Research on environmental, economic, and social impacts of resource circulation systems in Asia

Preliminary assessment of iron recycling policy in Japan

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Overview of this study

- A part of 3-year research project funded by the Ministry of the Environment Japan on Policy Study of Economy and Environment on resource circulation policy.
- The whole research project identified 3 priority issues :
  - Assessment of impacts of resource scarcity and of increasing recycling rate (indicator of 3R as a whole).
  - Comparison of resource tax, waste discharge fee and EPR from the perspective of reduction part of 3R.
  - Comparison of domestic recycling and regional recycling of E-waste focusing on reuse and recycle parts of 3R.
- This study is an preliminary attempt to address the first issue: assess impact of resource scarcity and increasing recycling rate:

Final objectives of this study and preliminary target

- Final objectives of this study:
  - Model development: develop multi-regional CGE that can assess the impacts of resource supply constraints and recycling of supply constrained resource, reflecting costs of recycling compare to production with virgin material. Ideally indicators are not only social welfare (EV) and GDP but also unemployment rate.
  - Scenario development: as exogenous shocks to the model, describe resource supply constraints of iron (and other key metals if possible) reflecting engineering reality such as relation between supply quantity and marginal mining cost (marginal mining cost curve).
  - Database development: prepare database for the model (SAM) with explicit recycling sector.
- This study is preliminary in the following sense:
  - Single country model for Japan. Perfect employment assumption (no unemployment). No cost implications of recycling.
  - Iron supply constraint is modelled in very crude manner. No reflection of marginal mining cost rising.
  - No explicitly recycling sector in the database. Assume land transport sector (otp) contain it.

Multi-sectoral Ramsey growth model (dynamic CGE model)

- Japan model (single country): World commodity prices are given (small country assumption)
- 14-sector: Steel sector and major purchasing sectors of steel, supplier of iron ore (mining), recycling sector (land transport).
- Government and household: Household dynamically optimises saving and consumption based on future expectation.
- Conventional specification of production functions: CES function among factors, Leontief function between value-added and intermediate inputs.
- Factor inputs: skilled and unskilled labour, capital, land, natural resource. Labour and capital are mobile across sectors, while land and natural resources are sector-specific.

Sectoral aggregation: relation to iron/steel sector

Source of intermediate input of steel

Sector	Code	Share
Ferrous metals	i_s	59.74%
Electricity	ely	10.05%
Business services nec	obs	5.97%

Sales of steel product

Sector	Code	Share
Ferrous metals	i_s	46.58%
Machinery and equipment nec	ome	14.06%
Metal products	fmp	13.13%
Motor vehicles and parts	mvh	8.64%
Construction	cns	7.56%

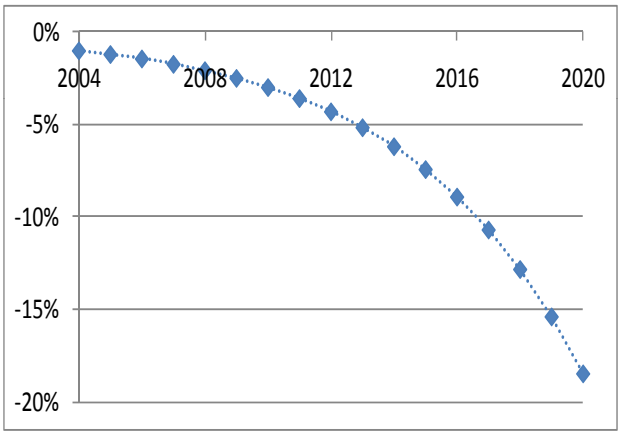
Sector aggregation

Sector	Code
Agri sectors	xag
Energies	xen
Minerals nec	omn
Petroleum, coal products	p_c
Ferrous metals	i_s
Metal products	fmp
Motor vehicles and parts	mvh
Machinery and equipment nec	ome
Other manufactures	xmf
Electricity	ely
Construction	cns
Land transport	otp
Transport nec	tpn
Other services	xsv

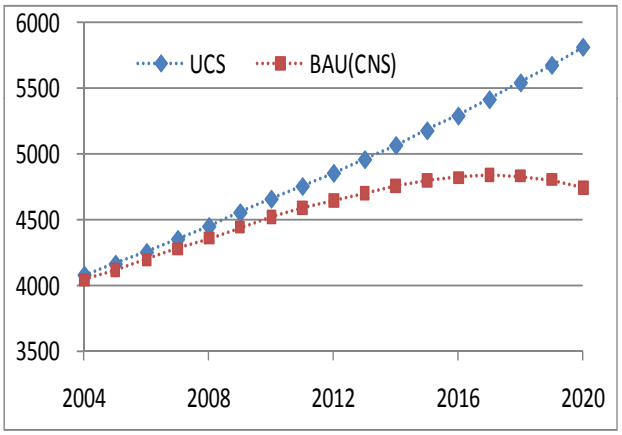
Modelling iron ore supply constraint and scrap iron recycling

- Iron ore supply constraint scenarios:
  - Intermediate input from mining sector (omn) to iron/steel sector (i_s), QINT(i_s, omn), represents supply of iron ore.
  - We are developing marginal mining cost curve of metals as a basis of supply constraint scenarios. At this moment, we give reduction shocks to QINT(i_s, omn) under unconstrained scenario.
- Modelling scrap iron recycling:
  - In GTAP database, Japanese scrap collection is contained in land transport (otp) sector data.
  - Scrap iron recycling is modelled as increasing shocks to QINT(i_s, otp), which is intermediate input from recycling sector (otp) to iron/steel sector (i_s). This input perfectly substitute iron ore input (no price or cost differentiation). This shock induces increased supply of Armington composite of otp product, which means not only domestic recycling sector but imported “recycling service” can subsitute iron ore input.

Resource supply constraint scenario

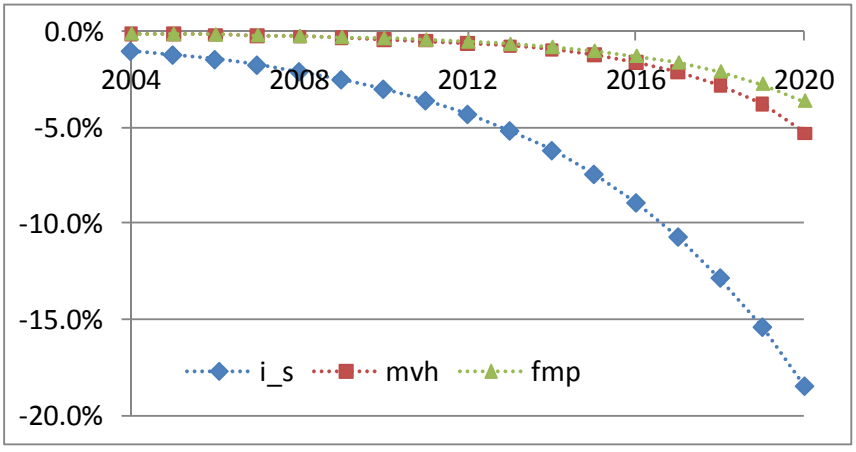


Reduction shocks to unconstrained (UCS) values

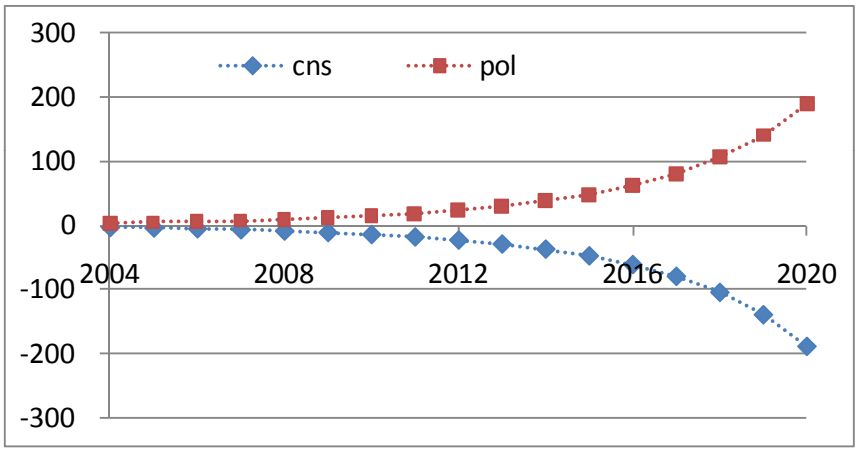


Iron ore supply paths under unconstrained (UCS) and constrained (BAU) scenarios

Impact of resource constraint on sectoral output (BAU-UCS)



Impacts of resource constraint and recycling on social welfare (EV)

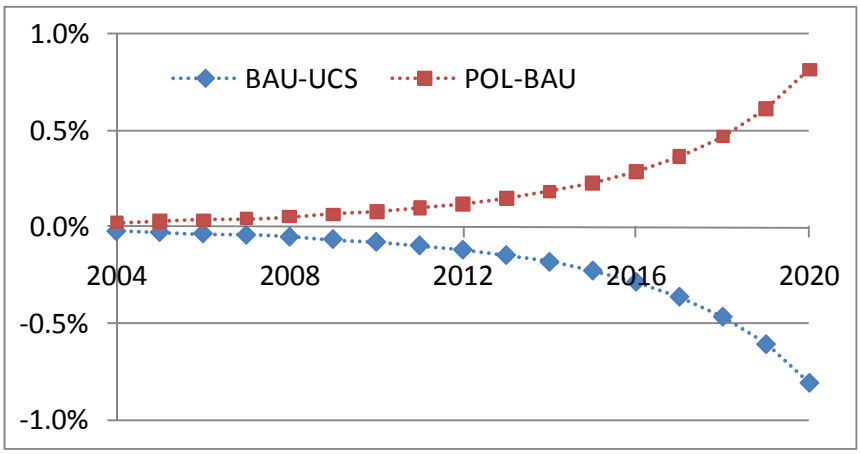


EV (USD per capita) of resource constraint (CNS) and recycling policy (POL)

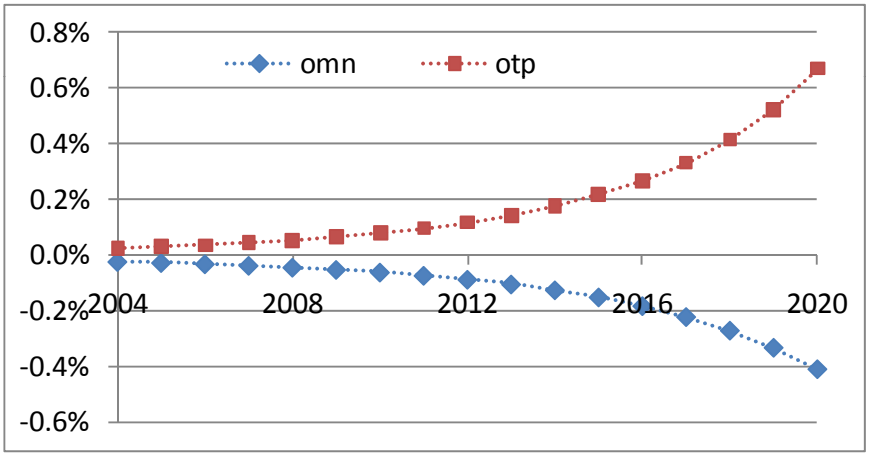
Net present value of EV (USD per capita)

CNS	POL
-741.0	744.4

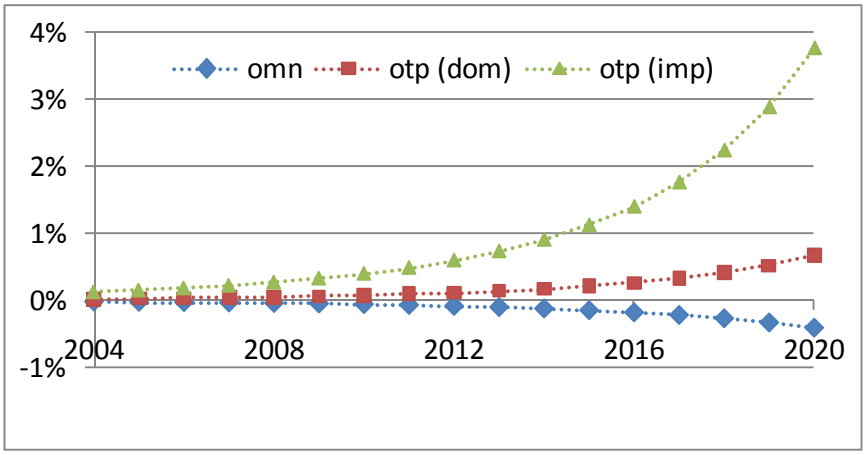
Impacts of resource constraint and recycling on Real GDP



Impact of scrap iron recycling on sectoral output (POL-BAU)

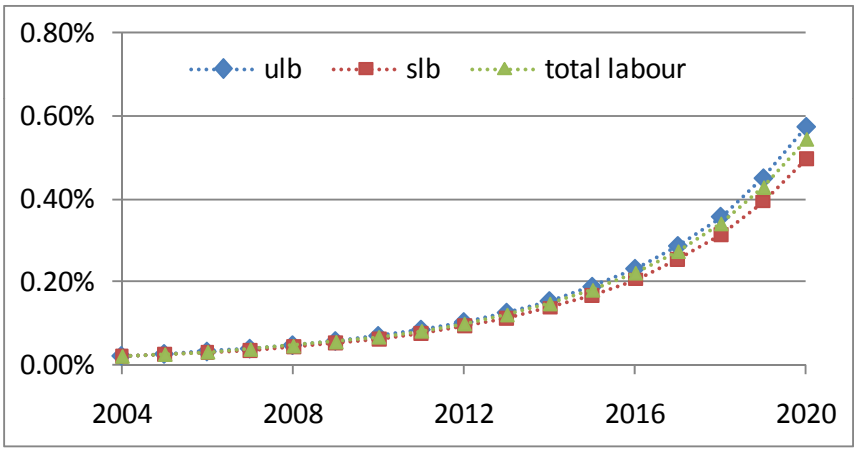


Impact of scrap iron recycling on sectoral output (POL-BAU)

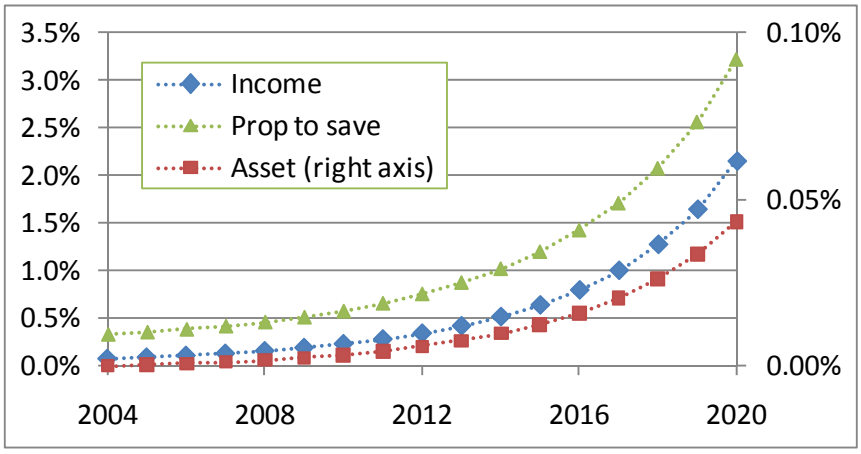


- For recycling sector, not only domestic output but also import increase (though the magnitude of import is around 2 – 3 % of domestic output)

Impact of scrap iron recycling on “otp” sector labour input



Impact of scrap iron recycling on household



Discussions

- Impacts of iron ore supply constraints
  - Due to our technological assumption (Leontief function for intermediate input), iron ore supply constraints directly reduces iron/steel sector output.
  - Major steel buying sectors e.g. metal products (fmp) and car manufacturing (mvh) are negatively affected but the magnitude is much less than iron/steel sector.
  - Nearly 20% reduction in iron/steel sector reduces national real GDP by 0.8%.
- Impacts of scrap iron recycling
  - 100% recovery of iron/steel sector output by scrap metal recycling has significant positive impacts on economy and social welfare. Our results show that recycling scenario achieves higher social welfare and real GDP even than unconstrained scenario.
  - Recycling scenario is associated with higher household income and propensity to save, which result in more household asset accumulation at the end of simulation period.

Achievement and next steps

- Achievements
  - Resource scarcity was modelled as quantity constraint (on intermediate input of steel sector from mining sector) in dynamic CGE framework. Many CGE models cannot handle this type of constraint.
  - Scrap iron recycling is modelled without explicitly separate recycling sector.
- Next steps
  - Once we establish marginal mining cost curves for metals, we will develop resource constraints scenario (quantity constraint on corresponding intermediate inputs) consistent with marginal mining cost curves.
  - Explicitly model recycling sector. Reflect cost for recycling.
  - Elaborate technology specification for steel sector to differentiate production with scrap iron.
  - Extend the model to multi-regional model.

Thank you for your attention.

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