The economic impact of Air Passenger Duty
Analytical update

May 2015

pwc

Report Commission

In July 2012 PricewaterhouseCoopers LLP (PwC) were commissioned by a group of UK and Irish airline operators – British Airways Plc, Virgin Atlantic Airways Ltd, Ryanair Ltd, and easyJet Airline Company Limited – to provide an evidence-based assessment of the impact of Air Passenger Duty (APD) on the UK economy, and its contribution to the public finances. The final report was published in February 2013 under the title "*The economic impact of Air Passenger Duty: A study by PwC*". For the purposes of this update we refer to this report as the "*2013 APD study*".

In December 2013, two further reports were published by the UK government that had direct implications for the conclusions drawn by the *2013 APD study*:

1. "*Analysis of the dynamic effects of Corporation Tax reductions*", joint report by HM Revenue and Customs (HMRC) and HM Treasury (HMT), 5 December 2013.[1]
2. "Econometric analysis to develop evidence on the links between aviation and the economy: A report by PwC for the Airports Commission", December 2013.[2]

Given the importance of these studies, the same group of airlines have commissioned PwC to update the *2013 APD study*. In this update we:

- explain the findings of these two reports and their relevance to the *2013 APD study*; and
- use their findings to inform a re-estimation of the economic impact of APD abolition on the UK economy.

To avoid repetition, from this point onwards we refer to the HMRC and HMT study on dynamic corporate tax effects as the "*HMRC-HMT study"* and the PwC study for the Airports Commission as the "*aviation links study"*.

While all four airlines in the commissioning group commented on the draft report, the final report represents the independent analysis of PwC.

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The economic impact of air passenger duty: analytical update

Introduction

The report is broken down into three sections:

1. We first compare the HMRC-HMT analysis of corporation tax and the PwC analysis of APD.
2. We then discuss the findings from our study for the Airport Commission that analyses the economic linkage between the aviation sector and GDP.
3. Based on the study for the Airports Commission we update the analysis in the *2013 APD report*. In this section our projects account for the fact that the Government has already removed bands C and D of APD, coming into effect from 1 April 2015. It means that the highest APD band levied is now band B.

Before we present our detailed analysis we first present a summary of our findings.

Summary of findings

Comparing the HMRC-HMT analysis of corporation tax and the PwC analysis of APD

Based on our comparison of the *HMRC-HMT study* and the *2013 APD study* we find the following:

1. Both papers use the same Computable General Equilibrium (CGE) modelling technique to analyse tax policy impacts. The models used are broadly comparable but there are two key differences:
   - **Data:** the HMRC model has more detailed tax and household data than the PwC model – this is because much of this data is not publicly available. However, in the instances where PwC does have less detailed tax information the model results are not significantly affected. This is because the effective tax rates in the model must be set within a certain range due to their statutory values, so there is a limited set of values that the tax data can assume.
   - By changing these assumptions within their full possible range, the magnitude of results generated by the CGE model can only vary by approximately 15%, which is not enough to effect the overall conclusion drawn from our *2013 APD study* that suggests that APD abolition would lead to increased tax revenues overall for the exchequer.
   - **Treatment of tourism:** the HMRC model does not explicitly account for tourism flows or spending. The PwC model does, and for the purpose of modelling APD, this is essential.
2. In their "normal" form, CGE models do not take account of the full set of economic costs and benefits associated with a change in tax policy, so they must be adapted depending on the particular tax scenario being considered. A key linkage that is not explicitly modelled in a standard CGE model is the relationship between a change in tax policy and productivity.
3. The *HMRC-HMT study* examines government cuts in the rate of corporation tax since 2010. However, it does not attempt to take account of the link between a change in the corporate tax

rate and the level of UK productivity. The *2013 APD study* used supporting research to make an explicit link between a change in APD and a change in UK productivity.

4. Standard economic theory predicts that when taxes rise, the level of economic output, as measured by GDP will fall.[3] However, the extent to which GDP falls by, will vary depending on the type of tax and there are numerous studies on this topic (for a summary, see OECD, 2010)[4]. In the *2013 APD study* we carried out analysis that compared the economic cost in GDP terms for a £1 rise in APD against an equivalent £1 rise in corporation tax. The *HMRC-HMT study* carries out the same type of exercise for corporation tax. Key results are as follows:

   - The *HMRC-HMT study* suggests that for every £1 cut in corporation tax, then in the medium-term, GDP will increase by £0.62.
   - In the *2013 APD study*, the same exercise was undertaken which suggested an equivalent figure of £0.55 for a £1 cut in corporation tax.
   - The equivalent figure for a £1 cut in APD was £0.59.

   There are some small differences between the exact scenarios compared, but overall our analysis suggests that the results generated by the PwC and HMRC models are comparable.

A new assumption relating to the economic linkage between the aviation sector and GDP

In December 2013 the Airports Commission published a PwC study prepared on its behalf on the links between aviation sector output and UK GDP growth: the *aviation links study*. This analysis suggests that if seat capacity were to increase by 10% then the short-term growth rate of GDP will increase by one percentage point. This implies that the level of GDP will rise by 1 % permanently.

To recap, the *2013 APD study* used an assumption that for every 10% increase in business travel, the level of UK productivity would increase by 0.2%. This assumption was based on the available econometric evidence at the time. However, the aviation links study provides a better proxy for the link between airline sector output and GDP for four reasons:

1. The *aviation links study* shows **a stronger statistical link** between aviation sector output and GDP than the previous evidence used in the *2013 APD study*. The *aviation links study* was conducted using a cointegration test that showed a statistically significant "two-way Granger causal" link between seat capacity and GDP. Not all of the evidence considered in the *2013 APD study* was able to show a statistical link this strong between GDP and the chosen measure of aviation sector output.

2. Because the *PwC aviation links study* result is **not restricted to business travel**, but overall seat capacity, it implies a larger productivity increase than used in the *2013 APD study*.

3. Not all of the evidence considered in the *2013 APD study* that linked aviation sector output to UK GDP was specific to the UK. Some of the connectivity measures included data on the UK and other countries, while these studies are reflective of the overall link between aviation sector output and GDP, the *aviation links study* is **specific to the UK**.

[3] This finding should be caveated with the principle that the effects of tax on GDP should, where possible, be cross-referenced with an assumption of how the tax revenue gets spent. In certain circumstances, additional government spending could offset the economic costs of taxation. These spending effects are factored into both the HMRC-HMT and PwC modelling.

[4]

4. The *aviation links study* is based on data up to the year 2012, making it, at the time of writing, **the most recent analysis** of the relationship between aviation sector output and GDP.

Seat capacity is one of many measures of aviation sector output, but it is also one that is relevant to the issue of analysing the economic effects of APD. The modelling in the *2013 APD study* found that, following APD abolition, demand for flights would increase by 10%. This demand could be matched by increased supply through two channels: increased connectivity through airlines flying to more destinations and increasing flight frequency on key routes; and higher load factors (more people using existing airline services).

We make a cautious assumption that 3 percentage points of the extra 10% of airline services demanded would be met through increased connectivity and the remaining 7 percentage points through increased usage of existing routes (larger planes or higher load factors). Based on the coefficient generated in the *aviation links study* this implies that APD abolition would boost the level of GDP by 0.3%. This linkage is then translated into a total factor productivity adjustment in the CGE model[5] and forms the basis for an update of the *2013 APD study*.

Updated results

Based on this new productivity adjustment a revised set of results from the CGE model shows:

1) In the first year following the abolition of APD, the show a positive stimulus to the economy of around 0.5 percent of GDP. The revised productivity assumption shows an increase in GDP of 0.01 percentage points which essentially corroborates the results published in the *2013 APD study*. This pattern continues in each year of the modelling following the abolition of APD. On this basis, in the years 2016 and 2017 combined we might expect the economy to be around £18bn larger than it otherwise would have been under the current APD regime.

- Over time, the benefits from APD abolition dissipate but the economy would still experience a small but positive longer-term gain of around 0.1% on the level of GDP.

- Should the rise in output associated with APD abolition materialise as our modelling suggests, then based on this updated analysis it could be possible that **almost 61,000 jobs could be created between now and 2020**. The equivalent figure for the *2013 APD study*, was 60,000 jobs created.

- The analysis suggests an abolition of APD could raise more than a net £0.5 billion in extra tax receipts in each of the first two fiscal years, falling to £0.3 billion by 2017-18. The initial fiscal costs of APD abolition, which are around £3 billion, are fully offset.

[5] Such an adjustment is needed to fully reflect the link between the aviation sector and GDP as the CGE model does not capture this linkage in its normal form.

Comparing the HMRC-HMT analysis of corporation tax with PwC's analysis of APD

The *HMRC-HMT study* is similar to the *2013 APD study* as both use the Computable General Equilibrium (CGE) modelling techniques to analyse the impact of tax cuts on the economy. In this update we compare the:

1. properties of the two models;
2. the modelling approaches; and
3. results from both studies.

Model properties

The CGE model used in the *HMRC-HMT study* is operated by HMRC. HMRC published a significant amount of detail relating to their CGE model in a separate 2013 working paper[6]. A more detailed description of the PwC CGE model can be found in the *2013 APD study*.

The HMRC and PwC CGE models are broadly similar in their structure. Their specifications are compared in Table 1 below.

[6] HMRC (2013) "HMRC's CGE model documentation", December. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263652/CGE_model_doc_131204_new.pdf In this working paper they describe CGE models and their use of them as follows:

"*A CGE model is a large-scale numerical model that simulates the core economic interactions in the economy. It uses data on the structure of the economy along with a set of equations based on economic theory to estimate the effects of fiscal policies on the economy*".

"*CGE models capture the inter-dependencies between the different product markets, factor markets, and public and private sectors in the economy, enabling analysis of how a policy change targeted in one part of the economy will affect the rest of the economy. Hence, this is a useful tool for analysis as policies can often have indirect effects that are difficult to quantify*."

Table 1: Summary comparison of the HMRC-HMT CGE model and PwC CGE model

	HMRC-HMT CGE Model	PwC CGE model
Model dynamics	Both models are dynamic and make forward-looking projections based on assumptions relating to the long-term growth rate of the economy. The PwC model assumes this growth rate is 2.3%, in line with Office of Budget Responsibility (OBR) assumptions.[7] HMRC-HMT do not publish the precise growth rate used in their model. The fact that these assumptions may differ should not lead to material differences. In this type of model, the higher the growth rate that is assumed implies there is more capacity in an economy to absorb any positive or negative effects associated with a change in tax policy, or any other modelled scenario. Overall the PwC model is fairly insensitive to this overall assumption and given the similarities in assumptions with the HMRC model, we would expect a similar outcome.	
Capital adjustment costs	Both models use the same assumption relating to capital adjustment costs. The assumption implies that as more capital is accumulated in the model, it becomes more costly. There is a cost associated with each £1 of capital growth in the models.	
Treatment of taxation	The models appear to account for the same taxes but the HMRC model has a more bespoke treatment of sector specific tax rates. For corporation tax this is important as different sectors pay different amounts of corporation tax depending on their average profitability. This data is not publicly available.[8] For APD this is not such a serious issue as it is a tax that is levied directly on the airline sector which is modelled separately in the PwC CGE model. Where tax policy analysis requires data for the same tax head, but at a specific household or sector level, the HMRC model will be more accurate.	
Detailed tourism sector	There is no explicit treatment of the tourism sector in the HMRC model. The inclusion of a tourism sector is a complex addition to a CGE model, but its usefulness is limited to the analysis of policy measures that are directly related to the tourism sector – hence this modelling extension is not included in the HMRC model.	The main data set for the UK economy is supplemented with tourist passenger arrivals and tourist spending patterns data. It also incorporates the UK Tourism Satellite Account (UK-TSA) published by the Office for National Statistics (ONS) which provides information about the demand for goods and services associated with the activity of tourists and the relationship of this demand to the supply of such goods and services within the UK economy. This additional data is essential for modelling a change in APD.
Sector data	Both models are based on the same 2010 UK Supply Use Tables (SUT) dataset published by the Office for National Statistics (ONS). The SUT's contain data on 96 different sectors. The modelling software used by both models (GAMS/MPSGE) does not have the capacity to solve a model with so many sectors, so the models must be aggregated. The model aggregation will depend on the focus of the models application. To analyse APD the PwC CGE model is aggregated to 20 sectors. Of these 20 sectors the model contains specific data on the air transport, hotel and accommodation, tour operator and leisure sectors for which data are published as part of the 96 SUT sectors. The HMRC-HMT model uses around 20 sectors as well, but we do not know the precise sector specification.	
Elasticities	A review of key model elasticities suggests they are broadly the same.	

[7] OBR Working Paper No. 1:"Estimating the UK's historical output gap", November 2011, http://budgetresponsibility.org.uk/wordpress/docs/WorkingPaperNo1-Estimating-the-UKs-historical-output-gap.pdf

[8] Taxpayer confidentiality laws prevent HMRC from publishing this data in full.

Household treatment	There is a maximum of 50 representative households in the HMRC-HMT model based on aggregated survey data.	This survey data is not public so cannot be used in non-government models. We comment on this in more detail below.

Source: PwC analysis

Based on the comparison above the PwC and HMRC CGE models are broadly similar in their design and construction. The publication of model documentation by HMRC confirms this, although there are some key differences between the two models which would lead to differences in modelling results. These are:

1. the detailed household and tax data that is held by the UK Government but not published, so is therefore not available to external researchers;[9] and
2. the treatment of tourism in the PwC CGE model, which is not present in the HMRC-HMT model.

Overall the absence of household or sector specific tax data is not a major risk when modelling APD as it is a tax levied directly on the airline sector which has a separate treatment in the PwC CGE model. However, if the PwC CGE model was used to examine the effect of cutting corporate tax in one sector and raising it in another, and the detail of the associated corporate tax burdens was not known, then this would represent a substantial challenge to the reliability of the model.

Due to data restrictions, a precise sectoral allocation of tax payments cannot be included in the PwC model. On this basis we have approximated this information as best we can from existing government data and assumptions.[10] However, in the instances where PwC does have less detailed tax information the model results are not significantly affected. This is because the effective tax rates in the model must be set within a certain range due to their statutory values, so there is a limited set of values that the tax data can assume. Sensitivity tests suggest that the absence of this data from our model means that our fiscal results could be affected by as much as plus/minus 15%. We have tested the model and this range is not substantial enough to change the main message of the results presented in the final section of this document, that abolishing APD would be at least fiscally neutral.

Modelling approach

In their standard form the PwC and HMRC CGE models do not capture the full dynamic effects of a tax policy change. The key piece of missing information in the modelling relates to how these alternative tax policy scenarios affect productivity.

CGE models are based on sector specific average productivity rates. These average productivity effects are accounted for through increases in investment or human capital in the model. However, the modelling does not capture productivity benefits associated with innovation or technology spillovers.[11] This means that unless specific additional adjustments are made for these particular productivity effects the results from the model are likely to underestimate the benefits and costs of tax policy changes.

In the case of cuts to corporation tax, the *HMRC-HMT study* makes specific mention of the potential for a change in productivity. It notes specifically that "*Corporation Tax rates may affect productivity*

[9] The absence of household data in the PwC CGE model would be a concern if it was being used to analyse in detail a tax that is explicitly levied at the household level (e.g. income tax) as it would not be able to fully map the distribution of income tax by different wage earning groups. For instance, it would not be possible to model a shift in the income tax burden from lower rate to higher rate tax payers in the PwC model.
[10] The key assumption being that tax receipts are allocated across sectors in proportion to their share of the particular tax base.
[11] Some taxes are actually designed to increase productivity. Research and development tax credits are a prime example.

by incentivising research and development (R&D) and high-tech foreign investment, increasing labour productivity and wages". However, despite acknowledging this linkage the *HMRC-HMT study* takes no specific account for it despite it being a relatively straightforward adjustment to make. In contrast, the *2013 APD study* makes a specific productivity adjustment. The rationale for this adjustment is discussed below.

The *2013 APD study* finds that in response to the abolition of APD, the demand for flights could increase by 10% and the supply of airline services would rise to meet this demand. There is a question as to whether this increase in supply is met through:

1. **Increased connectivity:** the creation of new routes or an increase in the volume of services on existing routes.
2. **Increased usage of existing routes:** the use of larger planes or an increase in load factors (i.e. taking up spare capacity on existing planes).

The CGE model is not granular enough to determine the precise channels through which supply would increase, so an assumption is made. This assumption is based on an adjustment in whole economy productivity which occurs as a direct response to a change in airline sector output. The rationale for this adjustment is that *"greater connections to the global air transport network can boost the productivity and growth of economies by providing better access to markets, enhancing links within and between businesses and providing greater access to resources and to international capital markets*" [12].

There is a body of evidence that suggests a link between increased airline sector output, increased connectivity and GDP.[13] Links have also been made between increased business air usage, which could be a result of increased connectivity or increased load factors and productivity. A selection of the key studies are summarised in Table 2 below:

[12] 'Airline Network Benefits: measuring the additional benefits generated by airline networks for economic development', IATA (2006).
[13] Following a detailed search we did not find any studies that would actually refute the link between airline sector output and GDP. Although, not all studies show strong linkages - this is often down to the data used which is focussed on direct and hubbed flight routes. The performance of hubbed flight routes will be dependent on a much wider range of factors than GDP, so links can be difficult to establish. Studies that use direct flights as their measure of airline sector output tend to show stronger links with GDP.

Table 2: Studies showing a link between aviation sector output and GDP

Source	Scope of report	Modelled variables	Scale of impact	Other key findings
Oxford Economics (2006)	Estimates a statistical relationship between UK business air usage and total factor productivity based on panel data for 31 UK industries over 27 years.	Business air usage variable is constructed by combining the number of business passengers at UK airports with the volume of airfreight.	A 10% increase in business air usage raises total factor productivity and UK GDP by 0.6%.	Results imply that rapid growth in air transport usage over the last decade has boosted long-run underlying productivity by 2% across the EU-25.
IATA (2006)	Estimates a statistical relationship between connectivity and GDP using panel data for major airports across the EU.	Defines connectivity as the number of flights from a given airport weighted by the importance of each of the destinations served.	A 10% increase in connectivity (relative to GDP) increases both long-run productivity and GDP by 0.9%.	
IATA/InterVISTAS (2010)	Estimates a relationship between a number of aviation-specific variables (including connectivity) and labour productivity based on panel data for 48 countries over 9 years.	Defines connectivity as the Aviation Connectivity Index, which is produced by IATA.	A 10% increase in connectivity would increase long-run productivity and GDP by 0.07%	'Small' estimate may be driven by outliers (e.g. Poland). Aviation impact is strong and cumulative over time, driving higher exports, higher tourism and potentially higher export prices.

Sources: See footer[14]

In the *2013 APD study*, based on the studies cited above, we chose a reasonably conservative point estimate. The assumption we imposed on the model was that a 10 percent increase in business air usage would lead to an increase in whole economy productivity of 0.2 percent.[15]

Comparing results from HMRC's modelling of corporation tax vs. PwC's modelling of APD

The publication of *the aviation links study* supersedes the evidence presented in Table 2; so on this basis the *2013 APD study* is updated. This is discussed in more detail in Section 1.4. However, given that the *HMRC-HMT study* does not include a specific productivity adjustment we first make a direct

[14] Sources include:
"The economic contribution of the Aviation Industry in the UK", Oxford Economics (2006),
"Airline Network Benefits: measuring the additional benefits generated by airline networks for economic development", IATA (2006) and Economic Impacts of Aviation: Catalytic Impacts, IATA/InterVISTAS (2010).
Tam,R. and Hansman, R.J. (2002) "Impact of air transportation on regional economic and social connectivity in the United States" International Center for Air Transportation Department of Aeronautics and Astronautics Massachusetts Institute of Technology Cambridge, Massachusetts, USA.
http://dspace.mit.edu/bitstream/handle/1721.1/35884/atio_tamhansman.pdf

Smyth,A. Christodoulou,G. Dennis,N. AL-Azzawi,M. Campbell,J. (2012) "*Is air transport a necessity for social inclusion and economic development?",* Journal of Air Transport Management, Volume 22, July 2012, Pages 53-5

[15] This choice is governed by the range of quantitative estimates discussed above. The lower end of the range is the IATA/InterVISTAS study which deals explicitly with connectivity and concludes that "a *10% increase in connectivity, relative to GDP, can increase long-term productivity levels by 0.07%"* and at the upper end a separate IATA study carries a similar coefficient equal to 0.9%.

comparison with equivalent results from the *2013 APD study* (i.e. results without a productivity adjustment).

The purpose of the *HMRC-HMT study* is to examine the dynamic economic effects of the UK governments policy to cut the headline rate of corporation tax from 28% in 2010 to 20% in 2015-2016. By 2016-17 when all the cuts have been implemented they will constitute reductions in corporate tax revenues of £7.8bn a year. The key results from this study are as follows:

- The modelling suggests that the tax reductions will increase investment by between 2.5 per cent and 4.5 per cent in the long term (equivalent to £3.6 billion – £6.2 billion in today's prices) and GDP by between 0.6 per cent and 0.8 per cent (equivalent to £9.6 billion - £12.2 billion).

- The modelling shows increased profits, wages and consumption all add to higher tax revenues from other heads of tax. This means that the policy does not cost the government the full £7.8bn per annum that the government quotes for 2016-2017. HMRC-HMT estimate that when the revenue gains from other tax heads are factored in then the cost of the policy falls by between 45% and 60% of the original figure in the longer-term.

- The *HMRC-HMT study* also constructs a measure of the economic efficiency of corporation tax. This is measured as the cost/benefit to GDP per £1 of tax cut/tax rise. This is a standard measure and is widely used in the academic literature (see Varian, 2010 for a definition). Modelling suggests that for every £1 cut in corporation tax, then in the medium-term, GDP will increase by £0.62.

What differentiates the *HMRC-HMT study* from previous government published analysis of tax policy proposals is its open treatment of "dynamic effects"– changes to the economy that are caused by the tax changes themselves. Previously it had only published revenue estimates that did not consider dynamic effects on tax receipts – known as "static scoring". The *2013 APD study* also includes dynamic effects and given the similarities in the models used it is possible to draw some direct comparisons between the two studies.

For instance, the *HMRC-HMT study* suggests that for every £1 cut in corporation tax, then in the medium-term, GDP will increase by £0.62. In the *2013 APD study*, the same exercise was undertaken which suggested an equivalent figure of £0.55 for a £1 cut in corporation tax. The equivalent figure for APD was £0.59 and a full set of results from that exercise are published in Table 3 below.

Table 3: Results from a CGE model simulation, 2013 APD study: How much extra GDP results from a £1 tax cut (median value over 30-year time horizon)

VAT	Income Tax	NICs	CT	APD	Fuel Duty
£0.15	£0.25	£0.28	£0.55	£0.59	£0.63

Source: PwC analysis

Overall, results are broadly comparable, given that the differences outlined above in the comparison of model structures and the differences between the different scenarios run through the models (the PwC scenario looked at a £1 change in taxation, while the HMRC-HMT scenario cumulated to a £7.2bn change which in part explains why the HMRC-HMT result is larger).

Updating the link between airline sector and GDP: revised APD impact results

New evidence on the link between aviation sector capacity and GDP

In December 2013 the Airports Commission published a PwC study on the links between aviation sector output and UK GDP growth: *the aviation links study*. This analysis suggests that if seat capacity increased by 10% then the short-term growth rate of GDP will increase by 1%. This implies that the level of GDP would rise by 1% permanently.[16]

This study shows a stronger link between aviation sector output and GDP than the previous evidence used in the *2013 APD study*. This analysis was conducted using a cointegration test that showed a statistically significant "two-way Granger causal" link between seat capacity and GDP.

This relationship is statistically more robust than the evidence cited as a basis for the *2013 APD study* – hence the need to update the analysis. Not all of the studies considered in the *2013 APD study* were able to show that was a Granger causal link between GDP and the corresponding measure of aviation sector output chosen for that particular study. Also, not all of these studies were specific to the UK and the *aviation links study* is based on more recent data than the other studies. On this basis we update the analysis in the *2013 APD study* to better account for the link between aviation sector output and GDP.

To recap, *the 2013 APD study* used an assumption that for every 10% increase in business travel, the level of UK productivity would increase by 0.2%. This assumption was based on the available econometric evidence at the time. Because the *PwC aviation links study* result is not restricted to business travel, but overall seat capacity, it implies a larger productivity increase than used in the *2013 APD study*.

Using seat capacity as a proxy for aviation connectivity the econometric analysis conducted in the *PwC aviation links study* also found that a 10% increase in seat capacity is associated with increased levels of:

- **tourism:** a 4% increase in tourist arrivals in the UK and around a 3% increase in UK tourists abroad;
- **trade:** a 1.7% increase in UK goods imports and a 3.3% increase in UK goods exports; and a 6.6% increase in UK imports of services and a 2.5% increase in UK exports of services;
- **FDI:** a 4.7% increase in UK FDI inflows and a 1.9% increase in UK FDI outflows; and
- In the regional FDI model a 1% increase in connectivity is associated with approximately a 1.1% increase in manufacturing related FDI inflows.

However, the interpretation of these links should be treated with caution. The statistical analysis passed necessary robustness tests. But as is normal with econometric analysis of this type, and any type for that matter, the results should be read not as representing causality but association. The results simply suggest that an increase in seat capacity provides more scope for trade or that an increase in trade increases the need for seat capacity, or some combination of the above. These results are based on a system GMM panel data econometric model using instrumental variables to correct for endogeneity. As far as econometric results stand, the statistical linkage is strong.

[16] This analysis was conducted using a cointegration test that showed a two-way Granger causal link between seat capacity and GDP.

Economic impact of abolishing APD: revised modelling result

Estimating the additional link between airline sector output and GDP

Based on this revised and more robust statistical linkage between airline sector output and GDP we have re-run our main scenario from the *2013 APD study*. In our scenario we model the complete abolition of APD and examine its direct and indirect economic consequences.

In our *2013 APD study* our modelling showed that abolishing APD would have a positive impact on the level of UK GDP, compared to a baseline case of no policy change. In response to the abolition of APD we found that the overall demand for flights increased by 10% and the quantity supplied increased to match this. However, as described above, it is not clear whether this increase in demand would manifest itself in terms of increased connectivity or increased usage of existing routes.

For the purposes of our analysis we assume a 30:70 split i.e. 3 percentage points of the 10% increase in demand manifests itself in greater connectivity and 7 percentage points in higher levels of existing route usage. This 3 percentage point increase in connectivity is proxied through a 3% increase in seat capacity. Based on the coefficient estimated in the *aviation links study*, this would imply that following APD abolition the level of GDP would increase by 0.3% on top of the "normal" range of dynamic economic effects predicted by the CGE model. As described above this is due to associated positive productivity spillover effects.

Model results – GDP impacts

Model results from the 2013 APD study are compare with the updated results in in Should the rise in output associated with APD abolition materialise as our modelling suggests, then based on this updated analysis it could be possible that almost 61,000 jobs could be created between now and 2020. The equivalent figure for the *2013 APD study* was 60,000 jobs created.

*Figure **1*** below. The results show the estimated impact of APD abolition are presented in Figure 1 below and are compared with results using the revised assumption relating to seat capacity and the level of GDP. In the first year following the abolition of APD, the results show a positive stimulus to the economy of around 0.5% of GDP. The revised productivity assumption shows an increase in GDP of 0.01 percentage points which essentially corroborates the results published in the *2013 APD study*. This pattern continues in each year of the modelling following the abolition of APD.

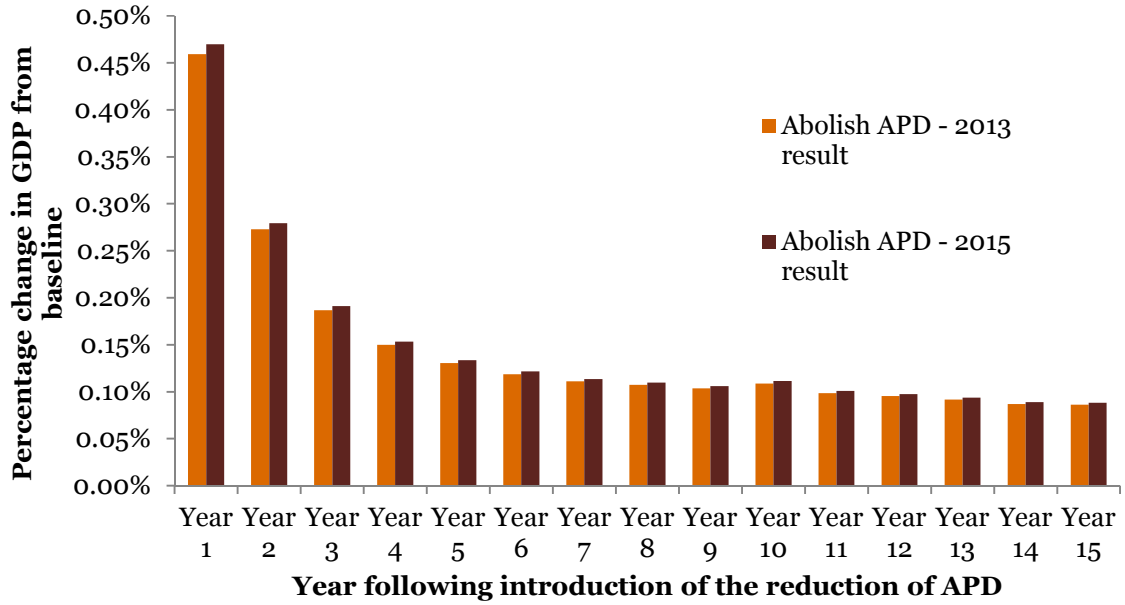
Over time, the benefits from APD abolition dissipate but the economy would still experience a small but positive longer-term gain of around 0.1% on the level of GDP. The results show an average gain to the economy of 0.3% in the first two years following abolition. The difficulty in predicting the precise trajectory of GDP in the early years of the models is that it is dependent on the pace at which both airlines and non-airline sector business are willing to invest, able to expand their export customer base and seek better deals on their imported goods and services.

There is an inherent risk that these benefits will not materialise as this outcome is dependent on the performance of the global economy. Alternatively, for the same reason, the benefits shown could actually be larger than our modelling suggests. Our model assumptions regarding how international trade and investment might respond to APD abolition are cautious in that they are assumed to adjust in line with the long-term growth rate of the UK economy. Nonetheless, we might expect the economic response to be front loaded as any cut in APD would most likely pass through to airline ticket prices relatively quickly.

All gains to the economy are shown to be permanent in the model. In the 5 years to 2020 the output of the economy could be around 1.7% bigger than it otherwise would have been without the abolition of APD when the new larger productivity shock is introduced.

Should the rise in output associated with APD abolition materialise as our modelling suggests, then based on this updated analysis it could be possible that almost 61,000 jobs could be created between now and 2020. The equivalent figure for the *2013 APD study* was 60,000 jobs created.

Figure 1: The impact on the level of real GDP of abolishing APD – comparison of productivity assumptions.



Source: PwC analysis

The volume of net foreign inbound tourism passengers is 7 percent higher by 2020 compared to the baseline where APD continues to rise in line with current announced plans. This 7 percent figure can be broken down into inbound and outbound tourists. Notably, inbound household and business passenger travel are modelled which increase by 11 percent and 10 percent respectively. This equates to approximately 200,000 extra inbound tourist arrivals in the UK. A reduction in APD will also stimulate additional outbound trips of around 240,000 passengers each year. While outbound tourists represent a net loss to the economy in that they spend money abroad when they travel, foreign holidays are "welfare improving" and around one-third of this figure consists of business travelers who use these trips to generate new trade and investment for the UK economy. This passenger outcome is based on the assumption of a structural response by the airline sector whereby it increases the overall level of connectivity to the UK economy by approximately 5% in the medium-term.

Model results – fiscal impacts

The CGE model also produces a detailed set of tax revenue results and shows the effects of APD abolition on other tax heads. As described above these receipts estimates are dynamic in that they include the economic effects from the additional growth generated by the abolition of APD.

Key results are given in Table 4 below where again we compare the results from the 2013 APD study and the updated results using the revised productivity assumption from the aviation links study. The "static" scorecard i.e. our estimate of the figure HMT would publish in official Budget/Autumn Statement documents is published alongside the dynamic scorecard estimates for comparison.

Table 4 can be interpreted as follows:

- Row 1 shows our estimate of the cost of abolition based on standard "static" HM Treasury scorecard methodology as published in the *2013 APD study*.
- Row 2: shows the dynamic scorecard results from the *2013 APD study*.
- Row 3: shows our estimate of the revised cost of abolition, based on upgraded forecasts and the rise announced in Autumn Statement 2013 using static HMT scorecard methodology.
- Row 4: shows the new results from the CGE model.

Both the *2013 APD study* and the updated results show a net exchequer gain to abolishing APD. However, the results from the new productivity assumption are more positive. The analysis suggests an abolition of APD could raise more than a net £350m in extra tax receipts in each of the first three fiscal years.

Table 4: Dynamic and static scorecard comparison of fiscal results for abolition of APD

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1. Static Scorecard: 2013 APD Study	**2.27**	**2.4**	**2.5**	**2.6**	**2.69**	**2.78**	**2.87**	**2.95**
2. Dynamic Scorecard: 2013 APD Study	**0.48**	**0.51**	**0.31**	**0.23**	**0.14**	**0.1**	**0.07**	**0.05**
3. Static Scorecard: Abolition based on Autumn Statement forecast				**-3.1**	**-3.2**	**-3.4**	**-3.5**	**-3.7**
4. Dynamic Scorecard: Abolition based on New Productivity assumption				**0.57**	**0.38**	**0.36**	**0.35**	**0.37**

Source: PwC analysis

A more detailed breakdown of the fiscal numbers underpinning rows 3 and 4 in

Table ***4*** are given in Table 5.

This positive net benefit for the Exchequer in Tables 4 and 5 arises from:

- **Higher tax receipts from indirect taxes.** The increased consumption and production associated with the abolition of APD raises VAT and other indirect tax receipts.
- **Higher tax receipts from corporations**. As business costs fall, domestic business activity expands and more firms set up in the UK, increasing corporation tax receipts.
- **Higher tax receipts from individuals**. Expanding business activity boosts employment, so direct income tax receipts increase.
- **Small increases in benefit expenditure**. Higher employment reduces the number of benefit claimants and lowers Government welfare payments. However, the increased productivity associated with the rise in business growth leads to a slowing of wage growth meaning that workers claiming in-work benefits must then be compensated. Overall, there is a small net increase in benefit spending but this is a minor offsetting effect.

The results from this updated modelling exercise suggest that the HMRC and PwC CGE models generate broadly similar results when analysing the economic effects of corporate taxes. When APD is compared in this framework an increase is found to cost the economy at least as much in GDP terms as corporation tax. Further, the abolition of APD would most likely lead to a net revenue gain for the Government of around £350m to £400m per annum through to 2020. By introducing the link between aviation sector capacity and GDP in the *aviation links study*, the results have become more positive than those presented in the *2013 APD study*.

Table 5: APD Abolition, new productivity assumption, detailed dynamic scorecard.

	2015-16	2016-17	2017-18	2018-19	2019-20
Static score card:					
Air passenger duty	**-3.10**	**-3.20**	**-3.40**	**-3.50**	**-3.70**
Dynamic Scorecard:					
Taxes on products (including APD)	**-2.59**	**-2.67**	**-2.84**	**-2.92**	**-3.09**
VAT	0.38	0.32	0.30	0.28	0.28
Taxes on production	0.13	0.12	0.12	0.12	0.12
Total indirect taxes (1)	**-2.07**	**-2.23**	**-2.42**	**-2.52**	**-2.69**
Income tax	1.51	1.46	1.54	1.57	1.65
NICs	0.82	0.81	0.86	0.88	0.94
Corporation tax	0.26	0.28	0.33	0.36	0.41
Total direct taxes (2)	**2.59**	**2.56**	**2.73**	**2.81**	**2.99**
Benefits (3)	0.05	0.05	0.05	0.06	0.06
Net position (1+2+3)	**0.57**	**0.38**	**0.36**	**0.35**	**0.37**

Source: PwC analysis

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