

Welfare measurements with heterogeneous agents.

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Motivation

THE MISSING INDEX

- A policymaker designing a stimulus package chooses among variants differing in size, duration and targeted consumers, evaluated in a stochastic infinite-horizon model with heterogeneous consumers.
- There the classic money-metric indices generate ambiguous predictions: recommendations may depend on the assumed status quo or on the order in which alternatives are implemented. Formally, the index is not additive on a set of policies (Roberts 1980, Slesnick 1991).
- The paper offers a positive result: in a small open economy with heterogeneous consumers, money-metric welfare is nearly additive for transient policies when consumers are patient.

Money-metric welfare indices

DEFINITIONS AND THE CONSISTENCY FAILURES

Following Hicks (1939) and McKenzie (1983), fix a consumption flow x as numeraire. For consumer i with lifetime utility V_i , wealth w_i and a policy experiment $p \rightarrow p'$, the equivalent and compensating variations solve

$$V_i(w_i + EV_i; p) = V_i(w_i; p'), \quad V_i(w_i; p) = V_i(w_i - CV_i; p').$$

- Additivity would require the index of a bundle of policies to equal the sum of the indices of its elements. It fails for general preferences, and with its order-independence of rankings.
- A policy-relevant index must also respect the existing consumers' heterogeneity, which makes interpersonal aggregation the second obstacle.

Motivating example

OPEN ECONOMY, TWO CRRA CONSUMERS

Each consumer $i = 1, 2$ maximizes utility over deterministic consumption streams subject to a sequence of budget constraints,

$$\max \sum_{t=0}^{\infty} \beta^t \frac{(c_t^i)^{1-\theta_i} - 1}{1 - \theta_i} \quad \text{s.t.} \quad c_t^i + q_{t+1} w_{t+1}^i = w_t^i + A_t^i l_t^i,$$

with bond prices q_{t+1} determined exogenously in international markets, inelastic unit labor supply $l_t^i = 1$ and labor productivity A_t^i .

- Policies perturb fundamentals, prices and productivities, in the initial periods. The question is how the aggregate equivalent variation of such perturbations behaves as $\beta \rightarrow 1$.

Example: the surplus formula

LIMIT WELFARE FROM ONE CLOSED FORM

For policies affecting fundamentals in period zero, the limit welfare effects follow from a closed-form surplus function (eq. 1 of the paper),

$$S_p = S(Y_0, q_1; \theta_1, \theta_2),$$

a function of aggregate income Y_0 and the price q_1 of the bond paying in period one, both under the assumed policy, and of the two risk-aversion coefficients.

- For any experiment $p \rightarrow p'$ the limit equivalent variation is the difference $S_{p'} - S_p$.
- The surplus consists of a terms-of-trade component and an aggregate-income component, so the index in the patient-consumer economy is nearly additive: bundles can be evaluated component-wise.

Admissible policies

ASSUMPTION 1 · VANISHING PERTURBATIONS

The general framework restricts admissible policies to transient ones.

- **Assumption 1.** For policy p there exist constants $C > 0$ and $\Delta \in (0, 1)$ such that

$$|\Delta q_{ht}| \leq C \Delta^t, \quad |\Delta A_{ht}^i| \leq C \Delta^t$$

for all periods t , histories h^t and consumers i . The collection of all such policies is denoted $\mathcal{P}$.

- The class covers technological and income shocks, sales and service taxes, lump-sum transfers, subsidies, public spending and social safety-net programs, provided their effects die out geometrically.

Well-posedness and the main theorem

PROPOSITION 1 AND THEOREM 1

- **Proposition 1.** For any pair $p, p' \in \mathcal{P}$ and discount factor $\beta < 1$, the equivalent variation $EV_{p,p'}$ exists and is unique.
- **Theorem 1.** Aggregate equivalent variation has an additive limit, measurable with respect to aggregate income:

$$\lim_{\beta \rightarrow 1} EV_{p,p'} = \frac{S(\Delta q^0, \Delta Y) - S(\Delta q^{0'}, \Delta Y')}{\bar{v}_x}.$$

- Utilities become unbounded as $\beta \rightarrow 1$, yet the equivalent variations have well-defined limits, and the limits satisfy $|\lim EV_{p,p'}| = |\lim EV_{p',p}|$: status-quo dependence vanishes.

Aggregation without Gorman

A BYPRODUCT FOR THE AGGREGATION LITERATURE

- Classically, average equivalent variation depends on the distribution of endowments only through the aggregate endowment if and only if preferences are in Gorman polar form (Gorman 1953), a restriction strongly rejected empirically (Blundell et al. 2007, Lewbel and Pendakur 2009).
- In the patient-consumer limit the surplus, and hence the limit equivalent variation, is unaffected by the income distribution: aggregation holds for arbitrary preferences when policies are transient.
- In the example, two counterfactuals with identical aggregate output $Y_0 = 6$ but different allocations across consumers generate the same normative predictions, and the aggregation gap $Ag\%$ converges to zero as $\beta \rightarrow 1$.

| Application: the Polish economy

CALIBRATION FROM MICRO-ECONOMETRIC DATA

- Preference and income distributions are extracted from Polish micro-econometric data: the productivity distribution from household-level sources and risk-aversion heterogeneity based on the Polish risk-taking preference micro-data of Falk et al. (2018), with the two distributed independently.
- The quarterly discount factor is $\beta = 0.9924$, corresponding to the annual value 0.97 typically assumed for Poland.
- Uncertainty enters through global and idiosyncratic shocks: labor markets are in a normal state or a slowdown, consumers are employed or unemployed, and the calibrated transition matrices yield an unconditional employment rate of 0.9161, matching average BAEL rates.

Experiment: recovery paths from the pandemic slowdown

FACTUAL VS STIMULUS VARIANTS

- The experiment compares recovery paths from the slowdown triggered by the COVID-19 pandemic. The labor market starts in recession, with the period-zero employment rate set to 0.94, the empirical value for January 2021, and initial beliefs determined accordingly.
- The factual policy is a recovery path without intervention; counterfactual variants of a stimulus package differ in how and when they perturb productivities.
- For each variant the welfare effect is computed exactly and via the additive surplus approximation, so the approximation error is observable by construction.

| Accuracy of the additive approximation

QUANTIFIED ERROR BOUNDS

- For policies affecting the economy within the first four quarters the approximation error is no greater than 1.5% of the total welfare effect.
- For policies affecting the economy within twelve quarters the error is no greater than 5%.
- Accuracy improves with the discount factor and with shorter policy duration, so a decision-maker can reach arbitrary accuracy by restricting attention to sufficiently short-lived policies.

| Implications

FOR APPLIED POLICY EVALUATION

- Welfare statements in heterogeneous-agent models gain a consistent money-metric foundation for the empirically dominant case of short-lived policies evaluated by patient consumers.
- Policy bundles can be evaluated component-wise and summed, and rankings are invariant to the order of implementation up to the quantified approximation error.
- The result connects the applied macro practice of reporting consumption-equivalent welfare numbers to an explicit preference foundation, without imposing Gorman polar form.

Thank you.

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