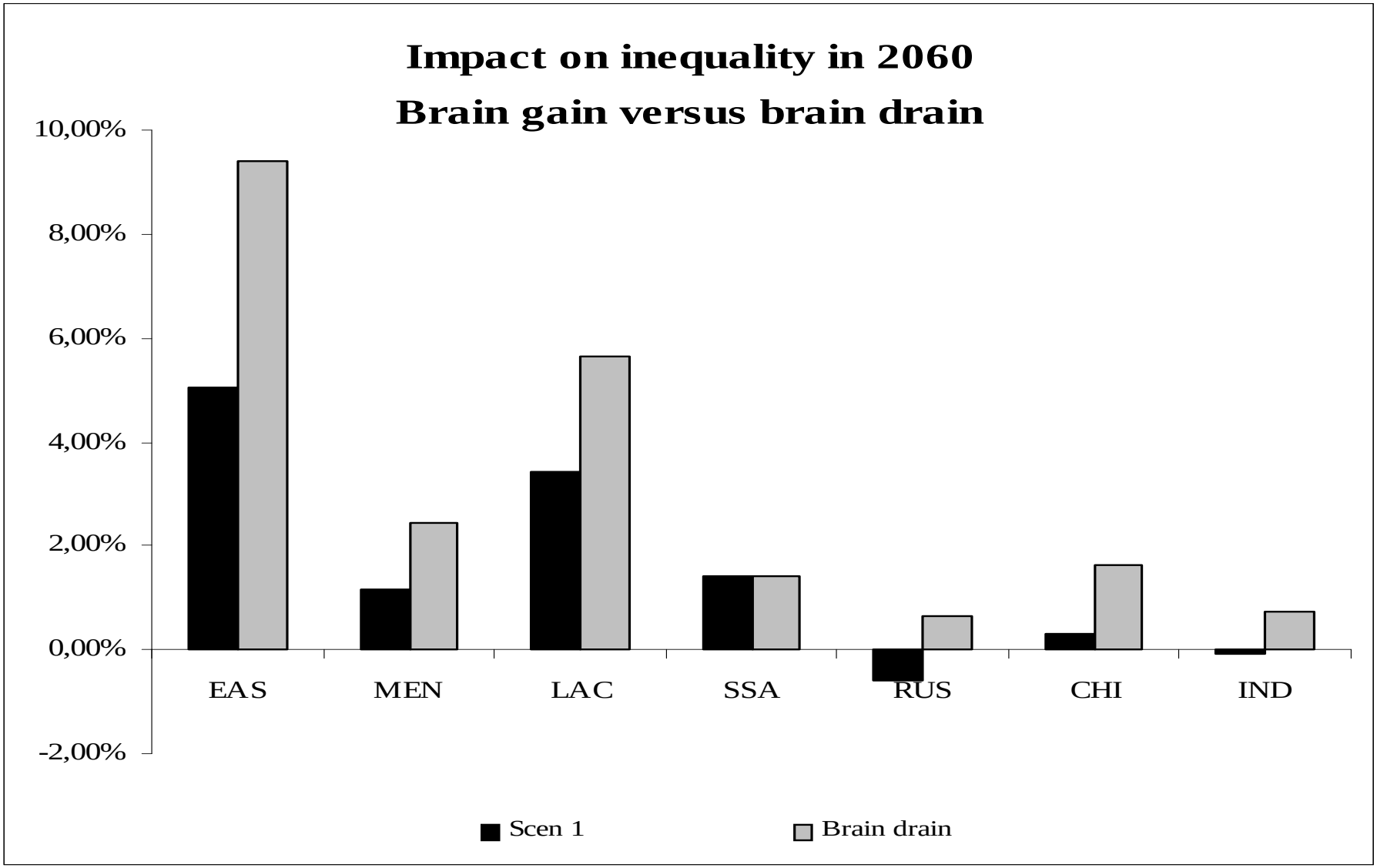
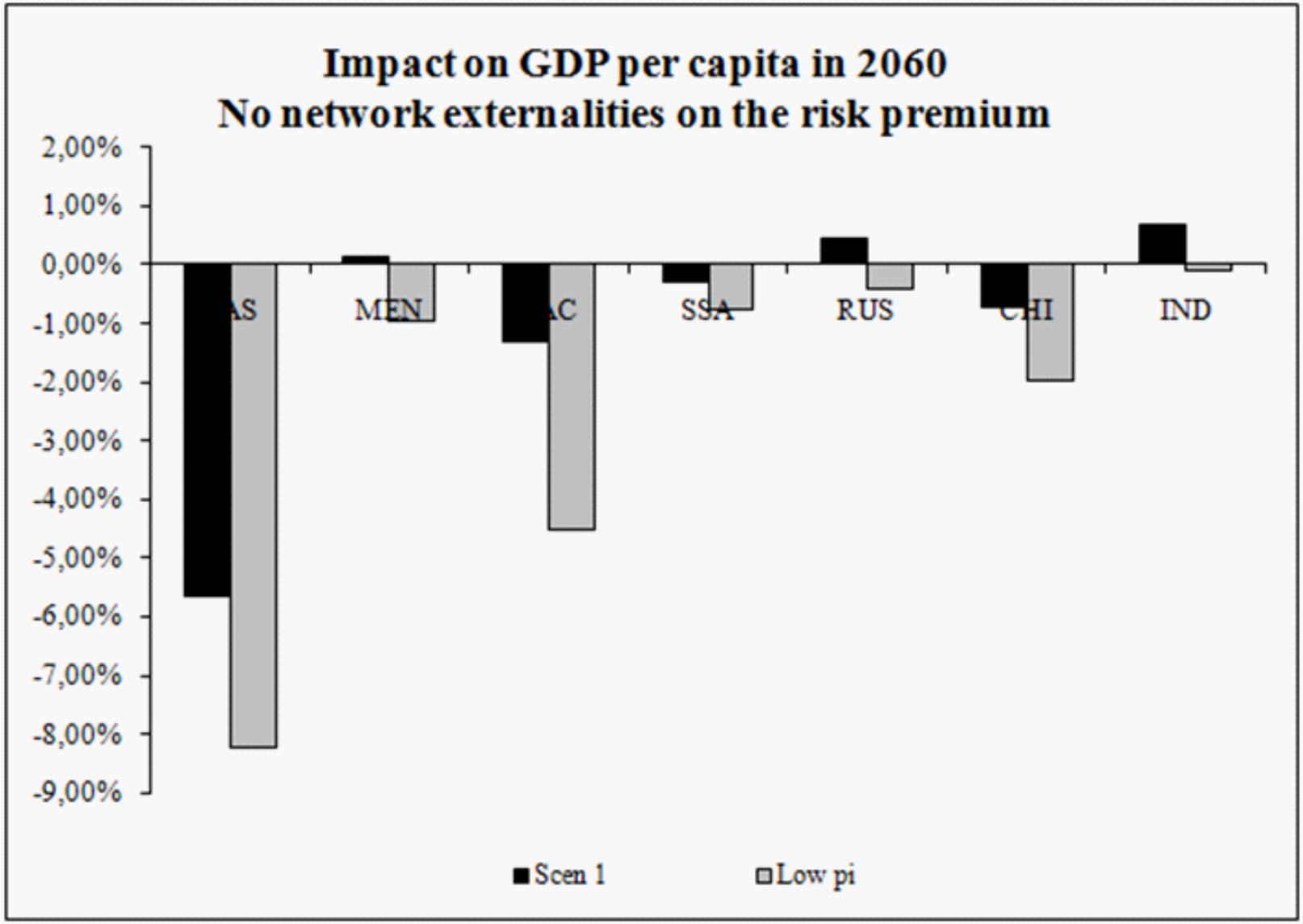


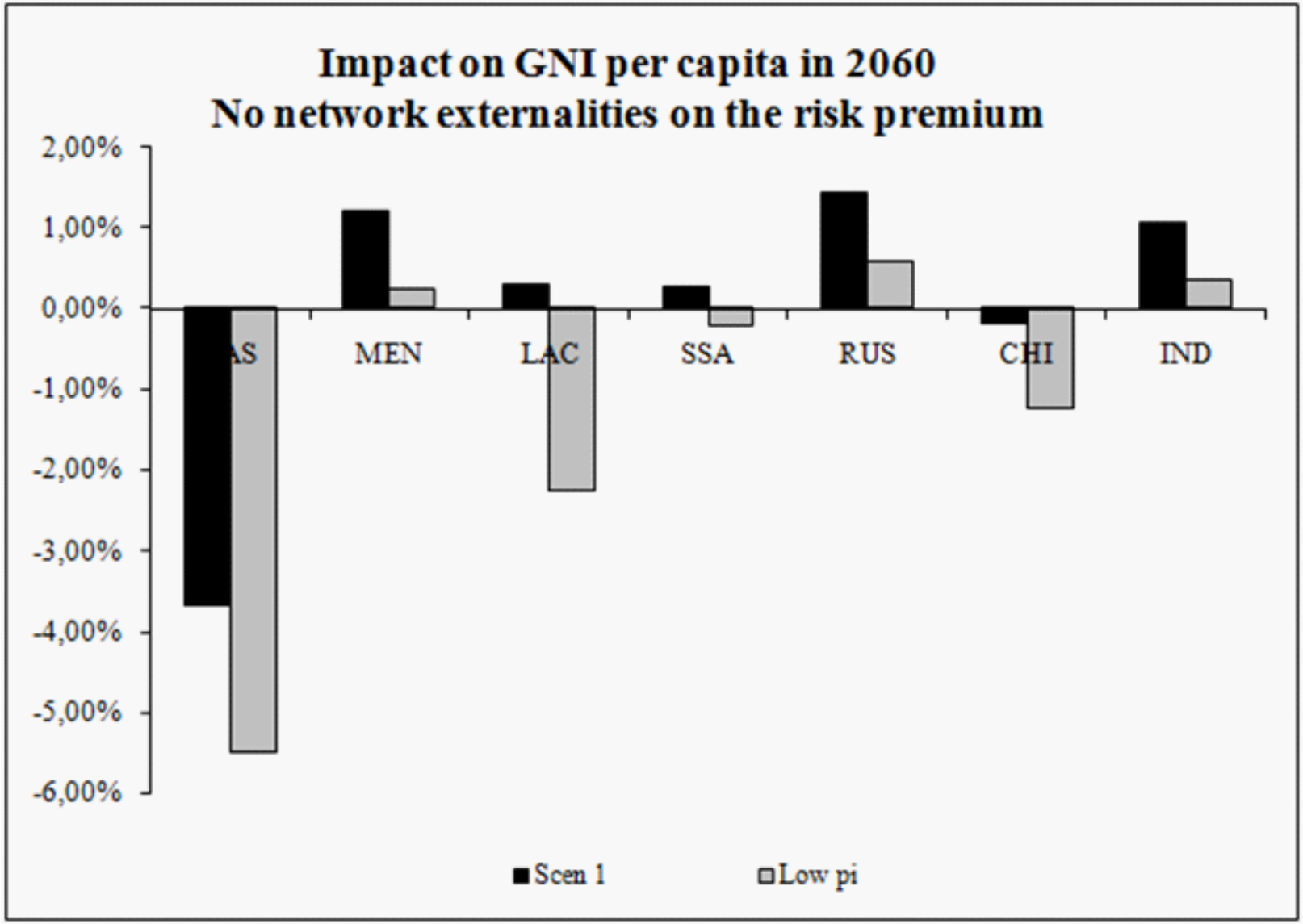
4.3. Robustness - No network effects

- Effect of skilled diaspora on π_t calibrated using elasticity of FDI to diaspora (Docquier and Lodigiani, 2007) and assuming that FDI represent 12.5% of total investments. Scenario 1: long-run elasticity from the panel regression $= 0.75$
- Alternative scenario: no diaspora externalities on π_t
- Same time path than in scenario 1 $\Rightarrow$ focus on the effect in 2060
- More pessimistic or less optimistic predictions for GDP and GNI per capita
- No effect on inequality

4.3. Robustness - No network effects



4.3. Robustness - No network effects



4. CONCLUSION

Conclusion - New insights

Heterogeneity in the global impact of a higher brain drain:

- Effect on GDP per capita can be small/positive (MEN, RUS, IND), small/negative (CHI, SSA), strong/negative (EAS, LAC)
- Effect on GNI per capita is positive in all regions (except in EAS, CHI and LAC under some variants)
- Effect on inequality is positive in EAS, LAC, MEN, SSA; negative in IND and RUS; status quo in CHI

Conclusion - Possible extensions

- Extrapolating country-specific results
- Improve the modeling of children costs, in particular education costs of young emigrants (public versus private, local versus foreign)
- Sensitivity analysis to saving behavior in the South (what if unskilled workers are myopic in LDS'c?)
- Distinguishing agricultural sector (traditional, feudal) and city sector (human capital intensive) in the South
- Effect of brain drain on fertility at origin (skilled workers have fewer children, migrants can transfer fertility norms, migration prospects can affect the quality/quantity tradeoff): endogenizing the population growth rate

Conclusion - Theoretical insights

- The brain drain/brain gain controversy plays a minor role on the aggregate
- Idem for the endogeneity of productivity growth
- Results are robust to various assumptions about remittances
- The demographic impact should not be disregarded in aging societies
- Diaspora externalities (trade, FDI) play an important role.