Modelling the consequences of GST reform for state and territory economies.

Federal Relations Tax Reform Workshop
The University of Adelaide, School of Economics

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Introduction

- While there is no constitutional impediment to the Commonwealth Government unilaterally legislating to change the GST, all major parties back the unanimous state support tenet of the original GST agreement.

- Input to state & territory deliberations on GST change options is likely to include assessments of state & territory economic impacts.

- In the distribution of additional GST revenue that is raised, CGC considerations will influence the dispersion of macroeconomic outcomes between donor / recipient states & territories.

- But do the legislated details of the GST interact with region-specific details of economic activity to generate unanticipated additional economic consequences from changes to the GST?

Introduction (cont.)

- We specify an equation system describing the legislated details of the GST (tax rates, exemptions, refund factors, registration rates, low-value imports, taxation of on-shore non-resident purchases).

- The GST equation system is: (a) used to better specify the distribution of GST payments in the database of a multi-regional CGE model; (b) embedded in the theory of a multi-regional computable general equilibrium (CGE) model (VU Regional Model, VURM).

- VURM is a multi-regional model. For expository purposes, we focus on results for New South Wales and the Rest of Australia (NSW and RoA).

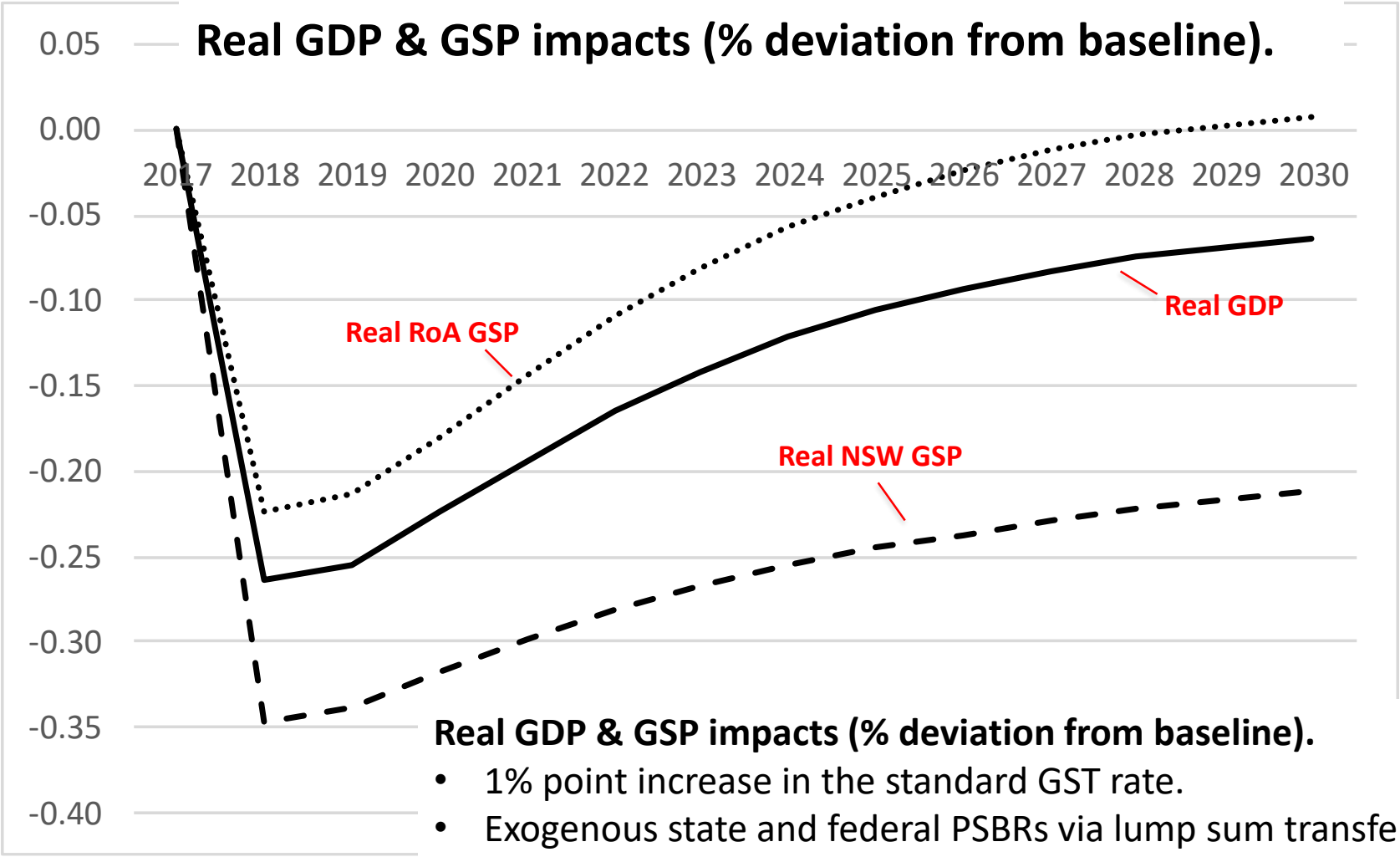
- We use CoPS' CGE solver, GEMPACK, to simulate in VURM the national and regional effects of raising the standard GST rate from 10% to 11%.

Introduction (cont.)

VURM is a dynamic multi-sectoral multi-regional CGE model in the ORANI / MONASH / MMRF tradition. The implementation in this paper features:

- 76 cost-minimising representative industries producing 78 commodities and operating in each of the model's 2 regions.
- 76 investors assembling industry-specific capital or each of the 76 industries in each of the model's 2 regions.
- a representative utility maximising household in each of the 2 regions.
- taxing, spending and transfer activities of a regional (state and local) government operating in each of the model's 2 regions, and a federal government operating nationwide.
- export demands specific to each of 76 commodities from each of the model's 2 regions, and foreign imports of each commodity.
- gradual transition paths for key variables:
  - short-run stickiness in: regional real wages, inter-regional migration rates, regional industry capital stocks.
  - long-run stickiness in: regional employment rates, inter-regional per-capita real disposable income relativities, rates of return on capital.

Introduction (cont.)



Real GDP & GSP impacts (% deviation from baseline).

- 1% point increase in the standard GST rate.
- Exogenous state and federal PSBRs via lump sum transfers.
- Exogenous national BOT/GDP ratio via endogenous APC.

Introduction (cont.)

NSW's relatively low GSP ranking traced to:

1. NSW has a higher share of its economic activity in **export tourism**. Rise in GST hits export tourism. Also, informality in accommodation, restaurants, etc. leads to input taxation.

2. NSW has a higher share of its economic activity in input-taxed **banking, finance, insurance**. Higher intermediate input usage of these commodities relative to RoA.

3. NSW has a higher share of its economic activity in **construction**. Informality leads to input taxation. Feeds into intermediate and capital costs.

4. Per-capita GST allocation renders NSW a **net donor state**, relative to a collections basis for GST distribution.

Introduction (cont.)

- Main features of an ideal GST or VAT system:
  - Only one rate, imposed on final consumption.
  - GST paid on inputs to current production and investment are fully reclaimed.
  - Exports are zero rated.
  - All consumption items are covered (i.e. no exemptions, no zero rated items).

- Reality always more complicated. The Australian GST system has:
  - Two rates: 0 and 10 per cent.
    - *0% rate: exports; basic food items; education; medical services, aids & appliances; drugs; residential care; private health insurance; water; religious services; charities; sewerage & drainage services…*
    - *10% rate: all other goods and services.*
  - Exempt commodities (hence input-taxed production).
    - *Financial services, life insurance, dwellings, fund-raising events by charities, supply of precious metals.*
  - Non-registration (leading to further input-taxation).
  - Exempt imports. Imports valued below $A1000.
  - Export taxation of on-shore purchases by non-residents (like tourists).

Introduction (cont.)

- Motivation for detailed modelling of the GST:
  - It is important to correctly model the details of the tax if we are to properly model the economic impacts of changes to the tax.
  - This requires a modelling framework that takes into account the full details of the GST system as they relate to: multiple tax rates, multiple exemptions, differential registration rates and refund rates, low value imports, taxation of onshore purchases by non-residents, multi-production firms, etc.
  - This allows the model to take into account the interplay between legislated rates, exemptions and refunds, and allows effective GST rates to be influenced by endogenous changes in regional economic structure.
  - It also facilitates the correct representation of GST payments in the CGE model database (important for allocative efficiency effects).

Introduction (cont.)

- Current GST data in the ABS Australian input output tables: with a detailed theory of the GST, we can identify problems with the allocation of GST in the ABS IO tables:
  1. Outside of finance, insurance and dwellings, no GST is recorded on intermediate inputs to production. This cannot be correct in the presence of unregistered producers or underground production.
  2. Many GST rates exceed the legal rate of 10%. E.g.
     - 22.5% on Motor vehicle used in Finance.
     - Rates on private investment: up to 15%. And this is on inputs for investments in all industries.
  3. No GST is recorded for some commodities on which GST should be collected (e.g. grain, cattle, aquaculture, gas supply, purchases by non-residents of some foods, repair and other services).
  4. Consideration appears not to have been given to the consequences of business non-registration and the underground economy.

The VURM GST equation system

- The VURM GST equation system generalises to the regional dimension the detailed VAT equation systems described in Giesecke and Tran (2010, 2012).

- The economy:
  - M commodities, from S sources, used by U agents in R regions
  - U agents: N industries, K investors, F final demanders in R regions
  - Multi-production: M commodities produced by N industries in R
  - VURM: M = 78, N = K = 76, R = 8, S = 9, F = 8 x1 +1+ 8 x1+1.

- Features of the Australian GST system:
  - Two GST rates
  - Differentiated GST legal exemptions for commodities
  - Differentiated registration rates (GST thresholds, underground activities)
  - Low value threshold imports
  - Unclaimed GST on onshore purchases by non-residents
  - No GST on purchases by government final consumption and investment

GST equation system – domestic users

Effective GST rate

$$GST_{c,s,u,r} = ER_{c,s,u} \times TRBASE_{c,s,u,r}$$

GST revenue

Value of transaction base

Transaction-specific GST collections

Legal GST rate

Refund share

$$ER_{c,s,u,r} = LR_{c,s,u} \times [1\text{-}EEX_{c,s,u,r}] \times [1\text{-}REF_{u,r}] \times CR_{c,s,u,r}$$

Effective GST rate

GST exempt sales share

Compliance rate

Effective rate of GST depends on legal rate, effective exemptions, refund factors, & compliance rate

78 Commodities

78 + 78 + 1x8 + 1x9 domestic users

$$(c \in COM; s \in SRC, u \in DOMUSER; r \in REG)$$

9 Sources

8 Regions

GST equation system – examples

Effective GST rate | Legal GST rate | GST exempt sales share | Refund share | Compliance rate

$$ER_{c,s,u,r} = LR_{c,s,u} \times [1 - EEX_{c,s,u,r}] \times [1 - REF_{u,r}] \times CR_{c,s,u,r}$$

(Ex. 1) Standard GST rate. No legal exemption. Use of NSW "TCF" by households in NSW.

0.096 = 0.10 x [1 – 0.0192] x [1 - 0] x 0.98

(Ex. 2) GST exempt sales. Use of NSW "banking" by households in NSW.

0 = 0.10 x [1 – 1] x [1 - 0] x 0.98

(Ex. 3) GST-free goods. Use of NSW "dairy products" by households in NSW.

0.025 = 0.026 x [1 – 0.003] x [1 - 0] x 0.98

(Ex. 4) Current production. Use of NSW "wood products" by NSW "Residential construction"

0.002 = 0.10 x [1 – 0.0076] x [1 - 0.981] x 0.98

(Ex. 5) GST exempt prod'n. NSW "residential construction" input to NSW "dwelling" investment

0.096 = 0.10 x [1 – 0.0194] x [1 - 0] x 0.98

GST equation system – legal rate example

IOPC 1267 commodities	IO115	Share in IO115	LR
Processed liquid milk (incl whole milk and skim)	DairyProds	0.136	0
Cream (incl thickened), not concentrated or sweetened	DairyProds	0.015	0
Ice cream and frozen confections	DairyProds	0.169	0.1
Flavoured whole milk drinks	DairyProds	0.092	0.1
Sour cream, yoghurt and other cultured milk products	DairyProds	0.116	0
Buttermilk (excl cultured)	DairyProds	0.022	0
Powdered skim milk	DairyProds	0.008	0
Fats and oils derived from milk (incl butter oil); casein	DairyProds	0.002	0
Butter	DairyProds	0.085	0
Cheese and curd	DairyProds	0.281	0
Milk based food preparations (excluding malt extracts) a	DairyProds	0.039	0
Milk and cream, concentrated or sweetened; lactose an	DairyProds	0.035	0
Dairy products - commission production (1131-1133)	DairyProds	0	0
Dairy products LR		**1**	**0.026**

GST equation system – domestic users

Transaction base = basic value + non-GST indirect taxes + margins

Value of transaction base

Indirect taxes (excluding GST)

$$\mathrm{TRBASE}_{c,s,u,r} = \mathrm{VBAS}_{c,s,u,r} + \mathrm{VTAX}_{c,s,u,r} + \sum_{m \in MAR} \mathrm{VMAR}_{c,s,u,r,m}$$

Transaction at basic prices

Margins (e.g. transport)

GST exempt sales share

De-facto exemption share

$$\mathrm{EEX}_{c,s,u,r} = \mathrm{LEX}_{c,s,u,r} + (1 - \mathrm{LEX}_{c,s,u,r}) \times \mathrm{DEX}_{c,s,u,r}$$

Legal exemption share

Effective exemptions depend on legal exemptions and de-facto exemptions

78 Commodities

78 + 78 + 1x8 + 1x9 domestic users

$$(c \in COM; s \in SRC, u \in DOMUSER; r \in REG)$$

9 Sources

8 Regions

GST equation system – domestic users

Share of commodity *c* from domestic source *s* produced by industry *i*

$$\mathrm{DEX}_{c,s,u,r} = 1 - \sum_{i \in \mathrm{IND}} \mathrm{SJ}_{c,s,i} \times \mathrm{REGIST}_{i,s}$$

De-facto exemption share (domestic goods)

Share of output of industry *i* in domestic region s produced by firms registered for GST

De-facto exemption rate depends on GST registration rate (domestic goods)

Undeclared imports

$$\mathrm{DEX}_{c,\mathrm{foreign},u,r} = \mathrm{ILM}_{c,u,r}$$

De-facto exemption share (imported goods)

De-facto exemption rate depends on undeclared import share (imported goods)

$$(c \in COM; s \in REG, u \in DOMUSER; r \in REG)$$

GST equation system – domestic users

Share of output of industry *i* in domestic region *s* produced by firms registered for GST

Non-registration arising from informal activity

$$\mathrm{REGIST}_{i,s} = (1-\mathrm{NRL}_{i,s})(1-\mathrm{NRI}_{i,s})$$

Registration rate

Legal non-registration rate

Proportion of GST paid on purchases by industry *i* in region *s* that are refundable

Share of industry *i,s'* output represented by commodity *c*

$$\mathrm{REF}_{i,s} = \mathrm{REGIST}_{i,s} \sum_{c \in COM} \sum_{u \in USER} \sum_{r \in REG} \mathrm{SO}_{c,i,s}\, \mathrm{SS}_{c,s,u,r} \left[1 - \mathrm{LEX}_{c,s,u,r}\right]$$

Registration rate

Share of sales to user *u* in region *r* in total sales of commodity *c* produced in region *s*.

Refund rate

$$(i \in IND; s \in REG)$$

GST equation system – domestic users

Share of GST paid on inputs to investment in industry *k,r* that is refundable

Share of GST paid on inputs to production in industry *i,r* that is refundable

$$\mathrm{REF}_{k,r} = \sum_{i \in IND} \delta_{k,i} \mathrm{REF}_{i,r}$$

Kronecker delta

Investor refund rate

$$(k \in INV; r \in REG)$$

Share of GST paid on household purchases that is refundable

$$\mathrm{REF}_{\mathrm{households},r} = 0$$

Household refund rate

Share of GST paid on government purchases that is refundable

$$\mathrm{REF}_{\mathrm{State\ gov},r} = \mathrm{REF}_{\mathrm{Fed\ gov},r} = 1$$

Government refund rate

$$(r \in REG)$$

GST equation system – foreign users

Legal rate of GST (households)

Share of total sales of (c.s) represented by on-shore sales to non-residents

Proportion of GST collected on non-resident sales refunded under TRS

GST collected on exports

$$GST_{c,s,export} = CR_{c,s,export} \left\{ \begin{array}{l} LR_{c,s,household} \cdot SHNRES_{c,s} \cdot (1\text{-}TRS_{c,s}) \\ TRBASE_{c,s,export} \cdot (1\text{-}EEX_{c,s,household}) \\ + \\ LR_{c,s,export} \cdot (1 - SHNRES_{c,s}) \cdot \\ TRBASE_{c,s,export} \cdot (1\text{-}EEX_{c,s,export}) \end{array} \right\}$$

Compliance rate

Typically 0

$$(c \in COM)(s \in REG)$$

ER	=	LR	x	SHNRES	x	(1-TRS)	x	(1-EEX)

(Ex. 6) Export sales of NSW "accommodation"

0.098	=	0.10	x	1	x	(1- 0)	x	(1–0.012)

(Ex. 7) Export sales of NSW "other equipment"

0.018	=	0.10	x	0.18	x	(1-0.009)	x	(1-0.015)

Simulation design

We raise the standard rate of GST from 10% to 11% under an environment in which:

(1) Regional real wages are sticky in the short-run, but flexible in the long-run, with region-specific unemployment rates returning to baseline in the long-run.

(2) Regional migration rates are sticky in the short-run, but adjust gradually in order to ensure that per capita regional real disposable income relativities return to baseline levels.

(3) Government borrowing requirements (federal and state) are exogenously held at baseline values via endogenous adjustment of national and regional lump sum household transfers.

(5) Federal government GST collections are allocated to state governments on the basis of population x per-capita relativity factor.

(6) The balance of trade : GDP ratio is exogenously held at its baseline value via movements in the economy-wide average propensity to consume.

(7) Subject to (6) above, region-specific household consumption spending is determined as a fixed proportion of region-specific household disposable income.

(8) Real public consumption spending by federal and state governments is exogenously held at baseline values.

Simulation design (cont.)

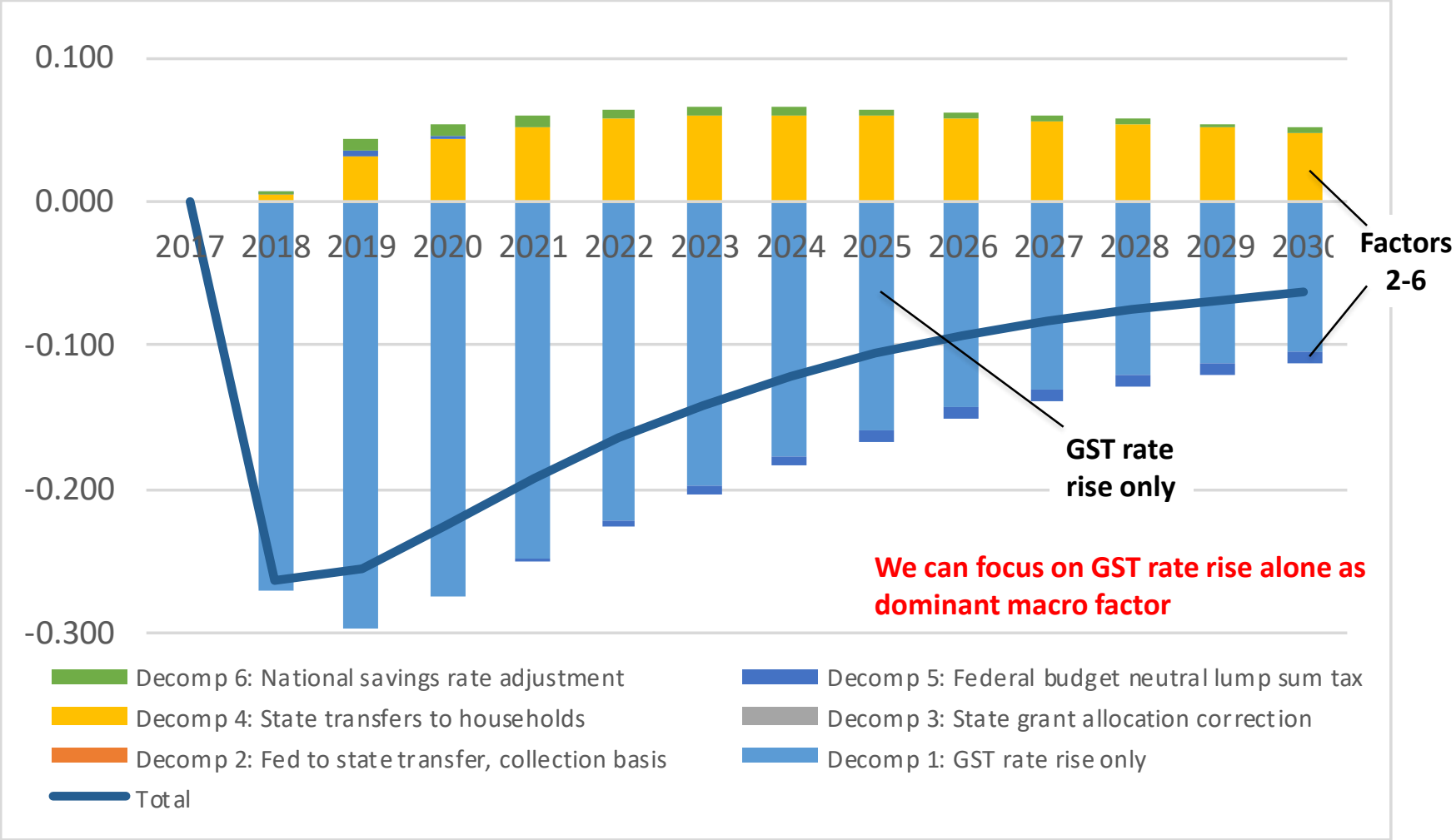
Model closure elements (3) to (8) above allow us to think about the effects of the simulation in terms of six separable elements or decomposition factors, under a model environment in which: (a) state and federal PSBRs are endogenous; (b) the BOT/GDP ratio is endogenous.

These decomposition factors are:

1. The federal government raises the GST rate.
2. The federal government grants the additional GST revenue to the states in line with GST collected within each state.
3. The federal government makes a grant correction to (2) sufficient to make net state-specific GST grants consistent with an HFE formula based on population x relativity.
4. State governments adjust state-specific lump-sum household taxes/transfers sufficient to leave their PSBRs at baseline levels.
5. Federal government adjusts economy-wide lump sum household taxes/transfers sufficient to leave its PSBR at baseline levels.
6. Households adjust their average propensity to save sufficient to leave the balance of trade / GDP ratio on baseline values.

Results are the same for both simulations, but above allows us to decompose outcomes into constituent parts

Decomposition of Real GDP deviation (% dev'n from baseline)



A useful "back-of-the-envelope" model

Adapted from Dixon and Rimmer (1999)

$$(1)\ P_C = P_D^{\alpha_D^C} \cdot P_M^{\alpha_M^C} \cdot T_C$$

Cobb-Douglas unit cost function for consumption

$$(2)\ P_I = P_D^{\alpha_D^I} \cdot P_M^{\alpha_M^I} \cdot T_I$$

Cobb-Douglas unit cost function for investment

$$(3)\ MP_L\,(K/L) = T_D \cdot (W/P_D)$$

Optimising use of labour under CRS production technology

$$(4)\ MP_K\,(K/L) = T_D \cdot (Q/P_D)$$

Optimising use of capital under CRS production technology

$$(5)\ W_R = W/P_C$$

Real wage

$$(6)\ \rho = Q/P_I$$

Gross rate of return on capital

Consumption taxes

Input taxes

Real wage

$$(7)\ MP_L\,(K/L) = T_D \cdot T_C \cdot W_R \cdot (P_M/P_D)^{\alpha_M^C}$$

Marginal product functions, depending on K / L only

P_M/P_D is a function of the terms of trade

$$(8)\ MP_K\,(K/L) = \rho \cdot T_D \cdot T_I \cdot (P_M/P_D)^{\alpha_M^I}$$

Rate of return

Investment taxes

A useful “back-of-the-envelope” model

In terms of the BOTE model, when we raise the GST, we are raising T_C, T_D and T_I

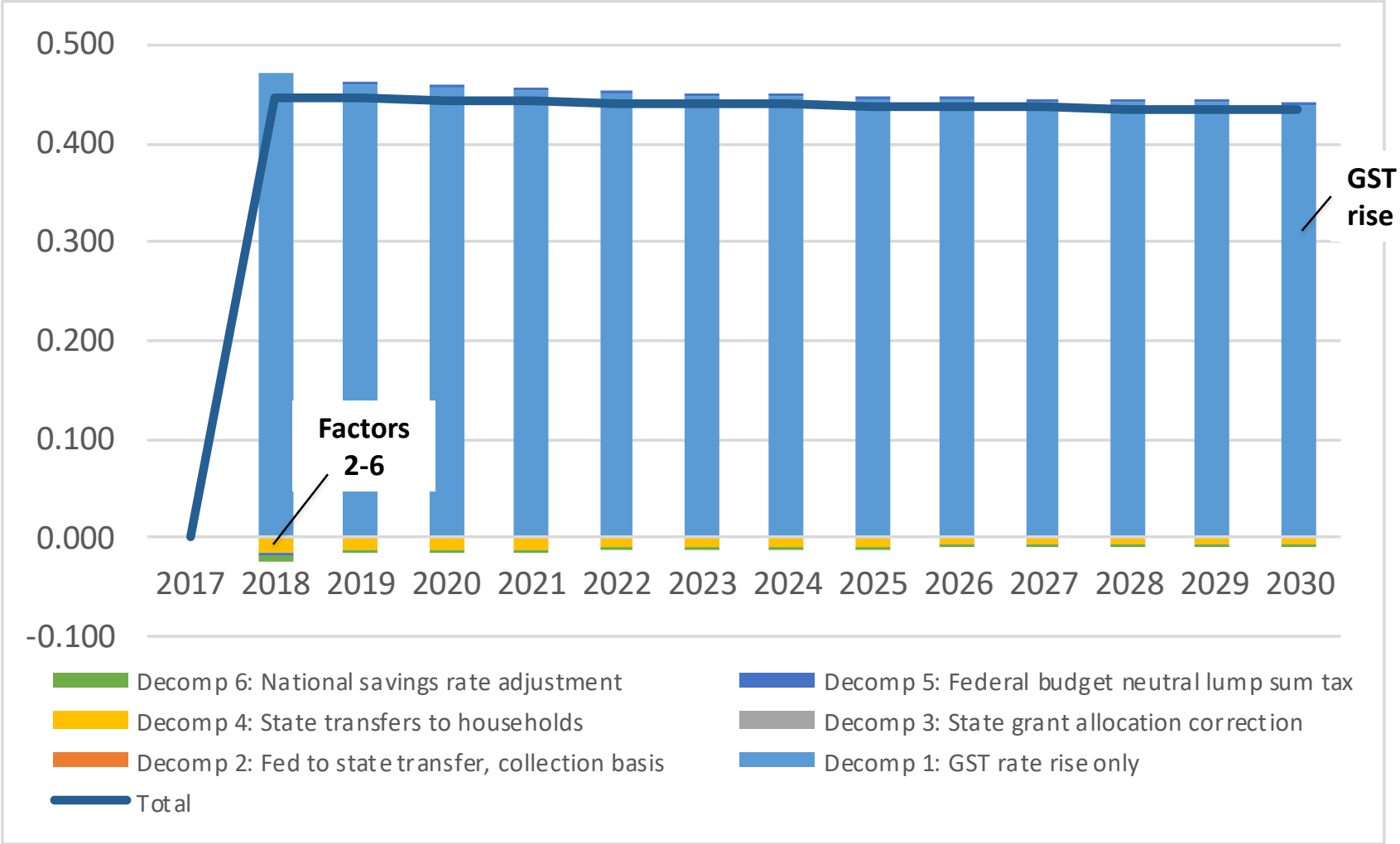
T_C: For the household user, values for EEX tend to be very low, and REF is 0. Hence, tendency for movements in LR to translate to equivalent movements in ER. This is a rise in T_C.

T_D, T_I: Under a theoretically pure GST system, $REF_{u,r}$ is 1 for all producers and investors. In practice, GST refunds are reduced by: (a) production of GST exempt commodities; (b) non-registration for GST. GST exempt status of banking, finance, insurance, & dwellings results in input-taxation of production and capital for these sectors. Low levels of non-registration create low levels of input taxation for all other sectors. A rise in the GST rate causes T_D and T_I to rise. Effective export taxation of export tourism also like a rise in T_D in BOTE.

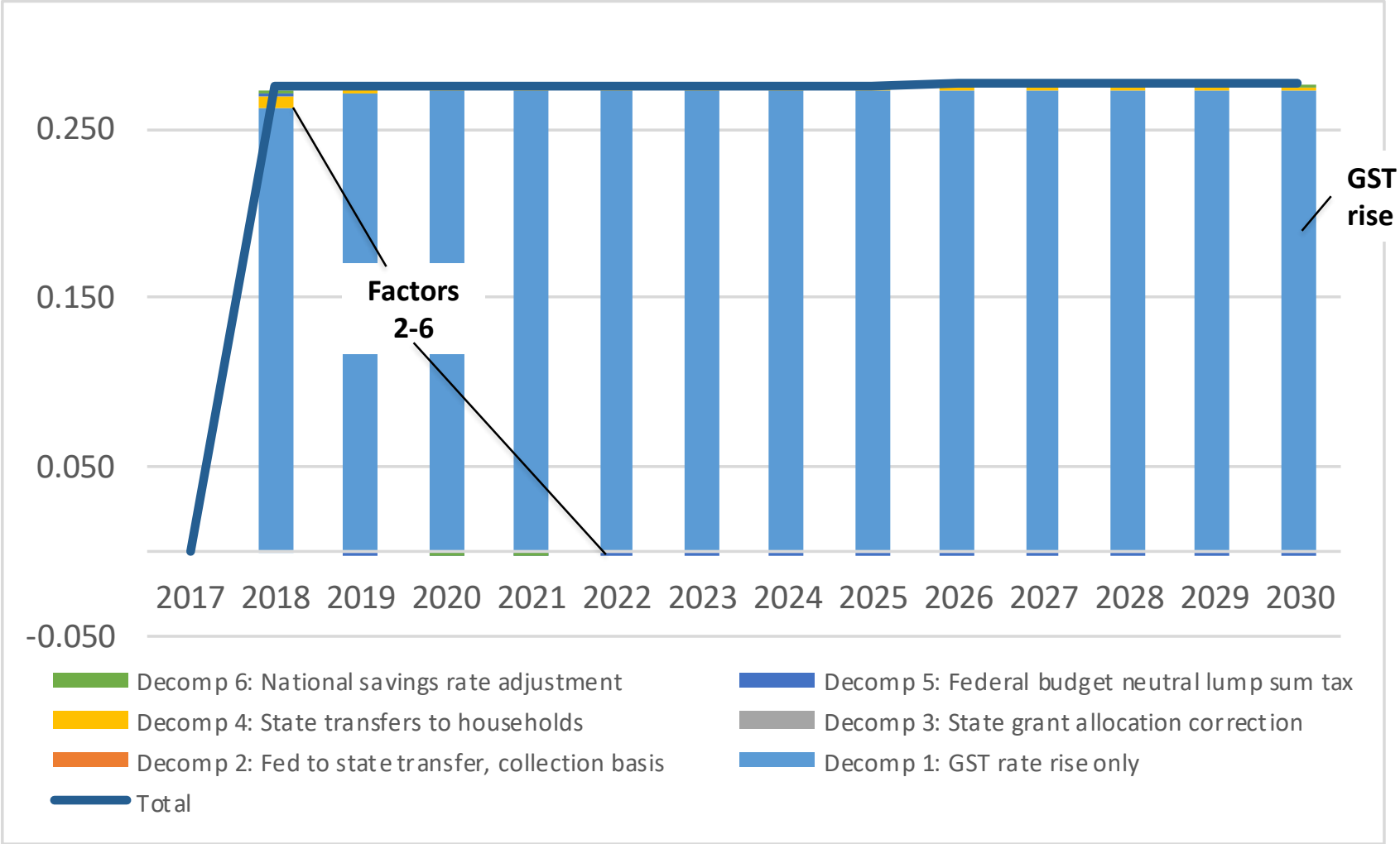
To see the *direct* impact of the GST on price deflators, define a new variable:

$$\text{Ratio}=\left(\frac{\text{Purchasers's price index as normally defined}}{\text{purchasers's price index as normally defined}-\text{GST}}\right)$$

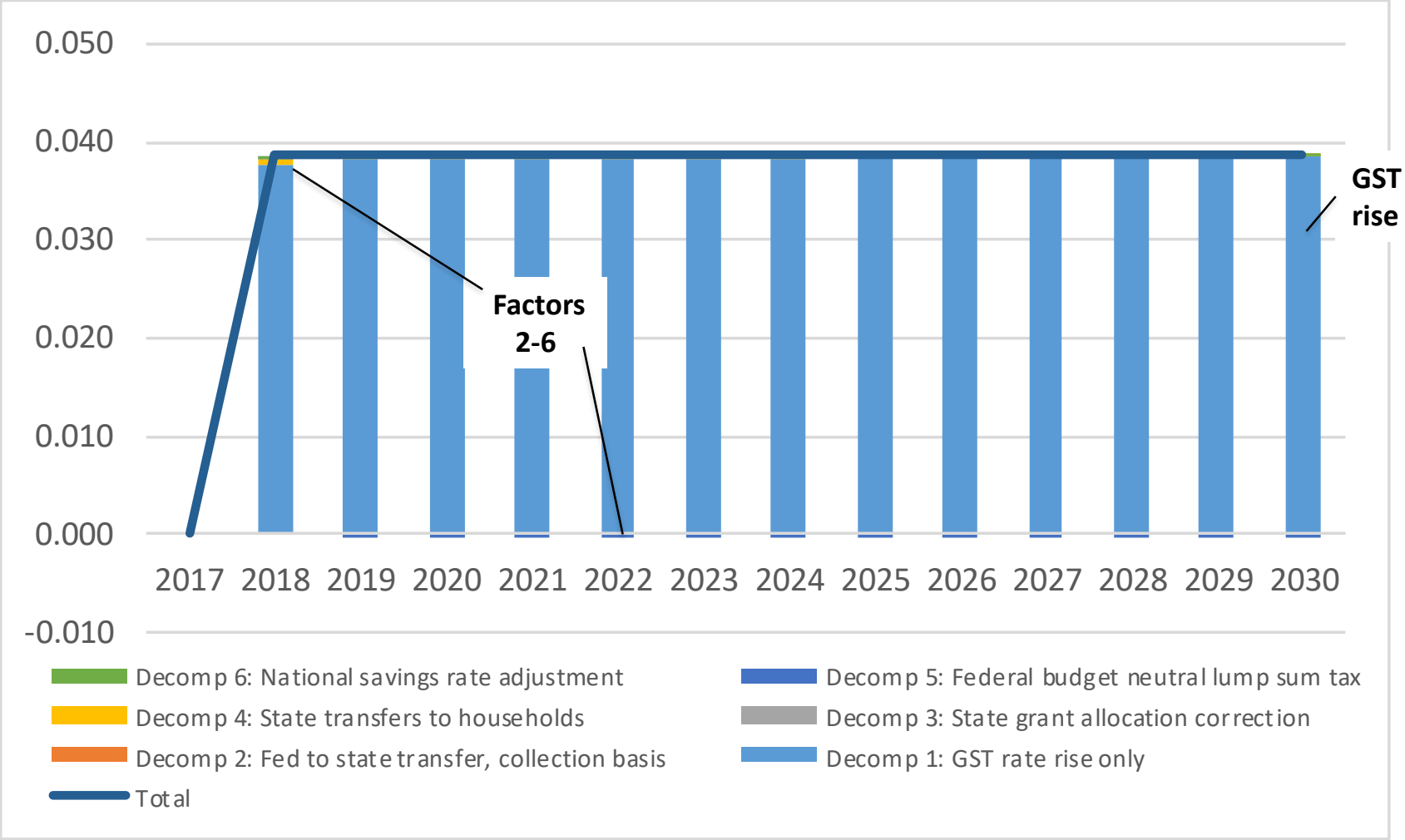
Ratio of CPI (c.GST) to CPI (ex.GST) (T_C in BOTE)



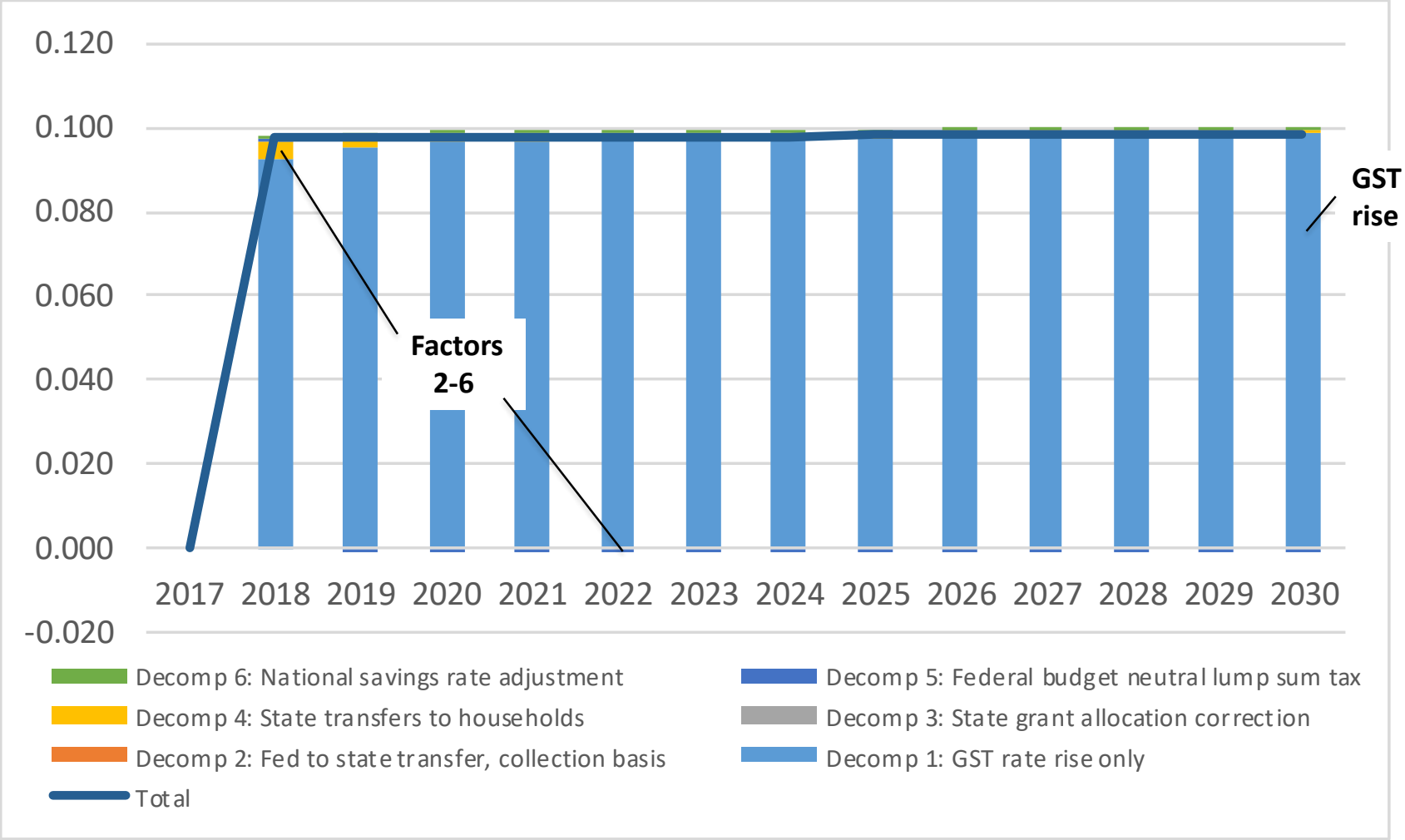
Ratio of investment price index (c.GST) to investment price index (ex.GST) (T_I in BOTE)



Ratio of input price index (c.GST) to input price index (ex.GST) (T_D in BOTE)



Ratio of export price index (c.GST) to export price index (ex.GST) (T_D in BOTE)



A useful "back-of-the-envelope" model

Short-run expectations from the BOTE model

$$(7)\ \uparrow MP_L\,(K/\downarrow L) = \uparrow T_D \cdot \uparrow T_C \cdot W_R \cdot (P_M / P_D)^{\alpha_M^C}$$

$$(8)\ \downarrow MP_K\,(K/\downarrow L) = \downarrow \rho \cdot \uparrow T_D \cdot \uparrow T_I \cdot (P_M / P_D)^{\alpha_M^I}$$

Red denotes an exogenous variable

In the short-run, we expect:

- **Employment to fall.**
- **GDP to fall.**
- **Investment to fall.**

Long-run expectations from the BOTE model

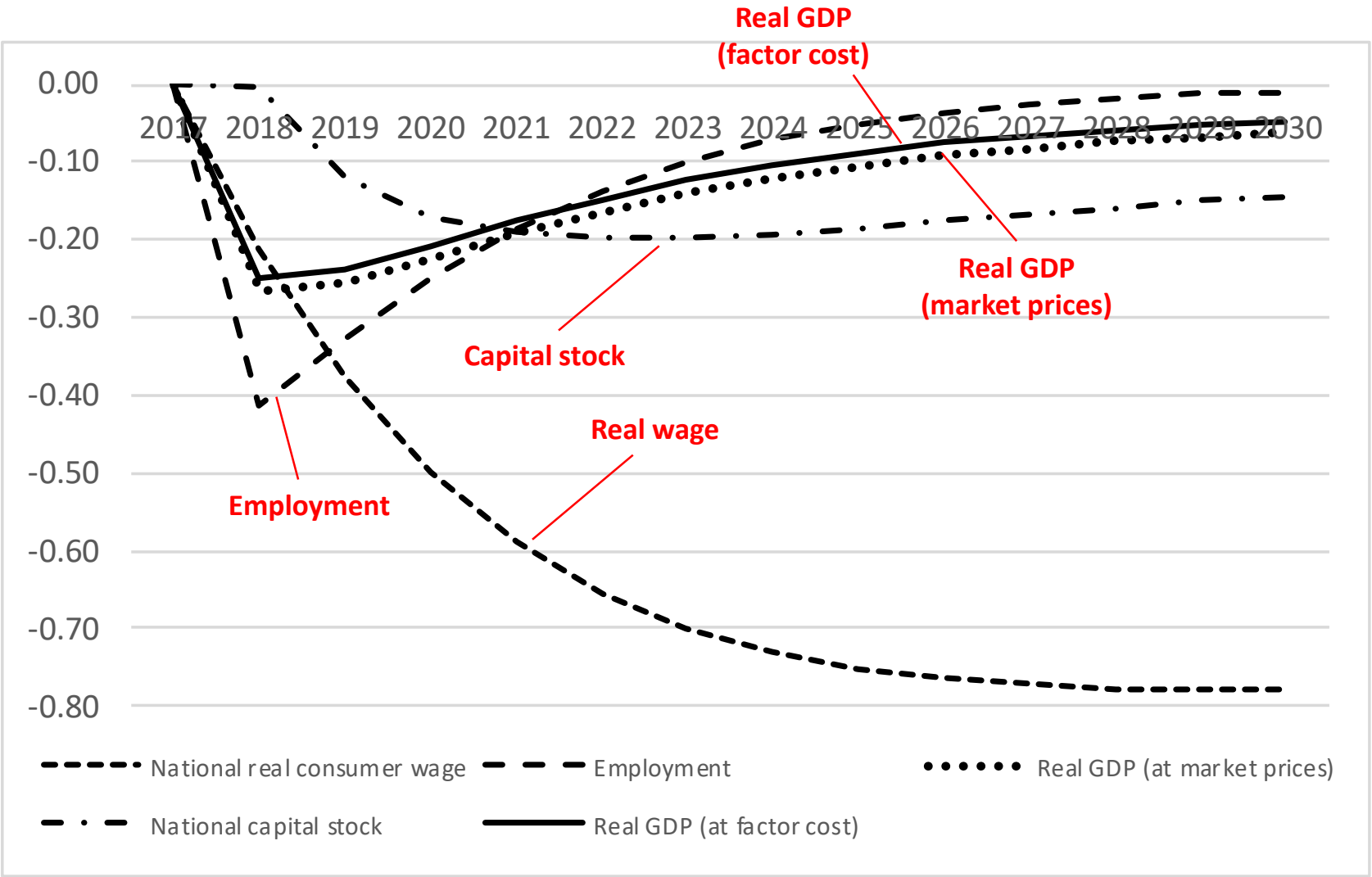
$$(7)\ \downarrow MP_L\,(\downarrow K / L) = \uparrow T_D \cdot \uparrow T_C \cdot \downarrow W_R \cdot (P_M / P_D)^{\alpha_M^C}$$

$$(8)\ \uparrow MP_K\,(\downarrow K / L) = \rho \cdot \uparrow T_D \cdot \uparrow T_I \cdot (P_M / P_D)^{\alpha_M^I}$$

In the long-run, we expect:

- **Capital to fall.**
- **GDP to fall.**
- **Real wage to fall.**

National employment, capital, GDP & wage (% dev'n from baseline)



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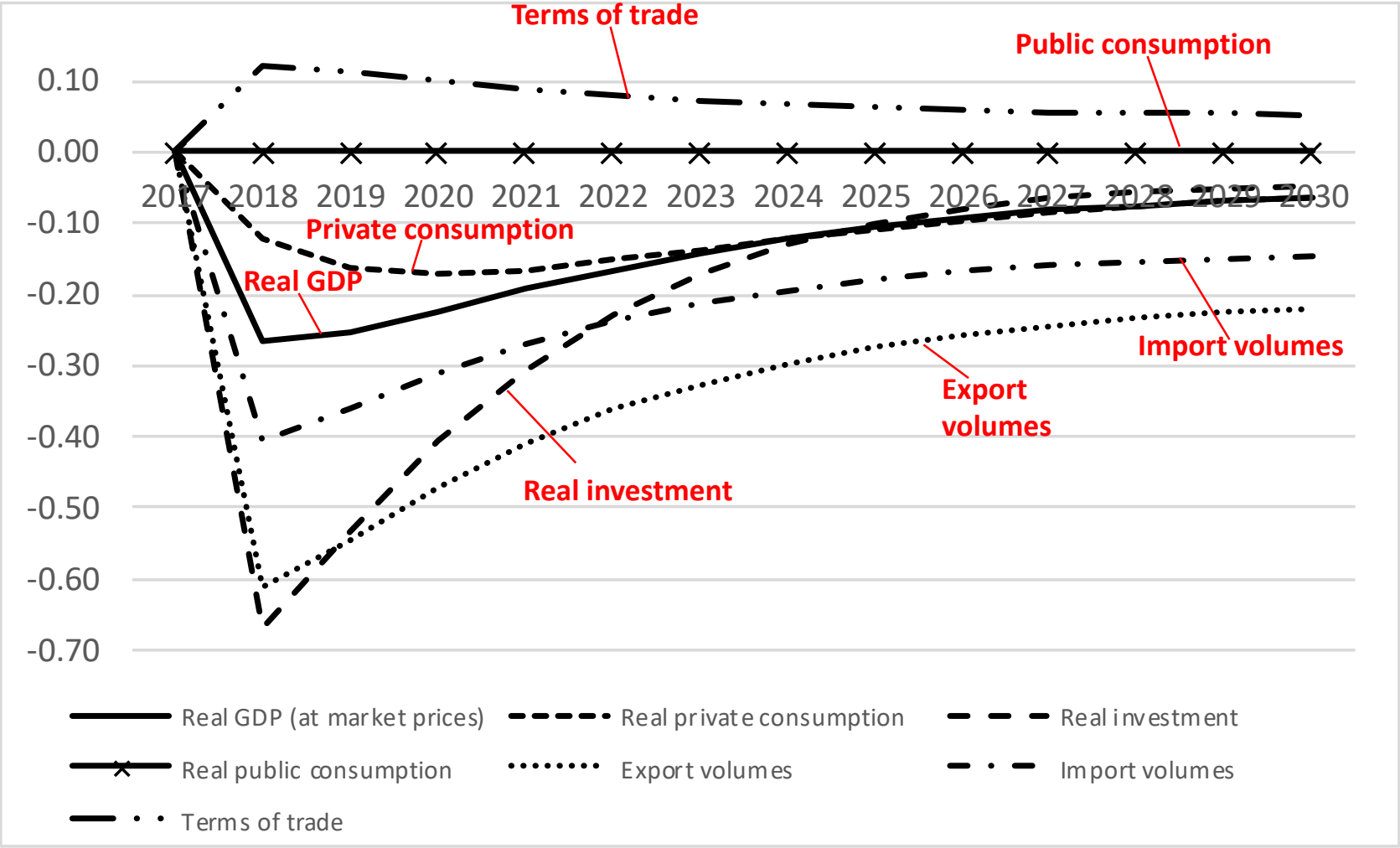
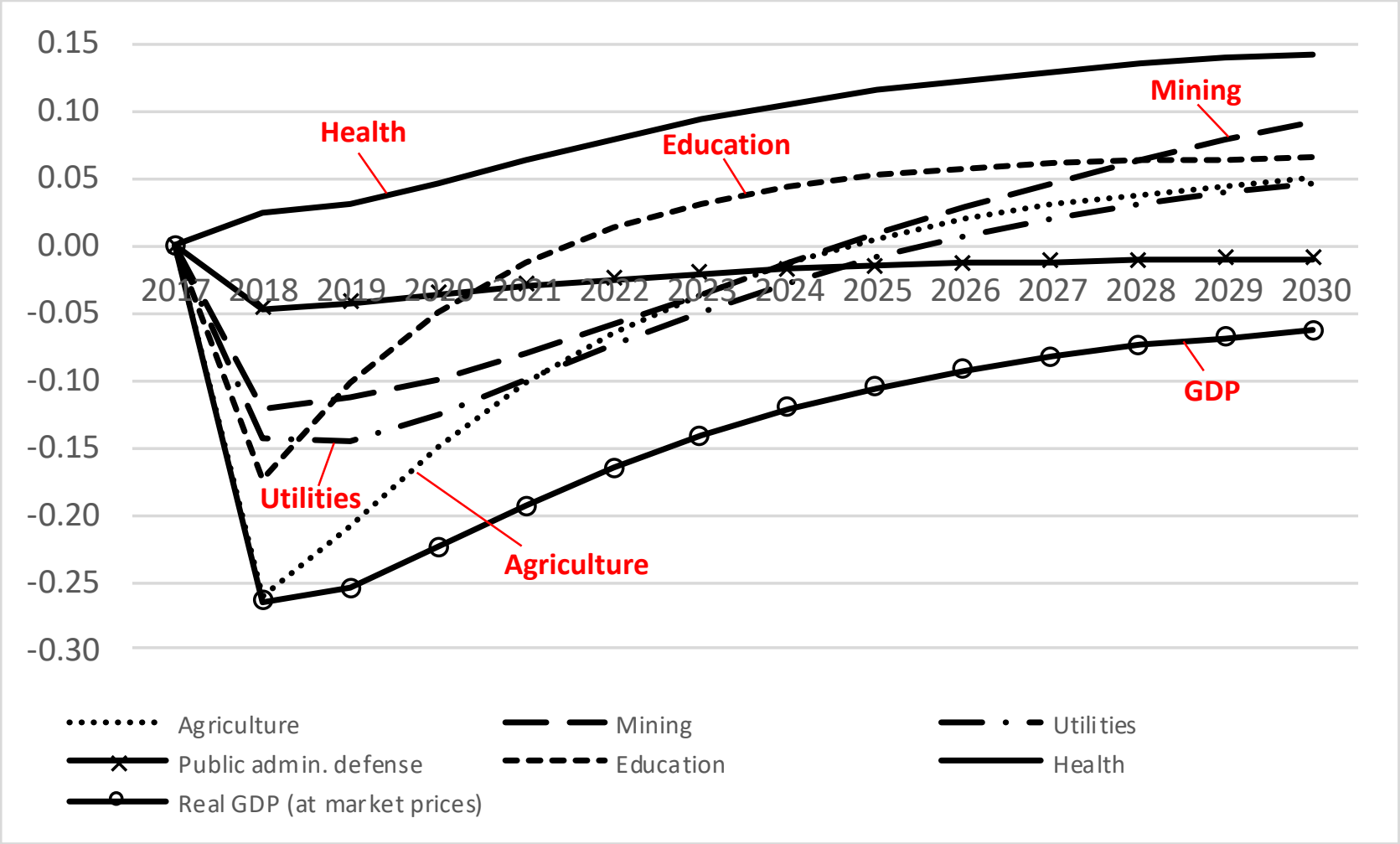
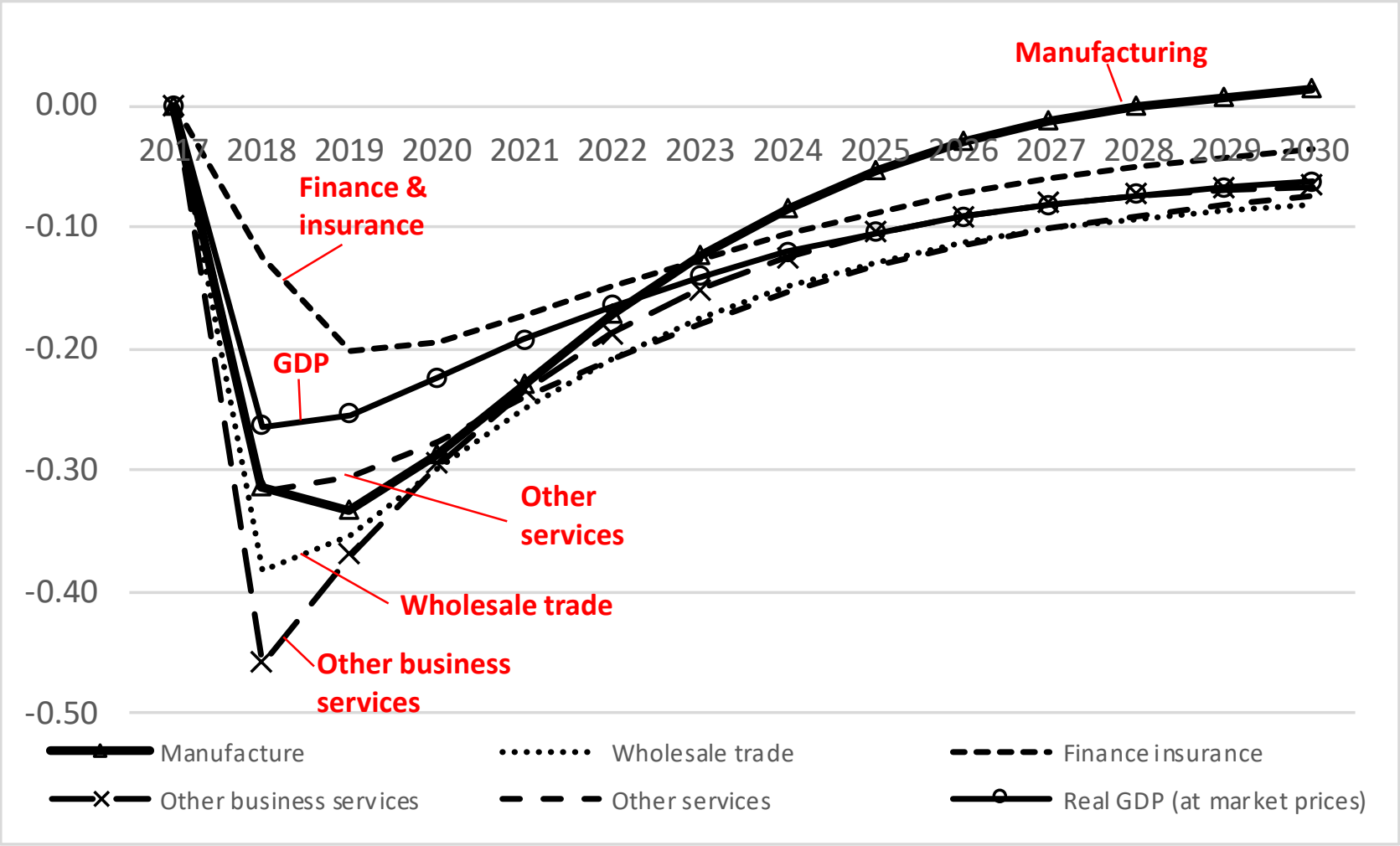
GDP and its expenditure components (% dev'n from baseline)



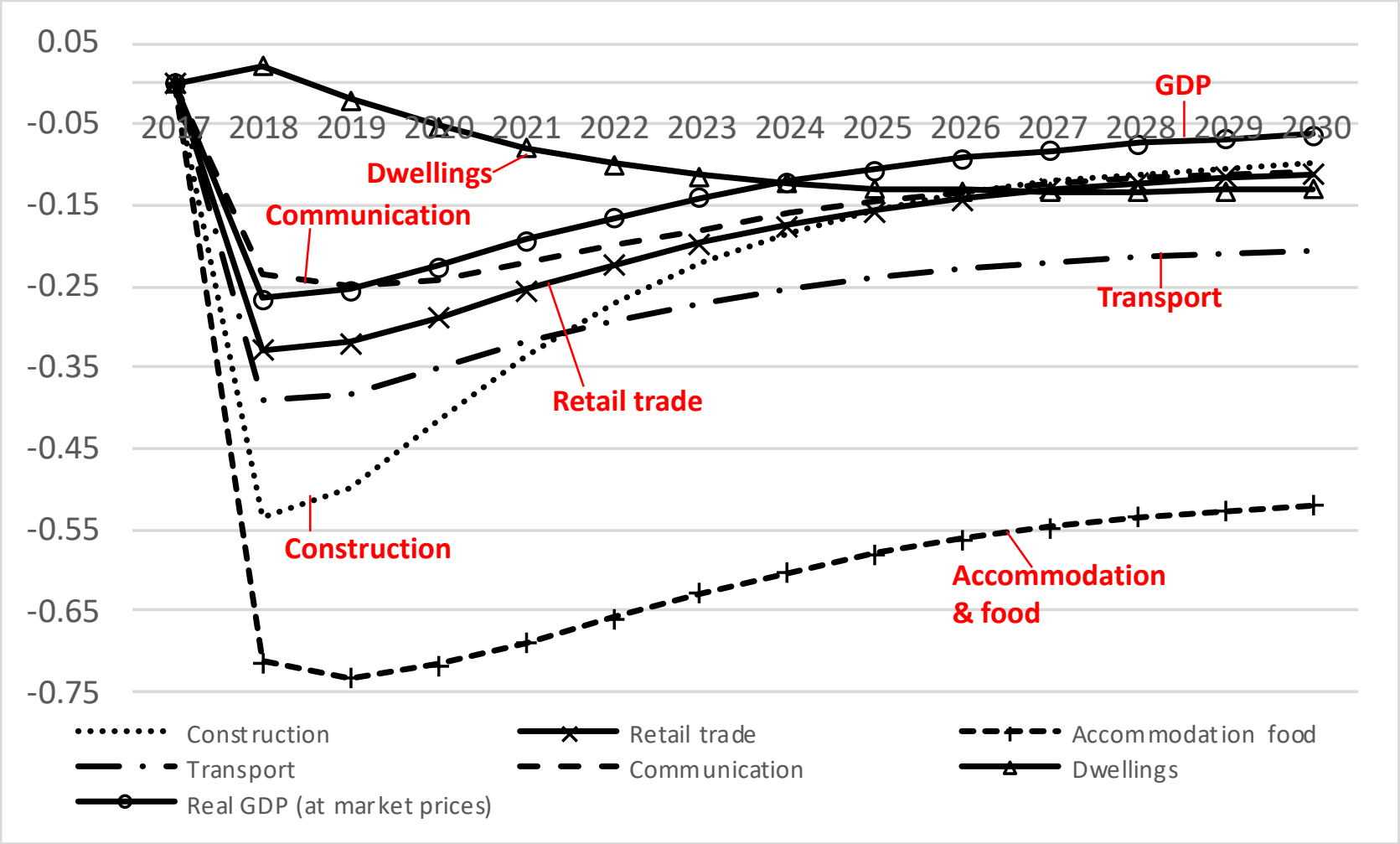
National sectors (output deviation %) – top ranked



National sectors (output deviation %) – middle ranked



National sectors (output deviation %) – bottom ranked



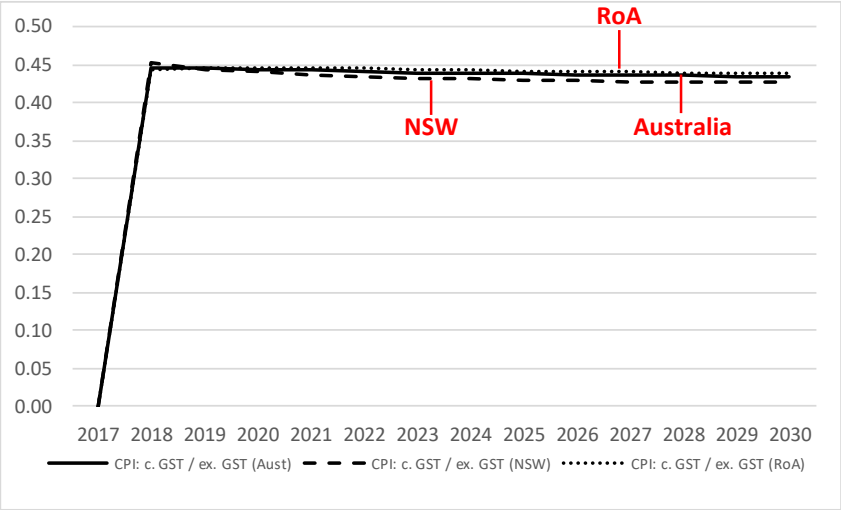
GST deflator impacts: NSW vs RoA

- We find sizeable differences in the impact of a rise in the GST on costs of various economic activities in NSW relative to RoA.
- These cost differences feed into long-run NSW production cost streams, raising relative NSW prices, thus damping the size of the NSW economy relative to RoA.
- **For investment deflator:** higher proportion of NSW activity is input-taxed sectors like banking, finance, insurance and dwellings. Banking, insurance, finance share of investment in NSW is 6.2%. Corresponding share for RoA is 3.3%. For dwellings investment, corresponding shares are 28% and 20%.
- **For intermediate input deflator**: relative proportion of input-taxed sectors again important. Banking, finance and insurance services also important intermediate inputs themselves (5.2% in NSW, 4.2% in RoA). Some tax cascading.
- **For export deflator**: NSW is an important destination for export tourism. Share of NSW exports accounted for by tourism-related products is 25% v 10% for RoA. More general measure of sensitivity is difference between NSW & RoA values for:

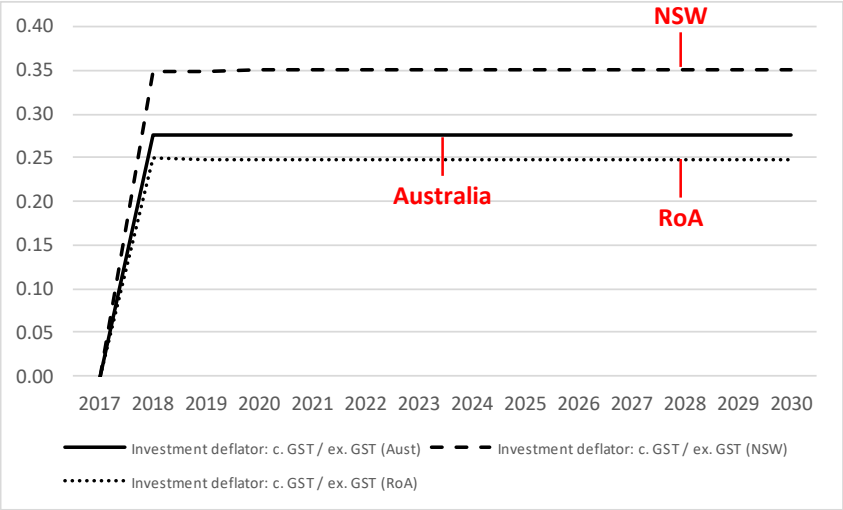
$$\sum_c \left(\mathrm{TRBASE}_{\mathrm{c,s,export}} \Big/ \sum_i \mathrm{TRBASE}_{\mathrm{i,s,export}} \right) \cdot \mathrm{SHNRES}_{\mathrm{c,s}} \cdot (1 - \mathrm{REFEXP}_{c,s}) = 0.04 = (0.156 - 0.117)$$

Ratios of c.GST & ex.GST price indices: NSW, RoA, Australia

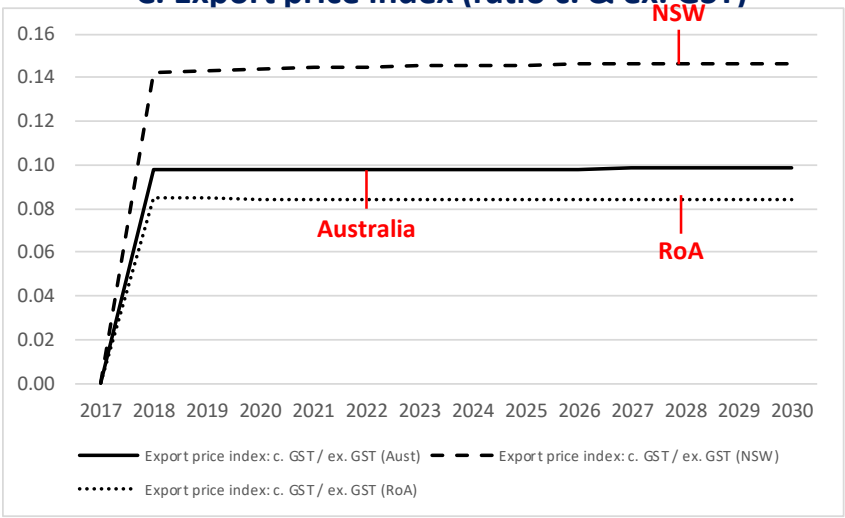
A. Consumer price index (ratio c. & ex. GST)



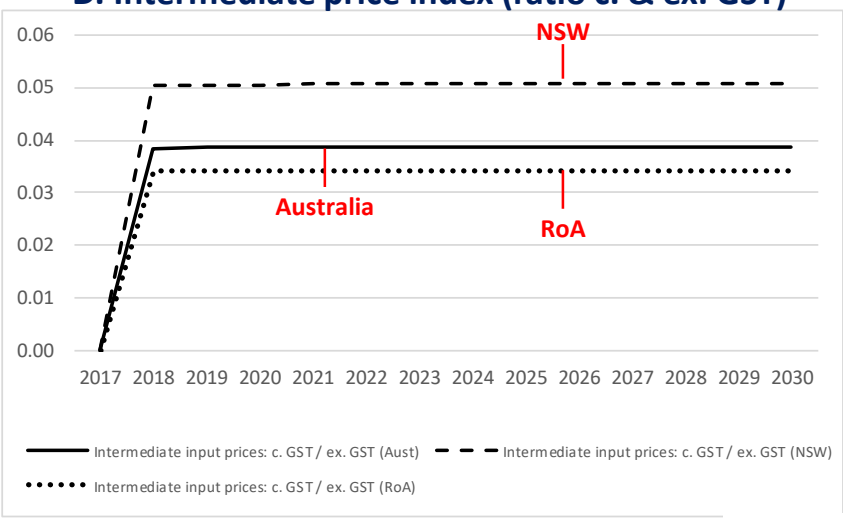
B. Investment price index (ratio c. & ex. GST)



C. Export price index (ratio c. & ex. GST)



D. Intermediate price index (ratio c. & ex. GST)



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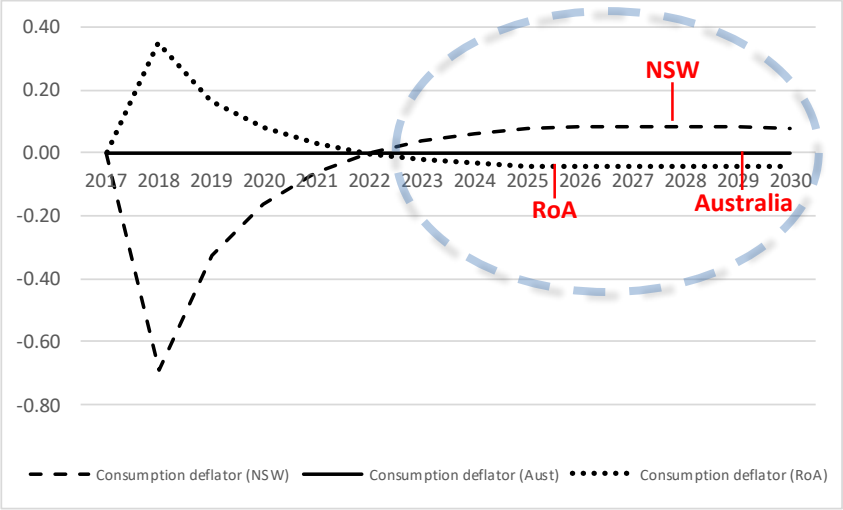
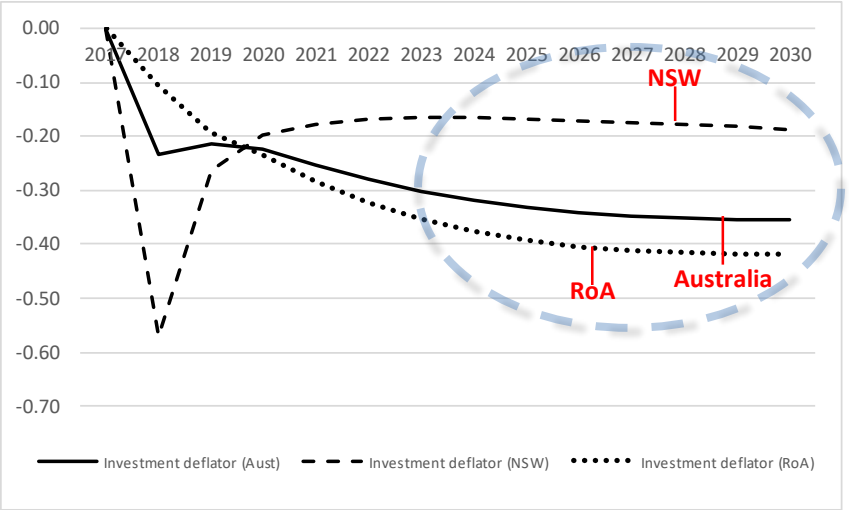
Key deflators, NSW, RoA, Australia (% dev'n from baseline)

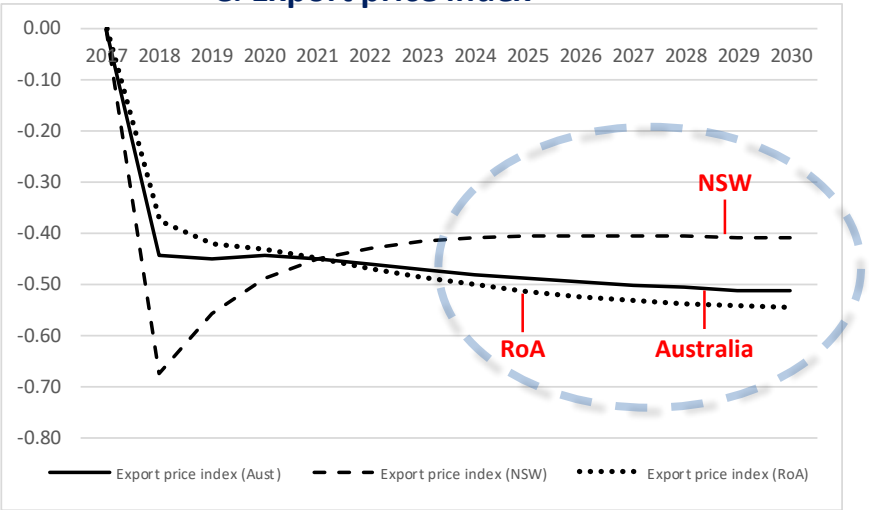
A. Consumer price index



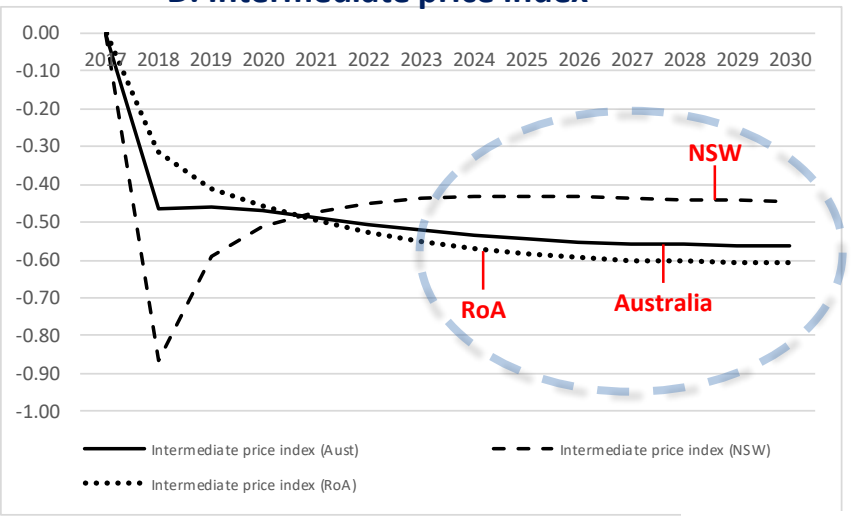
B. Investment price index



C. Export price index



D. Intermediate price index



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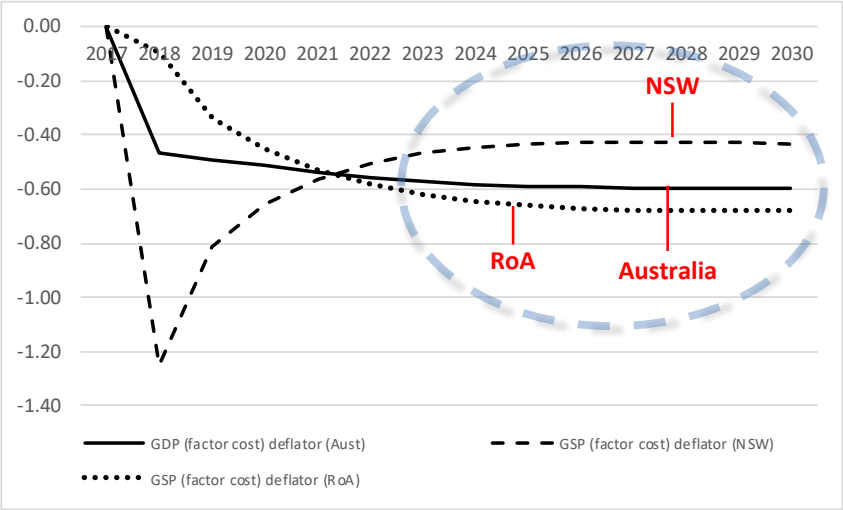
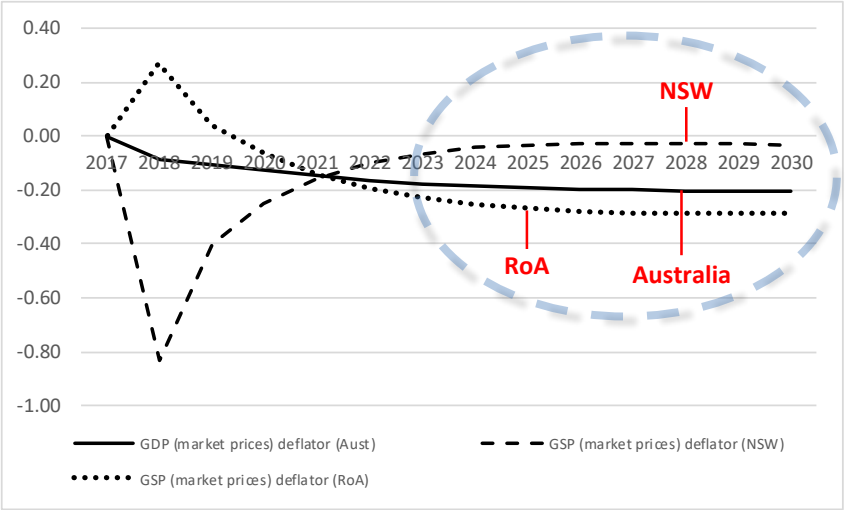
Key deflators, NSW, RoA, Australia (% dev'n from baseline)

A. GDP (factor cost) deflator

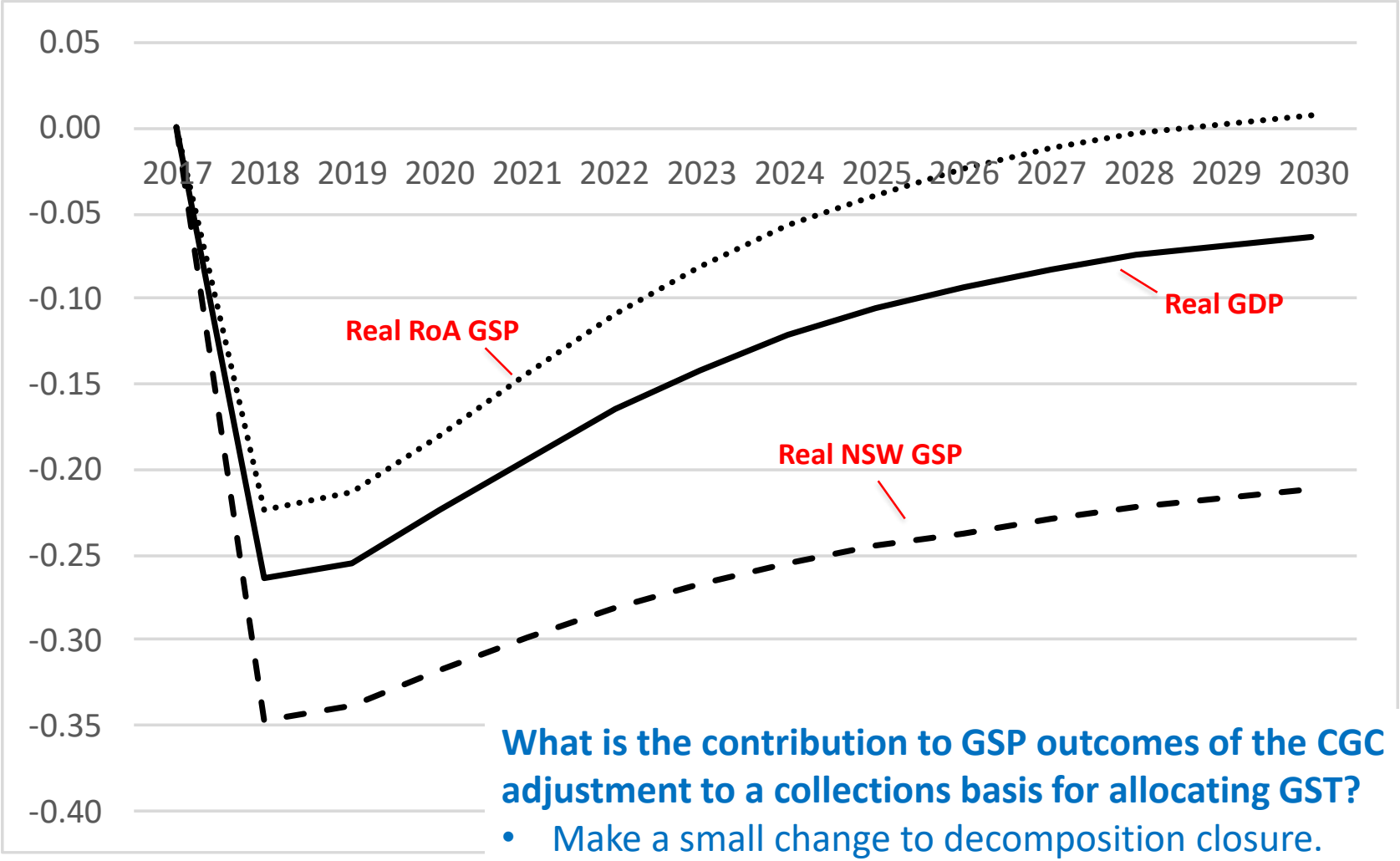


B. GDP (market prices) deflator



- Under appropriate regional factor market closures, changes in regional indirect taxes ultimately feed into regional production cost streams.
- Higher tax load on NSW raises long-run NSW prices relative to RoA prices.
- In VURM, agents substitute between alternative sources of supply based on relative prices.
- Result: decline in demand for NSW-sourced goods relative to RoA goods.

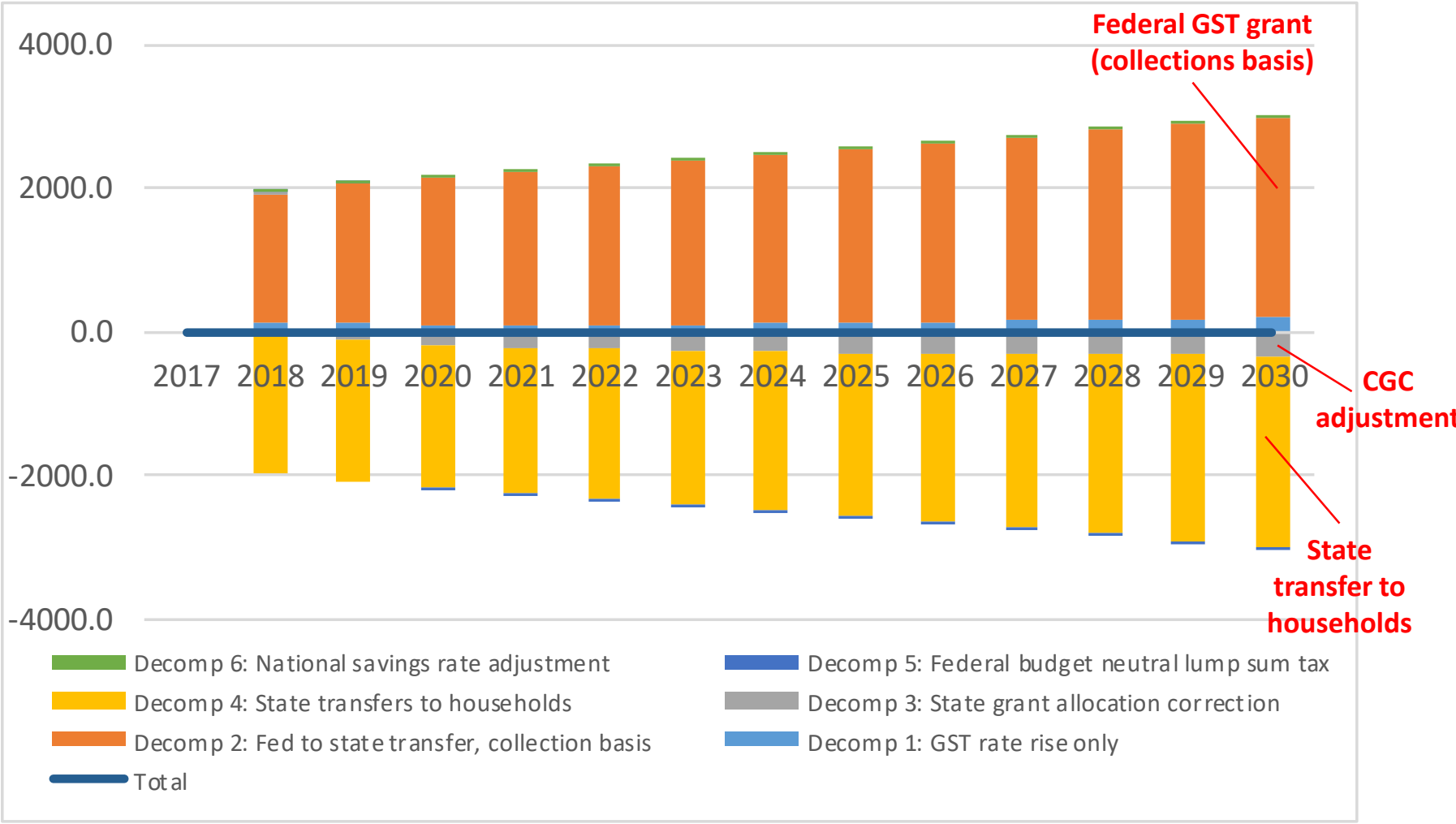
Comparative GSP impacts (% deviation from baseline)



What is the contribution to GSP outcomes of the CGC adjustment to a collections basis for allocating GST?

- Make a small change to decomposition closure.
- Now: state PSBRs are exogenous, with endogenous state transfers to household.
- Shock grants to states by CGC adjustment factor alone.

NSW state budget balance ($m. dev'n)



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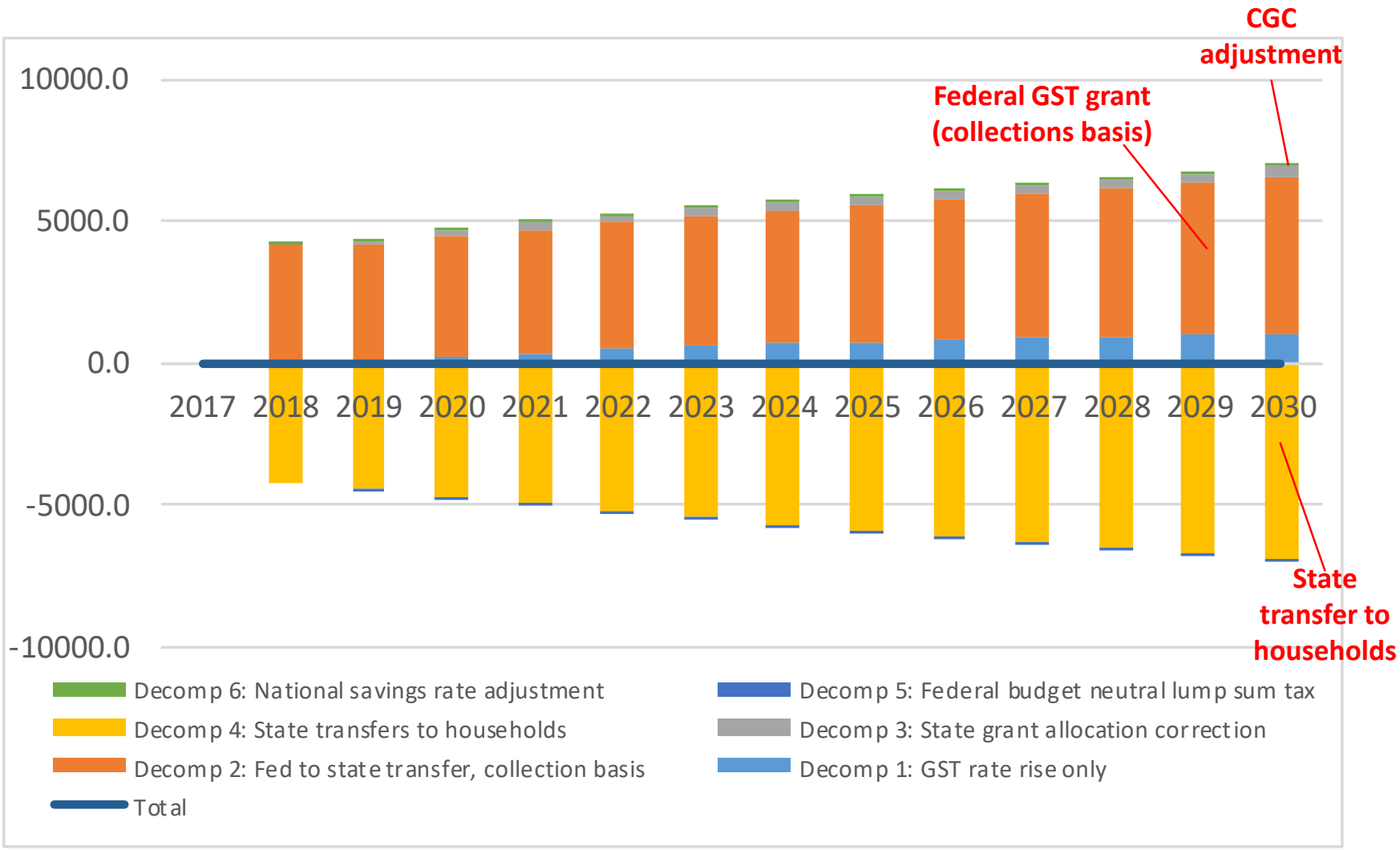
RoA state budget balance ($m dev'n)



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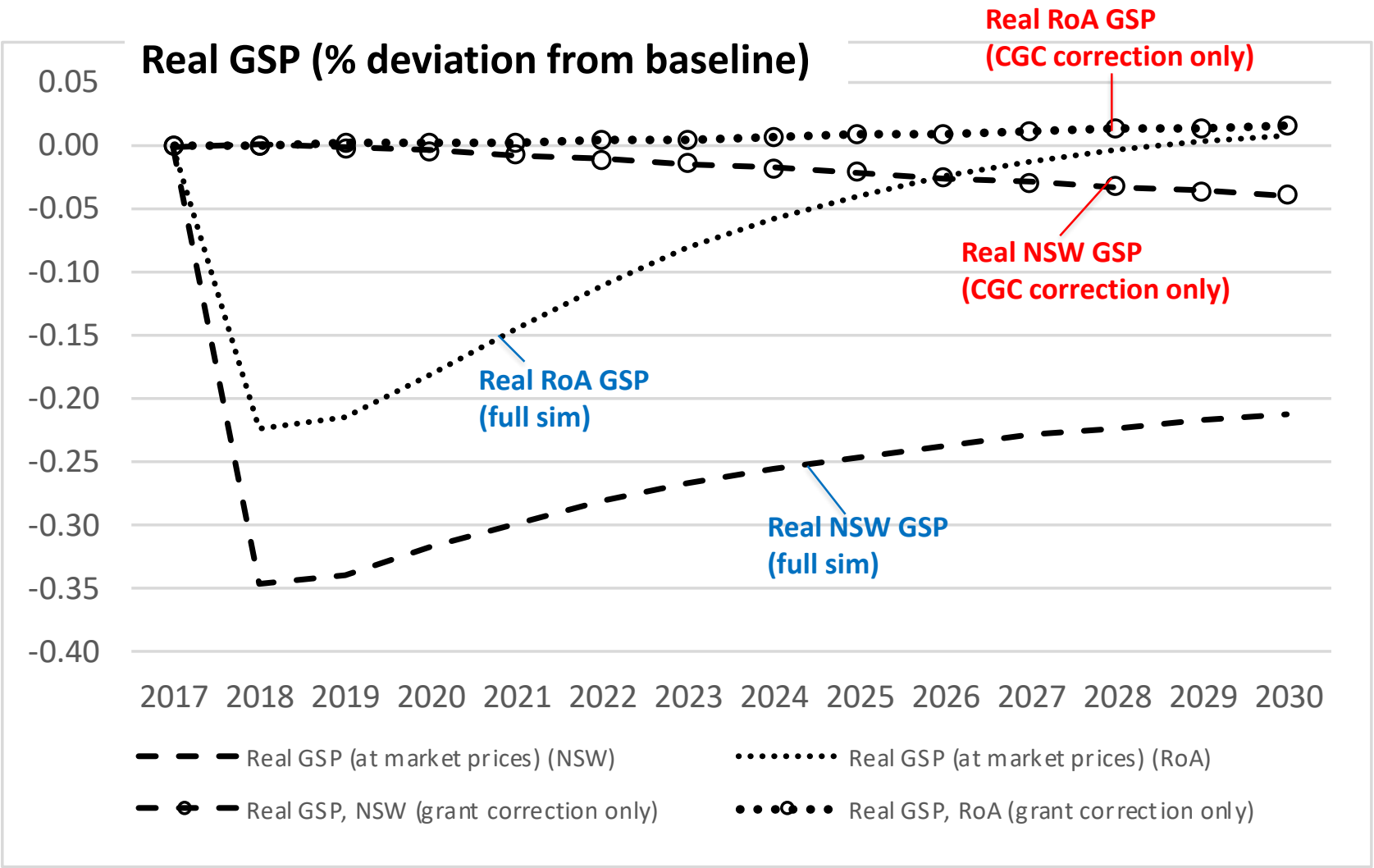
Isolation of CGC vs collection basis impact on GSP outcomes



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Concluding remarks

Explicit framework for modelling GST allows better modelling of:

(i) How changes in GST rates affect different sectors, commodities and users: important for sectoral and state and national macro impact analysis.
(ii) The sectoral distribution of indirect tax wedges between value in use and value in supply: important for welfare analysis.

In forecasting and policy analysis, allows changes in economic structure to endogenously affect GST collections and deadweight losses (e.g. role of multi-production in refund rate).

Opens a wide range of policy-relevant GST simulations: Exemptions, registration rates, legal rates, compliance rates, low value import threshold, TRS: all explicit exogenous variables. Analysis of results for all states and territories in fully disaggregated VURM model.