Flying high: Seizing the opportunity

How drones can save the public sector £1 billion

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Introduction: Urban drones for public benefit

Drone technology is evolving rapidly. An opportunity now exists to shape its application. In partnership with Innovate UK, Nesta Challenges has developed a multiphase programme – the Flying High Challenge – to help position the UK as a global leader in deploying urban drone systems to meet people's needs.

The aim of the Flying High Challenge is to address the technical, operational and system challenges that potentially deter the publicly beneficial use of urban drones in the UK. Flying High identified the opportunity to expand the use of drones to support public services so long as safety, security and privacy concerns can be adequately addressed. Recent PwC research has found that over 80% of the public would support the use of drones in cases where there is a risk to life such as search and rescue and identifying and tracking criminals[1]. Next, Flying High will look to support testing of urban drone services for public benefit.

Nesta Challenges asked PwC to assess the potential economic benefits of drone use by the public sector to deliver public services in urban areas in the UK building on our earlier report, 'Skies without limits' (2018)[2]. The earlier report estimated that:

- Take up of drones in the next 15 years could result in (net) cost savings across the UK economy of £16 billion through efficiency improvements; and
- These savings could, in turn, improve UK productivity resulting in a boost to the UK economy of £41 billion.

This report focuses on **public sector** (net) cost savings and the impact on Gross Domestic Product (GDP) from the use of drones within **urban areas** in the UK over the next 15 years. It presents some case studies of how drones can be used for public benefit in various urban settings, and sets out the key results from our analysis. The subsequent section provides an overview of our approach and methodology and explains how the results can be interpreted. An Appendix contains further details on the methodology used and our results.

[1] PwC (2019). Building Trust in Drones (https://www.pwc.co uk/trustindrones)

[2] PwC (2018). Skies without limits (https://www.pwc.co uk/intelligent-digital/drones/Drones-impact-on-the-UK-economy-FINAL.pdf)

Results: The potential public sector benefits of drones

The national UK picture

£6.9 billion uplift in GDP

We estimate that over the next 15 years the use of drones to support delivery of public services in urban areas in the UK could increase GDP by £6.9 billion. Our analysis uses the public sector as a proxy for the delivery of public services.

£1.1 billion in net cost savings

This potential benefit arises from two effects – improved productivity and reduced costs. These can be illustrated by reference to three use cases:

- The use of drones to transport medical products (such as blood, laboratory samples, medical equipment or supplies) can help to make health care services more time and cost effective, improving service quality;
- The use of drones to support emergency services (such as providing information to inform police and fire services responding to incidents) by improving the speed of response and provide better information on the situation on the ground; and
- The use of drones to support infrastructure development and maintenance (such as inspecting bridges) can improve safety of workers, quality of work and save time and money. For example, infrastructure costs account for approximately one third of a railway's operating costs.

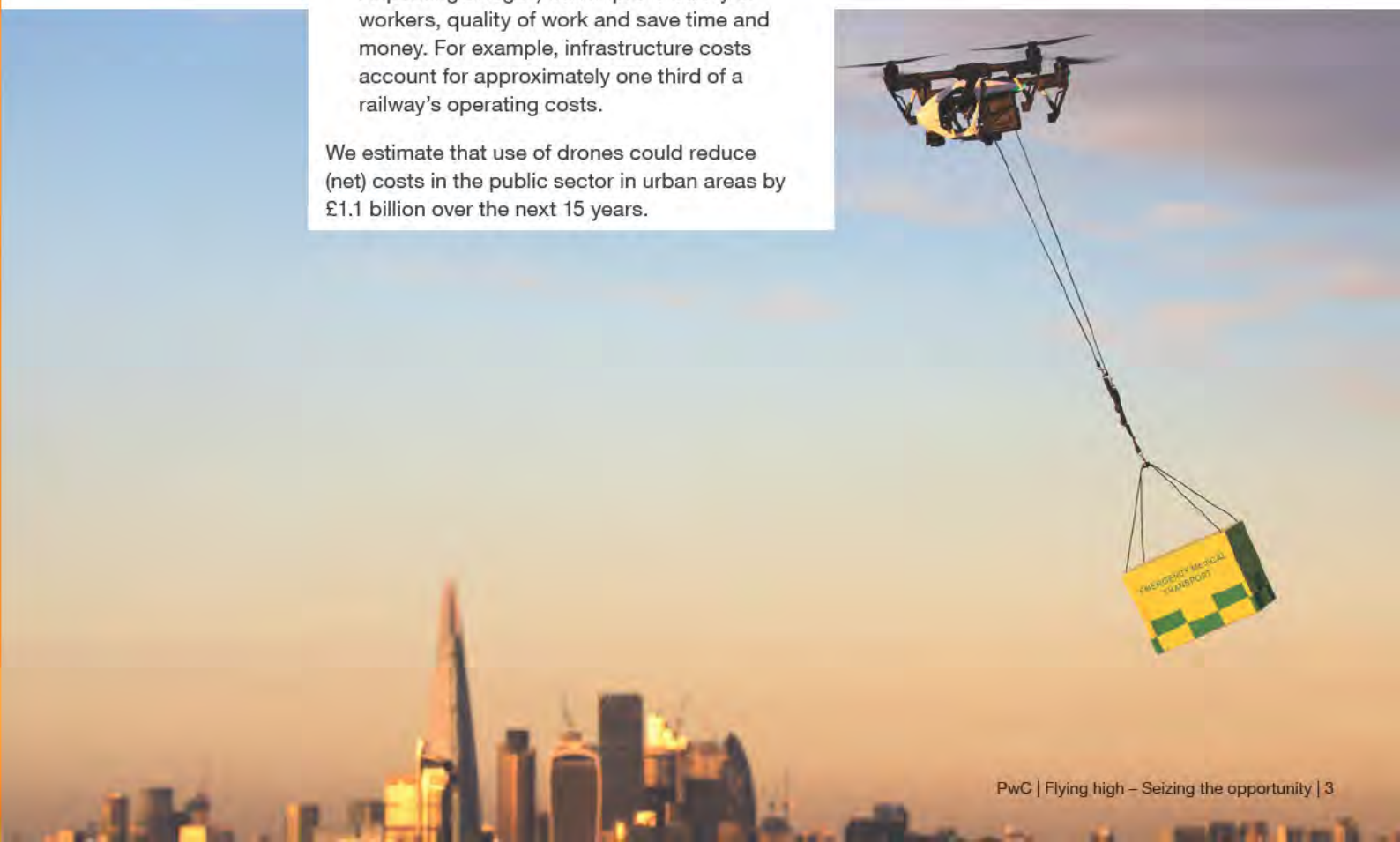
We estimate that use of drones could reduce (net) costs in the public sector in urban areas by £1.1 billion over the next 15 years.

Medical transport

London has 34 hospitals in relatively close proximity. Deliveries between hospitals are frequent and, in many cases, time sensitive, but traffic and the lack of major roads restricts this. Nesta Challenges explored how drones could be used to transport urgent medical products such as pathology samples, blood products and equipment between NHS facilities in London.

The test use case was the potential for delivering pathology samples between Guy's Hospital and St Thomas' Hospital which are close to each other, have a high volume of daily traffic between them and present complex technical and regulatory challenges. Potential benefits include time and cash savings (especially if a service operated at large scale), improved efficiency of medical logistics, quicker test results, improved health outcomes for patients and reduced traffic on congested roads.

In the longer term, people could take urgent diagnostic tests at home, at a chemist or a doctor's surgery and rely on a drone to collect the samples. Similarly, prescriptions and personal medical devices could be delivered by drone.



Emergency services

Besides causing injury and death, road traffic incidents can seriously disrupt travel. Nesta Challenges considered how drones could assist the emergency services responding to incidents on the strategic road network between Birmingham and Coventry by providing real-time information prior to first-responder arrival and support the emergency services during incident response. This might involve photographing, scanning and filming the scene to increase efficiency and effectiveness of response.

In the cases of fire and rescue, drones could provide high-quality information to support operational planners and controller. This enables them to direct resources faster and more reliably when an alarm has been sounded by providing real-time information to officers on the ground that otherwise would be impossible to collect. Nesta Challenges explored the use of drones to support West Yorkshire Fire and Rescue Service to act as rapid eyes on the scene and gather live operational intelligence.

In the longer term, a citywide emergency drone network could provide rapid initial assessment and ongoing monitoring of emergencies. As artificial intelligence technology improves, drones may also be able to carry out more complex tasks such as summarising key information about an incident, proactively monitoring traffic for incidents and identifying people in trouble.

Infrastructure development and maintenance

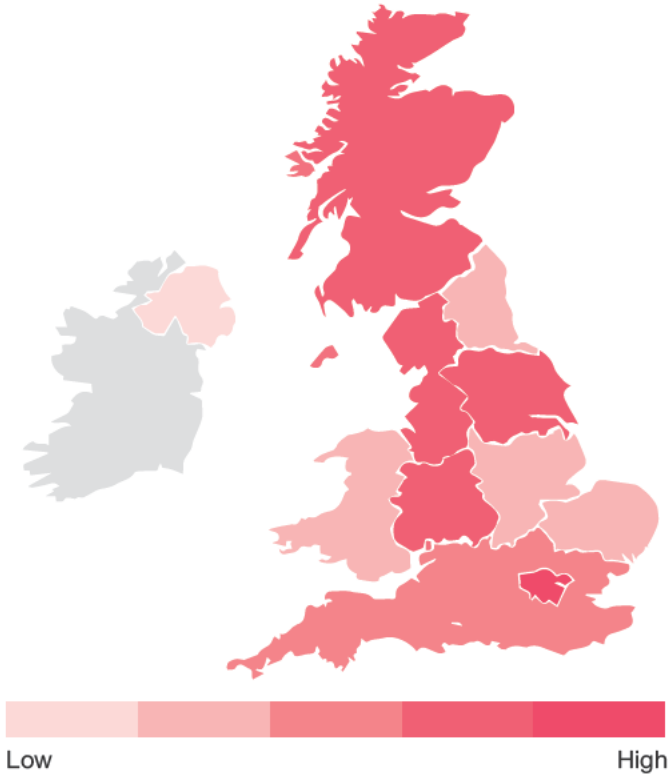
Drones can be used for several tasks linked to construction, including surveying land, monitoring build progress, inspecting quality of work and supporting health and safety. All of these can be used to improve the efficiency of large-scale construction projects such as major buildings, roads and railway lines. Nesta Challenges explored the use of drones to support the development of the Preston Western Distributor and East-West Link Road which will connect Preston to a new junction on the M55.

It established that, as the technology becomes more mature, drones could help assess the progress of a project, estimate the amount of resources used, check for incorrect or low-quality work and identify health and safety risks. They could also search autonomously for, diagnose and repair infrastructure problems as well as working in groups to cover a large infrastructure project more quickly. As robotic technology improves, drones could also start to help with the construction itself by delivering items to workers and performing dangerous tasks.

Regional impacts vary across the UK

Figure 1 shows a regional breakdown of the potential GDP benefits from greater drone use to support delivery of public services in urban areas in the UK. The biggest boost is expected to be in London (£1.4 billion).

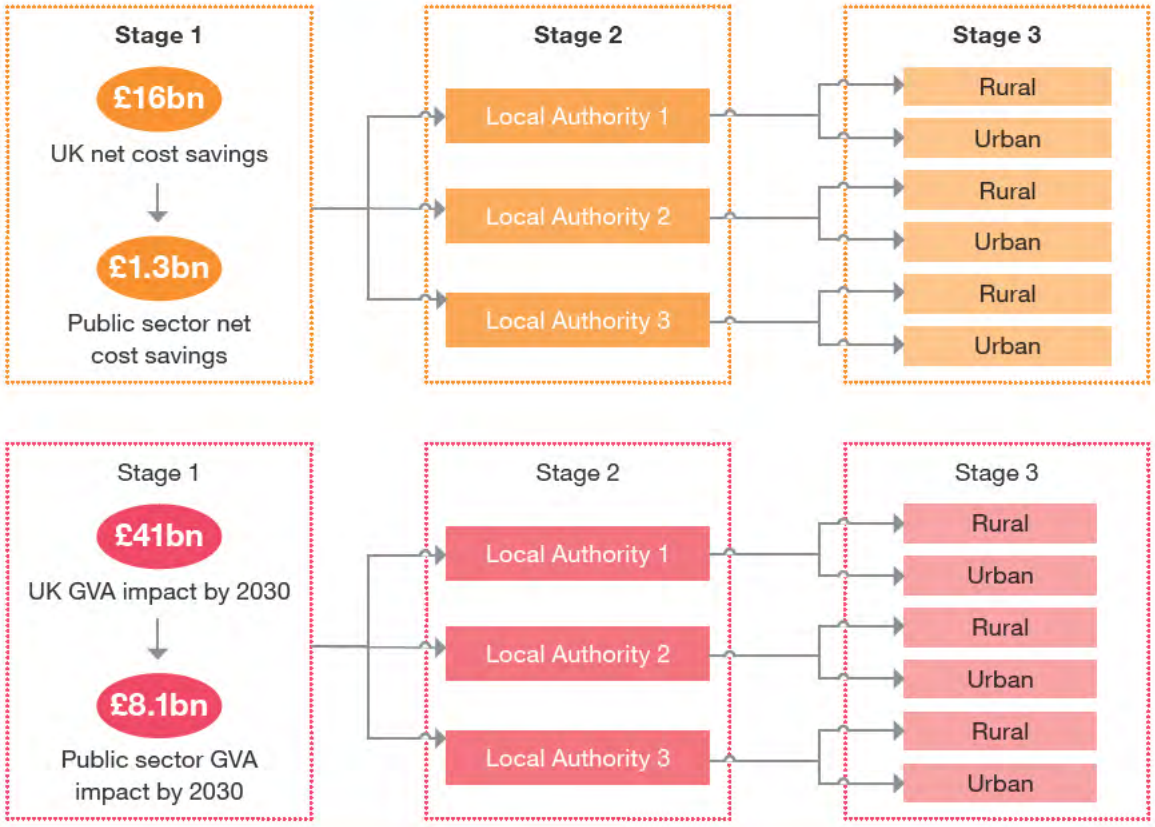
Figure 1: GDP impact in the public sector in urban areas, by region



Region	GDP impact in the public sector in urban areas (2018 prices)
London	£1.4 billion
West Midlands	£1.0 billion
Yorkshire and The Humber	£0.9 billion
North West	£0.8 billion
Scotland	£0.8 billion
South East	£0.5 billion
South West	£0.4 billion
East Midlands	£0.3 billion
East of Englands	£0.2 billion
North East	£0.2 billion
Wales	£0.2 billion
Northern Ireland	£0.1 billion

Our estimates of the potential benefits of using drones in the public sector to deliver public services in urban areas are based on our original estimate for the UK as a whole in 'Skies without limits'[3]. They are derived in three-stages (see Figure 2):

Figure 2: Summary of our approach



[3] PwC (2018). Skies without limits. (https://www.pwc.co.uk/intelligent-digital/drones/Drones-impact-on-the-UK-economy-FINAL.pdf).

Stage 1: Estimate the benefits attributable to the public sector.

Our analysis in 'Skies without limits' provides us with an estimate of the aggregate potential benefits of drones in terms of (net) cost savings and GDP across all sectors within the UK over the next 15 years. We assume that the public sector's share of the cost savings and GDP impact is the same as its share of Gross Value Added (GVA) within the UK.

Defining the public sector

We use the public sector as a proxy for the delivery of public services. In our analysis, we attribute activities related to public administration and defence, education, and human health and social work activities within the scope of the public sector. This is because of the way in which national data is published. The relevant International Standard Industrial Classification (SIC) codes are 'O', 'P' and 'Q'. Our analysis in 'Skies without limits' includes the linkages between the public sector and the private sector (i.e. the cost savings from the private sector are transferred to the public sector if the public sector purchases goods or services from the public sector).

Stage 2: Apportion the impact of drones to local authorities.

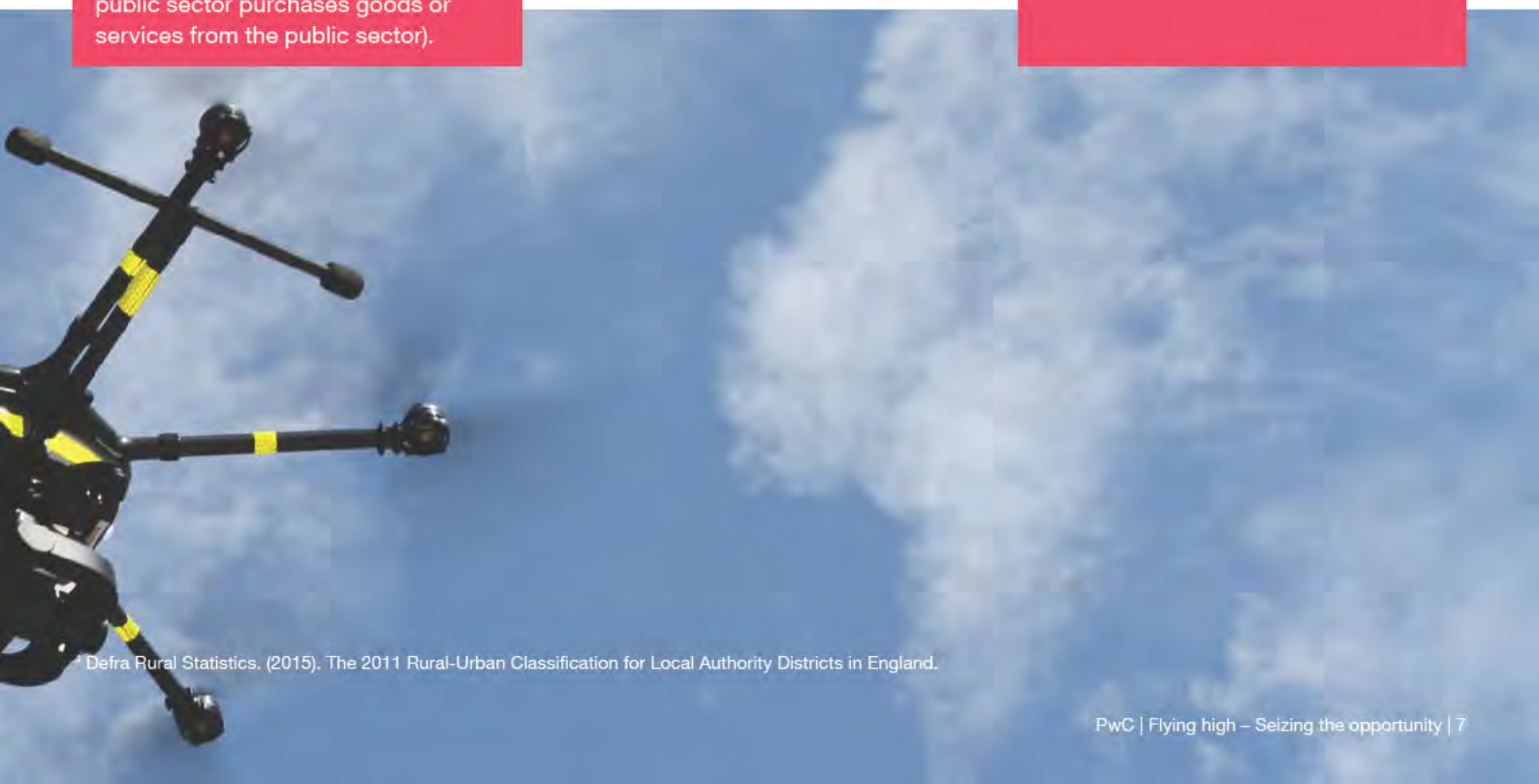
Using data on GVA share at local authority level, we apportion the public sector's share of the benefits of drones to each local authority in England, Scotland and Wales. We use a slightly different approach in Northern Ireland where data are unavailable at the local authority level.

Stage 3: Determine the urban and rural shares of regions.

For each local authority in England, Scotland and Wales, we estimate the share of the population living in urban and rural areas based on data from the 2011 Census. The share of urban and rural residents is determined for Northern Ireland as a whole due to data limitations. Using the urban share of residents for each local authority (and Northern Ireland), we then estimate the public sector impact of drones in urban areas. Our estimates of the potential benefits at regional level are based on aggregating the results across Local Authorities.

Defining urban areas

We define urban areas as settlements with more than 10,000 residents. This definition is consistent with the one used by Defra in its urban and rural classifications in England[4]. Data on population comes from the 2011 Census (the most recent available).



[4] Defra Rural Statistics. (2015). The 2011 Rural-Urban Classification for Local Authority Districts in England.

Interpreting the results

Our estimate of the potential benefits to UK GDP of drone use by the public sector in urban areas (£6.9 billion) represents the 'net' impact. As such:

- We treat the potential use of drones as being an additional technology stimulus over and above underlying trends; and
- Our estimate takes into account the creation and destruction of value in some activities and shifting of others between sectors.

This approach is in line with the UK Government's appraisal guidance[5].

Our economic model assumes that the adoption of drones in the UK follows an 'S-curve' pattern similar to previous waves of new technology. This is aligned with PwC's recent global study of the commercial applications of drones[6].

Finally, we note that the impact on GDP does not fully reflect the economic value of the use of drones to support public service delivery. Most – if not all – public services provide a range of economic, social and environmental benefits which are not fully captured in GDP (which is based on the market value). For example, as the use cases illustrate, drones can be used in medical delivery to reduce the time taken to transport life-saving medicines to patients and drone use in construction can reduce health and safety risks associated with surveying buildings. Such benefits are additional to those reflected in GDP.

[5] HM Treasury's 'Green Book'

[6] PwC (2018). Skies without limits. (https://www.pwc.co.uk/intelligent-digital/drones/Drones-impact-on-the-UK-economy-FINAL.pdf)

Next steps

If the UK is to realise the full potential of drones in public service delivery in urban areas, it is crucial to reduce the barriers to their take up. An emerging system such as drones which integrates various technologies and end-users requires a cross-sector approach to policy, regulation, technology and management.

The next steps to realise this opportunity include:

- Creating scope for the different actors across sectors to incubate and trial new products and services, further strengthening opportunities for UK plc to grow the entire drone ecosystem;
- Promoting understanding of the benefits - both economic and social – and engaging the public in a dialogue to shape the use of drones in urban settings;
- Incentivising technology and service developers to collaborate with end-users to develop, iterate and test new services;
- Aligning the incentives for public service providers and their suppliers to explore, develop and test the use of drones;
- Investing in technological innovation to establish the vehicle and infrastructure capabilities to create sophisticated urban drone networks that can operate safely, at scale in dense urban environments;
- Developing a supportive regulatory framework in concert with the Civil Aviation Authority, Department for Transport and local authorities;
- Enabling public trials and testing of publicly beneficial drone services in UK cities to capture the public's imagination and demonstrate the feasibility of such services; and
- Investing, as appropriate, in the infrastructure required to enable drones to be deployed in urban areas.

The purpose of Nesta's Flying High Challenge is to enable transformative new approaches to public service delivery in UK cities. If Flying High can integrate technology, regulation, city leadership, public services and public engagement, it will help position the UK as a global leader in developing urban drone services and will unlock the significant economic opportunity for our future.

Appendix

This appendix:

- Summarises the methodology we have used to estimate the potential economic benefits of drone use in the UK;
- Explains our approach to apportioning the benefits to the UK to potential use of drones to support delivery of public services; and
- Describes how we have apportioned the benefits in urban areas; and
- Provides more details of the key results of our analysis.

Methodology used in 'Skies without limits'

Our estimate of the impact of drone use on UK GDP in 'Skies without limits'[7] was generated using a large-scale dynamic economic (CGE) model of the global economy. The model includes 140 economies broken down into 57 different sectors. It takes into account how each sector trades with each other through their supply chains.

Our estimates of the potential economic impact of drone use show their expected effect compared to an alternative view of the world in which growth of the global economy reflects the long-term steady state which is driven by three key elements:

- Population growth;
- Growth in the capital stock; and
- Technological change.

Our results show the net economic impact of drones. Whilst some parts of the economy will benefit from the use of drones, other parts of the economy may suffer. Our model separates the potential effects of drones from other forces for change, such as shifts in global trade policy, financial booms and busts, major commodity price changes and geopolitical shocks).

Our results can, therefore, be interpreted as the potential economic benefits associated with increased drone use.

Over time, the direct effects of the productivity gains from increased done use will be boosted by dynamic impacts resulting from shifts in consumer demand, business investment and input demand. Businesses will value the cost, productivity and workforce effects, freeing up investment for new areas. Meanwhile, consumers will be attracted by cheaper prices and, over time, greater varieties and quality of goods and services from which to choose as new firms enter the market with new products in response to increased profits. In turn, this increased consumption will create a virtuous cycle of more demand, greater revenue, more firm entry and investment, more demand, and so on.

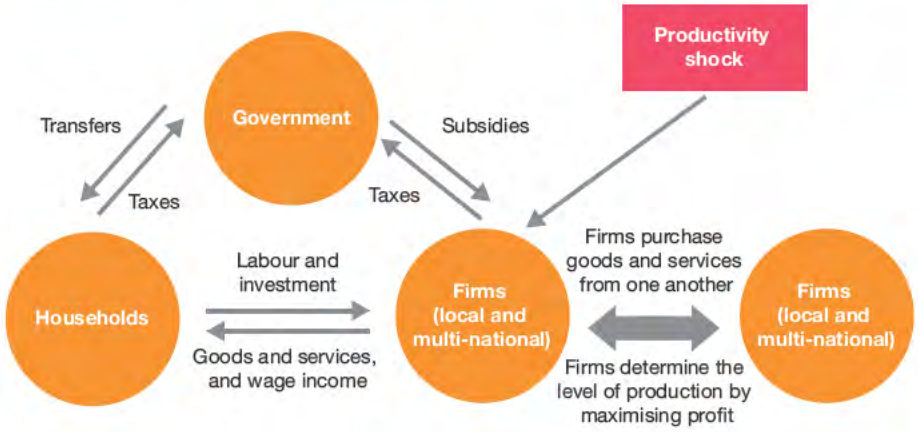
We estimate these dynamic impacts using a CGE model which quantifies the multidirectional relationships between the government, households and firms (see Figure 3). We quantify the relationships using historic data from the Global Trade Analysis Project (GTAP) database on expenditure by each sector on one another's final goods and inputs, as well as on general consumption, government expenditure, trade and investment levels at sector level.

Our analysis shows that drones will mainly impact the economy directly through the production side via productivity enhancements, as firms modify their business processes with drones. The CGE model quantifies the net impact of these productivity enhancements on the UK economy through the resulting interactions that occur in the economy. We separately estimate the direct 'productivity shock' in each sector of the UK economy from uptake of drones. This initial productivity impact then leads to the effects on trade, investment and consumption outlined above as firms interact with each other and with households and the government.

Further details of our approach can be found in the full report[8].

[7] [8] PwC (2018). Skies without limits. (https://www.pwc.co.uk/intelligent-digital/drones/Drones-impact-on-the-UK-economy-FINAL.pdf)

Figure 3: Overview of Computable General Equilibrium (CGE) model



Estimating the benefits of drones to the public sector

Our 'Skies without limits' report assessed the impact of drones across groups of sectors based on the International Standard Industrial Classification (SIC).

As our approach is a top-down estimate derived from the aggregate results presented in 'Skies without limits' we need to estimate the share of the GDP impact and the (net) cost savings. We use the GVA share to disaggregate the figures from 'Skies without limits' as GVA captures productivity effects as opposed to an alternative such as employment which does not.

The group that contains the public sector also includes the arts, entertainment and recreation sector (SIC code 'R'). To separate out the public sector (i.e. SIC codes 'O', 'P' and 'Q'), we use the GVA share of 'OPQ' as a percentage of 'OPQR' (92%).

Estimating the benefits arising in urban areas

England

We use data published by Defra based on the 2011 Census to estimate the proportion of residents living in urban and rural areas[9]. These data are available at local authority level for England. We define a rural settlement as one with less than 10,000 residents. Based on the percentage of rural residents within a local authority, each local authority can be classified into one of the four categories shown in Table 1.

We use the share of urban residents within each local authority to apportion both the estimated impact on GVA and the cost savings.

Table 1: Categorisation of urban and rural areas in England

Classification	Mainly rural	Largely rural	Urban with significant rural	Urban with city and town (and minor and major conurbation)
% of residents living in rural areas	>80%	50% – 79%	26% – 49%	<26%
Number of local authorities	50	41	54	181

Scotland

The Scottish Government has published data, also based on the 2011 Census, showing the proportion of the resident population living in six categories of area as shown in Table 2[10]. These data are available at the local authority level. For consistency, we define urban areas as those with settlements with more than 10,000 people.

Table 2: Categorisation of urban and rural areas in Scotland

Category	Large urban area	Other urban area	Accessible small towns	Remote small towns	Accessible rural areas	Remote rural areas
Definition	Population greater than 125,000	Population between 10,000 and 125,000	Population between 3,000 and 10,000, and within a 30 minute drive of a settlement with 10,000 residents	Population between 3,000 and 10,000, and more than a 30 minute drive of a settlement with 10,000 residents	Population less than 3,000 and within a 30 minute drive of a settlement with 10,000 residents	Population less than 3,000, and more than a 30 minute drive of a settlement with 10,000 residents
% of Scottish population	39.10%	30.40%	8.70%	3.70%	11.60%	6.50%

[9] Defra Rural Statistics. (2015). The 2011 Rural-Urban Classification for Local Authority Districts in England.

[10] The Scottish Government. (2012). Urban/Rural Classification 2011-2012.

Wales

Our urban/rural classification in Wales is also based on 2011 Census data. The definition of rural areas is the same as in England. The data available for Wales are at Middle Layer Super Output Area (MSOA) level and each MSOA is classified into one of the six categories shown in Table 3[11]. We then map each MSOA to a local authority. Using population data we can assess the percentage of residents living in rural and urban areas within each local authority in Wales.

Table 3: Categorisation of urban and rural areas in Wales

Type	Rural				Urban	
Category	Rural village and dispersed in a sparse setting	Rural village and dispersed	Rural town and fringe in a sparse setting	Rural town and fringe	Urban with city and town in a sparse setting	Urban city and town
% of Welsh population	10%	6%	2%	13%	2%	67%

Northern Ireland

Data on the population living in urban and rural areas are published on a different basis in Northern Ireland[12]. The analysis is based on Settlement Development Limits (SDL) which are defined in bands from A to H as shown in Table 4. SDLs in Bands A to G can be mapped to local authorities, however Band H settlements cannot be mapped easily in this way. This means we cannot assess the urban-rural split of all the population in Northern Ireland at the local authority level. Instead, we assess the urban/rural share at the Northern Ireland level by using adding up the number of residents in Bands A to D (urban residents) and Bands E to H (rural residents), as shown in Table 5.

Table 4: Urban and rural categories in Northern Ireland

Band	Band A to D	Band E to G	Band H
Definition	SDL population 10,000 or more	SDL population 1,000 to 9,999	SDL population <1,000

Table 5: Urban and rural split of population in Northern Ireland

Classification	Rural	Urban
% population	37%	63%

[11] Office for National Statistics. (2018). Rural Urban Classification (2011) of Middle Layer Super Output Areas in England and Wales.

[12] Northern Ireland Statistics and Research Agency. (2015). Review of the Statistical Classification and Delineation of Settlements (March 2015).

Detailed results

Table 6 summarises our estimates of the potential benefits of drone use by the public sector in urban areas by region over the next 15 years. We present the impact on GDP (in aggregate and per capita) and the (net) cost saving. All estimates are at 2018 prices.

Table 6: Impact of drone use in the public sector in urban areas over the next 15 years (£ billion, 2018 prices)

Region	GDP impact	GDP per capita impact	Net cost savings
London	£1.39 billion	£158	£0.23 billion
West Midlands	£0.98 billion	£211	£0.16 billion
Yorkshire and The Humber	£0.90 billion	£213	£0.15 billion
North West	£0.84 billion	£135	£0.14 billion
Scotland	£0.76 billion	£203	£0.13 billion
South East	£0.49 billion	£74	£0.08 billion
South West	£0.41 billion	£136	£0.07 billion
East Midlands	£0.31 billion	£98	£0.05 billion
East of England	£0.24 billion	£71	£0.04 billion
North East	£0.23 billion	£134	£0.04 billion
Wales	£0.20 billion	£95	£0.03 billion
Northern Ireland	£0.13 billion	£107	£0.02 billion
Total	**£6.87 billion**	**£141**[1]	**£1.15 billion**

[1] Average across UK