

Should we care about the technique effect in CGE?

An example of incorporating technology spillover into GTAP-E

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What is the technique effect?

Standard framework for linking trade opening and climate change has three effects:

- Scale effect: trade opening leads to increased economic activity and, all else equal, increased emissions.
- Composition effect: trade opening has an impact on a country's sector mix of production which can impact on emissions.
- Technique effect: trade opening can lead to improvements in energy efficiency through use of improved technology etc.



Technology spillover as a key driver of the technique effect

Technique effect: trade opening can lead to improvements in energy efficiency.

Two key drivers:

1. Increasing income drives demand for better environmental outcomes (domestic focus)
2. Technology and innovation spillover (international focus)

Modelling technology spillover in CGE

1. Van Meijl & Van Tongeren (1999): specify a transmission mechanism for technical knowledge in machinery and equipment used in agriculture. They assume that knowledge is embodied in traded commodities, both final products and intermediate inputs.
2. Perrado and De Cian (2014): knowledge is embodied only in machinery and equipment imports which is supported empirically by Carraro and De Cian (2013) who estimated a positive relationship between machinery and equipment imports and energy and capital productivity.
3. Gerlagh and Kuik (2014): focus on international technology diffusion, not through goods, but rather through knowledge where each region has a propensity to contribute to international knowledge and a propensity to absorb innovations.

Modelling technology spillover in GTAP-E

Comparison of two approaches:

- i. Perrado & De Cian: more focus on trade liberalisation, but not in the GTAP framework. They model trade-driven technology spillovers and analyse the interaction of climate and trade policies in the presence of such spillovers within a dynamic recursive CGE model. Approach adapted and incorporated into GTAP-E.
- ii. Gerlagh & Kuik: already uses GTAP-E, but with a climate policy focus. Include induced technical change by transforming the technical change parameter, which is normally an exogenous parameter, into an endogenous variable and relating it to the relative, price-induced change in the demand for energy. Applied here to trade policy.

Perrado & De Cian (PDC) approach

Using GTAP-E, but with additional equations:

$$afall_{c,a,r} = gamma_{c,a,r} \times qfm_{ome,a,r}$$

First equation links technical change parameter for energy and capital inputs to intermediate imports of machinery and equipment.

$$gamma_{c,a,r} = gamma0_c \times MS_r \times CR_r \times CS_{a,r}$$

Second accounts for a country's absorptive capacity, linking back to the econometrics.

Gerlagh & Kuik (GK) approach

Technical change parameter linked to relative, price-induced change in the demand for energy.

$$afetc_{c,a,r} = ABSC_r \times (ETC_r / (1 - (1 - ETC_r) \times ELFNCOAL_{a,r})) \times (ISPIL_s \times (qfa_{ncoal,a,s} - qfa_{c,a,s}))$$

Technical change can go in either direction. If a commodity is used more, the technology of its use improves and its unit cost decreases. If a commodity is used less, the reverse occurs.

Technological change is modelled in such a way that the overall effect of technical change on the costs of the final product is zero. If, for example, the energy good becomes more productive, another input factor becomes less productive. The model brought by technological change operates through the technology spillovers from one region to other regions augmenting their production possibilities.

Test scenario

1. UK FTAs using both approaches with and without technology spillover
 - a. Full tariff liberalisation between the UK and India, USA and Australia
2. Carbon taxes in UK and USA
 - a. \$10 carbon tax applied in both countries

Model setup

16 countries, 11 sectors

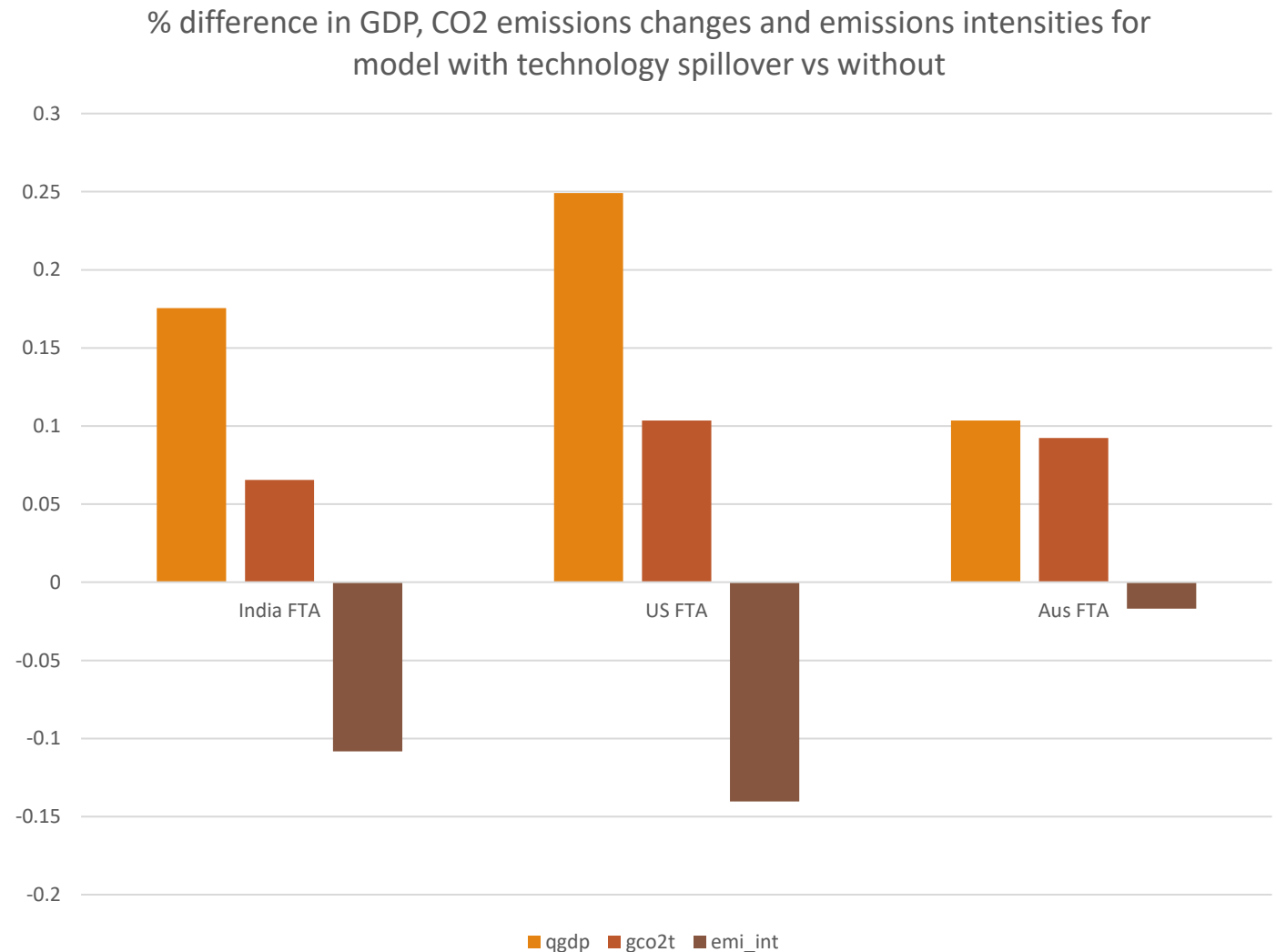
Database is GTAP11 pre-release: 2017 reference year

Additional parameters for Gerlagh & Kuik approach: spillover and absorptive capacity => calibrated based on an empirical study by Dechezleprêtre et al. (2011).

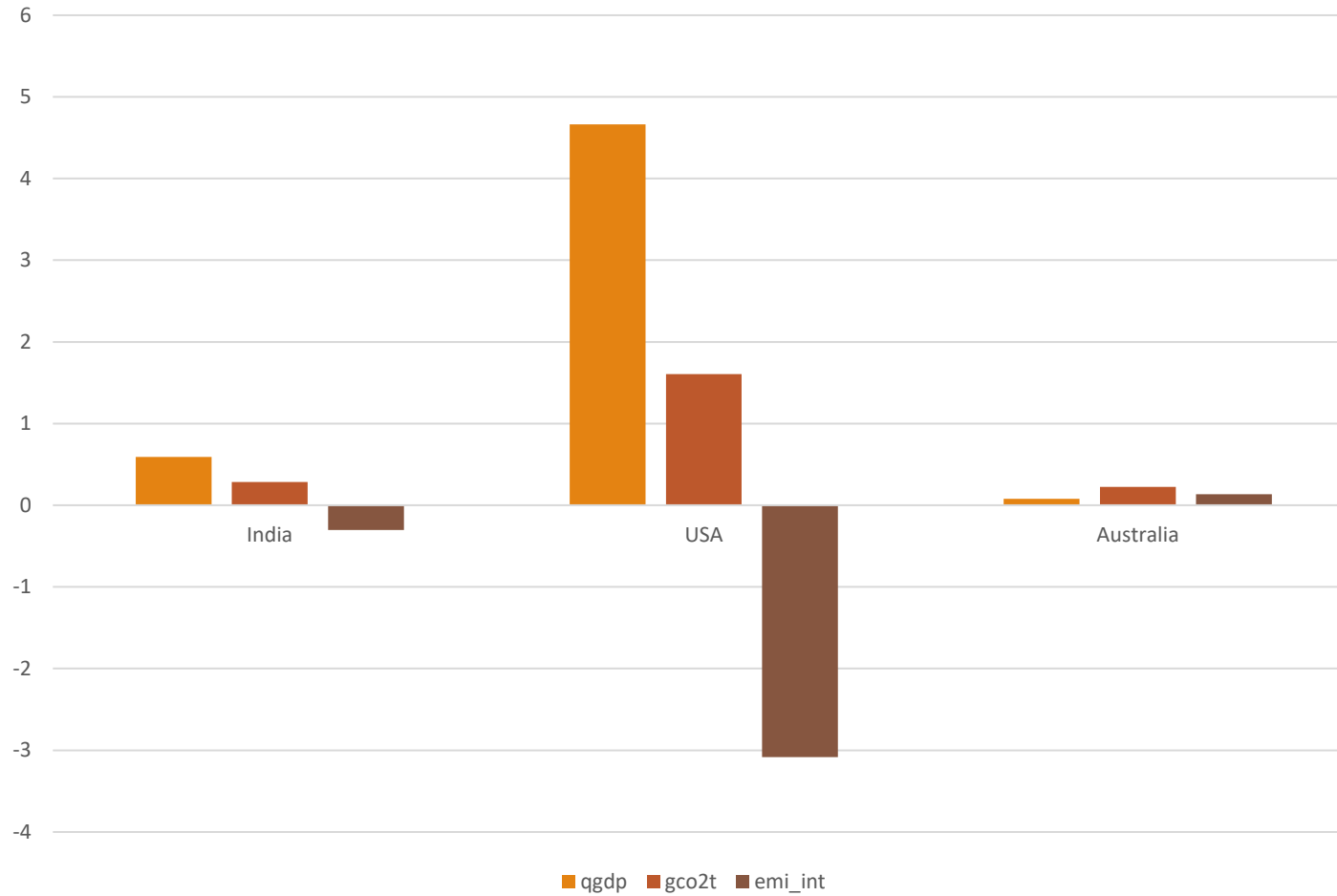
Additional parameters for Perrado & De Cian approach: spillover coefficient, and additional parameters => calibrated to econometric estimates from Carrado and De Cian (2012). OECD assumed to be the technology frontier.

Results - PDC approach

- Results suggest that inclusion of technology spillover reduces emissions intensity of growth from an FTA.
- But the implications for impacts of an FTA are limited (note the scale and that these are % changes in changes).



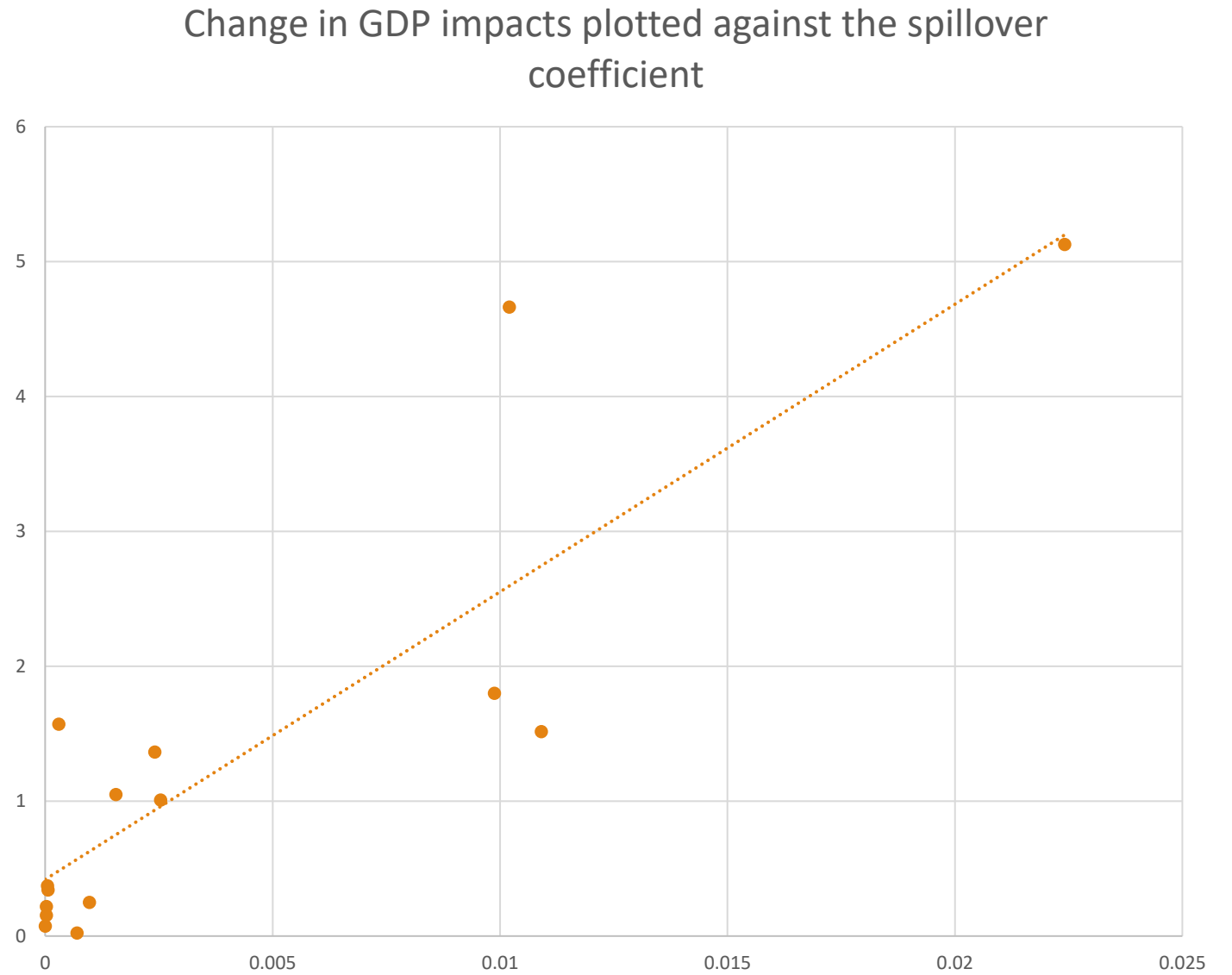
% difference in GDP, CO2 emissions changes and emissions intensities for model with technology spillover vs without



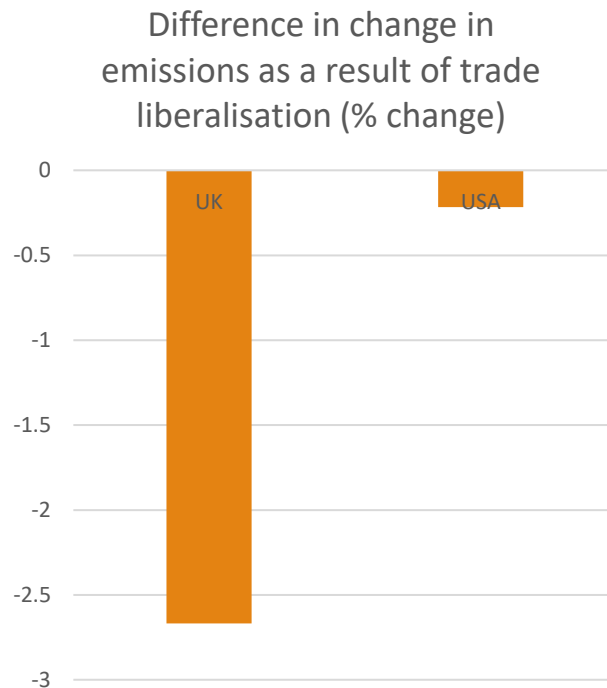
Results - PDC approach

- Similar story for FTA partners, but to different magnitudes.
- Indicates that spillover coefficient could be key.

Results - PDC approach



Results - GK approach



Using the GK approach, the additional impacts on FTA assessment is only significant when looking at a scenario with carbon taxes in the baseline.

Looking at the UK-USA scenario, with \$10 carbon taxes in the baseline, the UK change in emissions falls by just over 2.5%.

Conclusions

PDC approach

GDP changes as a result of FTA become less emissions intensive

However, impacts are small

A country's absorptive capacity likely to determine size of technology spillover impacts
(therefore assumptions around this are key)

GK approach

Could have an impact when incorporating climate policies, with FTAs on top

Could be useful in other policy work

Should we care about the technique effect in CGE?

Yes, but some considerations:

Importance of the spillover coefficient – how reliable is it?

More important when combined with climate policy – should this be a consideration when assessing trade liberalisation anyway?

Next steps

Introducing a dynamic element: GTAP-E-RD

Further testing of models to additional parameters

Thank you – any questions?

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