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The App Economy in Europe: Leading Countries and Cities, 2017

Dr. Michael Mandel and Elliott Long
Progressive Policy Institute

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INTRODUCTION

When Apple introduced the iPhone in 2007, that initiated a profound and transformative new economic innovation. While central bankers and national leaders struggled with a deep financial crisis and stagnation, the fervent demand for iPhones and the wave of smartphones that followed was a rare force for growth.

Today, there are more than 4 billion mobile broadband subscriptions—an unprecedented rate of adoption for a new technology.[1] Use of mobile data is rising at 55 percent per year, a stunning number that shows its revolutionary impact.[2]

More than just hardware, the smartphone also inaugurated a new era for software developers around the world. Apple's opening of the App Store in 2008, followed by Android Market (now Google Play) and other app stores, created a way for iOS and Android developers to write mobile applications that could run on smartphones anywhere.

The iPhone and the App Store were the beginnings of a global App Economy: an army of app developers writing mobile applications for billions of users.[3] For the most part, these developers are not hobbyists writing games in their basements. Instead, as more and more people are linked to the Internet through their smartphone and mobile data connections, mobile apps downloaded from the Apple App

Store, Google Play, UK-based F-Droid for Android, and other online depositories, have become an essential way for businesses, nonprofits, and governments to interact with their customers, members, and citizens. (Indeed, data shows that people spend most of their Internet time interacting with apps).

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Moreover, the long-term growth prospects of the App Economy are still strong. Yes, the great surge of new game, media, and ecommerce apps is probably close to its peak. However, the rise of the Internet of Things, augmented reality (AR) and artificial intelligence (AI) means that more and more objects and physical processes will be connected to the Internet.

Increasingly, individuals will be using mobile apps as their interface to their home, their travel, their entertainment, their car, their schools, their health providers, and their state and local governments. Employees in many enterprises are using mobile apps to monitor or control work processes. These apps will be highly functional and sophisticated, serving an essential role in interacting with our environment.

THIS PAPER

This report on European App Economy employment builds on previous estimates of App Economy jobs around the world, starting with our February 2012 report "Where the Jobs Are: The App Economy."[4] We then published an additional estimate in June 2016.[5]

As of January 2017, we estimate that the European App Economy totals 1.89 million jobs, a growth rate of roughly 15 percent over the past year. In addition, this paper estimates the number of App Economy jobs by country and as a percentage of all jobs on a country-by-country basis. Next, we provide an overall and country-by-country breakdown of App Economy employment by operating system, comparing the number of jobs in the iOS ecosystem with the number of jobs in the Android ecosystem. Finally, we provide a ranking of the top 30 App Economy cities in Europe.

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CONTEXT

In this paper we focus on App Economy employment in Europe. However, this paper is part of a larger research project examining App Economy employment in different countries and regions, including the United States, Japan, Australia, Mexico, Argentina, Colombia, Brazil, Vietnam, Indonesia, and China.

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There are several reasons we have focused on App Economy jobs. First, the invention of the smartphone was one of the two most important technological innovations over the past decade, from the perspective of economic impact, so it's natural to want to know how many jobs it is creating.[6] These are not numbers that can be found in government statistics, which typically have trouble capturing the impact of new technologies.

The App Economy, because it doesn't fit neatly into the old economic paradigms, is particularly hard for traditional government statistics to measure. For example, statistical agencies that count exports have no category in trade statistics for the revenues generated by the export of domestically-created apps to other countries, even though these revenues may be very significant. Indeed, statisticians may not be counting these exports at all.[7]

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The other reason we have focused on App Economy employment has to do with the broad ongoing debate about the link between technological innovation and jobs. There's a pervasive worry, especially in the aftermath of the financial crisis, that new technologies destroy jobs without creating very many new ones.[8] So we see reputable business publications like Fortune and the Wall Street Journal run articles with titles like "Silicon Valley Is Not a Job Creator" and "Wireless Jobs Evaporate Even As Industry Expands."[9,10]

Unfortunately, government economic statistics are much better at tracking the reduction of existing jobs than identifying the growth of new types of jobs. For reasons of both budget limitations and inertia, it takes years for new occupations to get their own categories in the employment statistics, if it ever happens at all.

This lack of data made it harder to measure the employment impact of the Internet and the New Economy. Equally important, without being able to track new jobs, it's impossible to figure out if policies are succeeding or failing. Without data—specifically data about the contribution of the App Economy to individual countries—policy makers in Hanoi, Berlin, or Washington can't make the right decisions.

MEASURING THE APP ECONOMY

As the App Economy grows in size globally, it becomes essential to have a consistent set of App Economy job estimates so policymakers can compare their country's performance with that of other countries and the sorts of policy actions they took. For that reason, we have developed a new, standardized methodology for estimating App Economy employment. This methodology can be applied to a wide variety of countries, languages, and economic environments. The methodology uses online job postings for workers with app-related skills as a real-time measure of App Economy employment. We benchmark this data against official government statistics in order to eliminate many of the well-known problems connected with using big data to measure economic variables.[11]

Our goal is to produce a set of globally-consistent and credible estimates for App Economy employment by individual countries, by broad geographical regions, and by major cities. The ultimate objective is to be able to track the growth of the App Economy globally and to see which countries are benefitting the most. Ideally, we should be able to link App Economy growth to policy measures implemented by governments.

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This preliminary report on Europe's App Economy represents the third in a series applying our new universal methodology to

countries and regions. Our analysis includes the 28 countries in the European Union, plus Norway and Switzerland. Our methodology is described in detail in the appendix to this paper.

DEFINING THE APP ECONOMY

For this study, a worker is in the App Economy if he or she is in:

- An IT-related job that uses App Economy skills—the ability to develop, maintain, or support mobile applications. We will call this a **"core" App Economy job.** Core App Economy jobs include app developers; software engineers whose work requires knowledge of mobile applications; security engineers who help keep mobile apps safe from being hacked; and help desk workers who support use of mobile apps.
- A non-IT job (such as sales, marketing, finance, human resources, or administrative staff) that supports core App Economy jobs in the same enterprise. We will call this an **"indirect" App Economy job.**
- A job in the local economy that is supported by either the goods and services purchased by the enterprise, or by the income flowing to core and indirect App Economy workers. These **"spillover"** jobs include local professional services such as bank tellers, law offices, and building managers; telecom, electric, and cable installers and maintainers; education, recreation, lodging, and restaurant jobs; and all the other necessary services. We use a conservative estimate of the indirect and spillover effects, as discussed in the appendix. Later in this paper we will give examples of App Economy jobs.

To estimate the number of core App Economy jobs, we use a multi-step procedure based on data from the universe of online job postings. Our first observation is that online job postings typically describe the skills and knowledge being sought by the employer. For example, if a job posting requires that the job candidate have experience developing apps for iOS—the iPhone/iPad operating system—then we can reasonably conclude that the posting refers to a core App Economy job.

> Core App Economy jobs include app developers; software engineers whose work requires knowledge of mobile applications; security engineers who help keep mobile apps safe from being hacked; and help desk workers who support use of mobile apps.

In practice, we compiled a short list of key words and phrases that would generally be associated with App Economy-related skills. These include "iOS," "Android," "Blackberry," "Windows Phone," "Windows Mobile," and "app." We applied these search terms to the real-time database of job postings developed by Indeed, which gave us an unadjusted count of job postings for core App Economy jobs.

However, that's only the beginning. Job postings for an occupation are only a fraction of the number of people employed in that occupation, since most positions are not empty. We developed an estimate for the ratio between the number of job postings for ICT jobs and overall ICT employment. This ratio is applied to the number of App Economy job postings to generate a provisional estimate of core App Economy employment. Crucially, we use a

validation procedure to ensure we are actually counting job postings that correspond to core App Economy jobs. We use a conservative estimate of the indirect and spillover effects.

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RESULTS

As of January 2017, we estimate that the European App Economy now includes 1.89 million jobs, a growth rate of roughly 15 percent since a year earlier. Companies employing workers with App Economy skills include large and small app developers; software and media companies; marketing and advertising groups; financial and retail companies; industrial companies; commerce firms and business accelerators; health and wellness enterprises; and leading European and non-European tech companies.

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FIGURE 1: The European App Economy

	MILLIONS OF JOBS (JANUARY 2017)	MILLIONS OF JOBS (JANUARY 2016)
EU-28 plus Norway and Switzerland	1.89	1.64
EU-28	1.80	1.57

Data: Progressive Policy Institute, Indeed, public job postings

App Economy Jobs by European Country

As noted above, one of our goals is to develop a measure of App Economy jobs by country, in order to assess the relationship between government policies and innovation-driven job growth. Figure 2 below provides estimates of App Economy employment for the top European economies. Like last year, the United Kingdom ranks first, followed by Germany and France.

FIGURE 2: App Economy jobs by country (January 2017)

COUNTRY	APP ECONOMY JOBS, THOUSANDS
United Kingdom	330
Germany	311
France	260
The Netherlands	184
Italy	101
Sweden	96
Spain	86
Finland	54
Poland	52
Norway	50
Denmark	46
Czech Republic	39
Switzerland	36
Portugal	31
Austria	27
Belgium	25
Romania	23
Hungary	19
Ireland	15
Greece	8
Luxembourg	3
European Union	**1796**
30-country total	**1891**

Data: Progressive Policy Institute, Indeed, ILO

As noted in the methodology appendix, we do not have separate data for Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia. However, these countries are included in the aggregate numbers.

Before the App Store opened in July 2008, there was no such thing as an App Economy job. No employer was hiring iOS or Android Developers. This has been an incredibly rapid transformation of the job market, matching the incredible growth of smartphone usage.

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Even more remarkable, the explosion of App Economy jobs came during the worst recession in 80 years. These 30 countries are only now

recovering to 2007 levels of employment. The resilient demand for App Economy skills drove firms to hire new ICT workers—and keep the ones they already had—even during the depths of the recession and slow recovery that followed.

A globally consistent methodology makes it easier to do comparisons across countries. Let's start by comparing the United States with the EU-28 plus Norway and Switzerland. For the first time, Europe has outpaced the United States in App Economy jobs—1.89 million versus 1.73 million.

In other ways, however, Europe still lags behind. We define "app intensity" as App Economy jobs as a percentage of all jobs. The United States has an average app intensity of 1.1 percent. By comparison, the European app intensity is 0.84 percent (Figure 3).

FIGURE 3: App Economy Matchup: Europe vs. The United States

	APP ECONOMY JOBS (MILLIONS)	APP INTENSITY*
Europe**	1.89	0.84%
United States	1.73	1.1%

**App Economy jobs as a share of all jobs*
***EU-28 plus Switzerland and Norway*
Data: Progressive Policy Institute, Indeed, Eurostat

We can do a similar comparison, ranking European countries by app intensity. Figure 4 ranks European countries by app intensity. Finland and The Netherlands—both small countries with a big presence in mobile apps—tie for top place with a 2.2 percent app intensity. Sweden ranks third, followed by Norway. By way of a measuring stick, the top U.S. state by app intensity is California, at 2.7 percent.

The United States has an average app intensity of 1.1 percent. By comparison, the European app intensity is 0.84 percent.

FIGURE 4: Ranking European Countries by App Intensity

COUNTRY	APP INTENSITY*
Finland	2.2%
The Netherlands	2.2%
Sweden	2.0%
Norway	1.9%
Denmark	1.6%
Luxembourg	1.1%
United Kingdom	1.0%
France	1.0%
Germany	0.8%
Switzerland	0.8%
Czech Republic	0.8%
Ireland	0.7%
Portugal	0.7%
Austria	0.7%
Belgium	0.5%
Spain	0.5%
Italy	0.5%
Hungary	0.4%
Poland	0.3%
Romania	0.3%
Greece	0.2%

**App Economy jobs as percentage of all jobs*
As noted in the methodology appendix, we do not have separate data for Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia. Data: Progressive Policy Institute, Indeed, Eurostat

Germany, which ranks highly on total App Economy jobs, is only average when judged by app intensity. Italy, which is fifth in total App Economy jobs, falls to the bottom of the app intensity listings with 0.5 percent.

Mobile Operating Systems

Many App Economy job postings list a mobile operating system or multiple mobile operating systems with which the job candidate is expected to be familiar. This allows us to assess the distribution of mobile operating systems in the European App Economy.

Here's how the App Economy job numbers in EU-28 plus Norway and Switzerland break down by operating systems. As of January 2017, we estimate that 72 percent of App Economy workers in Europe (1.4 million jobs after rounding) belong to the iOS ecosystem. This includes iOS-specific jobs as well as jobs supporting a combination of iOS and other platforms. The Android ecosystem accounts for 75 percent of App Economy workers in Europe (also 1.4 million jobs).

FIGURE 5: European App Economy Jobs by Operating System

	APP ECONOMY JOBS (THOUSANDS)	SHARE OF ALL APP ECONOMY JOBS
iOS ecosystem	1360	72%
Android ecosystem	1422	75%

Data: Progressive Policy Institute, Indeed

The numbers sum to more than 100 percent because some jobs specify more than one operating system—say, both iOS and/or Android skills. From a policy perspective, the iOS ecosystem is likely to have a larger impact on entrepreneurship and the economy in Europe. That's because iPhone owners in Europe typically have higher incomes, and iOS apps tend to generate higher revenues for developers.

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We can also estimate the number of jobs associated with major mobile operating systems across different countries in Europe. Figure 6 is in alphabetical order.

FIGURE 6: App Economy Jobs by Country and Major Operating System

COUNTRY	TOTAL APP ECONOMY JOBS (THOUSANDS)	JOBS BELONGING TO IOS ECOSYSTEM (THOUSANDS)	JOBS BELONGING TO ANDROID ECOSYSTEM (THOUSANDS)
Austria	27	20	22
Belgium	25	19	16
Czech Republic	39	27	27
Denmark	46	40	40
Finland	54	39	50
France	260	174	217
Germany	311	246	247
Greece	8	6	6
Hungary	19	14	14
Ireland	15	13	10
Italy	101	80	79
Luxembourg	3	2	2
The Netherlands	184	145	145
Norway	50	44	44
Poland	52	30	40
Portugal	31	22	25
Romania	23	16	18
Spain	86	65	72
Sweden	96	73	78
Switzerland	36	29	29
United Kingdom	330	255	242

Data: Progressive Policy Institute, Indeed

Leading App Economy Cities in Europe

In today's global economy, some urban areas have proven to be high-productivity economic dynamos, while other urban areas have lagged behind. One key is the speed at which different urban areas have been able to recreate themselves as hubs for tech employment.

In this section we rank the top 30 cities in Europe for App Economy employment. We find that London is number one with 138,000 App Economy workers, followed by Paris and Amsterdam. We then provide examples of App Economy jobs across European cities.

In today's global economy, some urban areas have proven to be high-productivity economic dynamos, while other urban areas have lagged behind. One key is the speed at which different urban areas have been able to recreate themselves as hubs for tech employment.

How we did the analysis: We calculate the App Economy job postings in an urban area as a share of App Economy jobs postings for the entire country. Then we apply the resulting percentage to the number of App Economy jobs in the country, as reported in Figure 2 (our definition of urban area is explained in the methodology appendix).

Several countries have more than one urban area that is an App Economy center. For example, both Madrid and Barcelona are on our top 30 list. The United Kingdom has five areas, led by London. Portugal, on the other hand, has only one.

Here are the top 30 App Economy cities in Europe.

FIGURE 7: Top App Economy Cities in Europe (January 2017)

RANK	CITY	APP ECONOMY EMPLOYMENT (THOUSANDS)
01	London	138
02	Paris	119
03	Amsterdam	89
04	Berlin	71
05	Munich	56
06	Stockholm	47
07	Helsinki	37
08	Rotterdam*	33
09	Oslo	29
10	Cologne**	26
11	Milan	25
12	Prague	23
13	Barcelona	22
14	Utrecht	22
15	Stuttgart	22

RANK	CITY	APP ECONOMY EMPLOYMENT (THOUSANDS)
16	Manchester	21
17	Copenhagen	21
18	Madrid	21
19	Hamburg	20
20	Eindhoven	20
21	Lisbon	19
22	Frankfurt	19
23	Birmingham	19
24	Brussels	16
25	Zurich	15
26	Vienna	15
27	Budapest	15
28	Lyon	15
29	Oxford	13
30	Bristol	13

**Radius around Rotterdam is only 45 kilometers to avoid overlap with Amsterdam.*
***Includes Dusseldorf.*
Urban areas are defined as 50 kilometers or 30 miles around a center city. See methodology for details. We did not have data for urban areas in Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia.
Data: Progressive Policy Institute, Indeed.

Examples

A few key trends are noticeable in the European App Economy today. First, we continue to see the digital revolution unfold as the App Economy embraces next generation technologies like the Internet of Things, connected cars, machine learning, and artificial intelligence. Second, the App Economy has spread outside of the traditional industries of tech and ecommerce and into other areas like fintech, entertainment, and everyday household tasks.

As Europe's leading App Economy country, the diversity of jobs in the United Kingdom is immense. For example, in September 2017, game developer Jagex was hiring a Game Engine Developer in Cambridge with iOS and Android knowledge and experience in an area that will help with game development such as artificial intelligence. Felcana, a pet data company using Internet of Things (IoT) products to collect data on pets that can be used to aid veterinary diagnoses, was hiring a Full Stack Developer in London with iOS and Android app development experience. Amazon Video was hiring a Software Development Engineer in London to build their video application using machine learning. Also in London, IT firm Purepoint was hiring an IoT Android Developer.

And App Economy jobs aren't just located in London. JP Morgan Chase was hiring a VP Full Stack Developer in Glasgow with opportunities to participate in cutting edge software development initiatives including artificial intelligence. Travel booking company On The Beach was hiring an iOS Developer in Stockport. BBC was hiring a Senior Software Engineer in Salford to create apps. Car Finance 24/7, an auto finance website, was hiring a Mobile Developer in Manchester.

In Germany, number two for App Economy jobs in Europe, the connected car is a focus of the app economy. IT firm TWT Science & Innovation was hiring a Software Engineer in Berlin to work on applications for automated driving and the Internet of Things. DSA data - and Systemtechnik GmbH was hiring a Software Developer in Aachen to work on applications that monitor a car's diagnostics through the Internet of Things and connected cars.

Digital insurance company Clark Germany was hiring a Frontend Developer in Frankfurt with mobile app development experience and an interest in artificial intelligence. In August 2017, Transport and logistics firm DB Systel GmbH was hiring a Senior Mobile Solutions Software Engineer in Aachen with knowledge in IoT and artificial intelligence.

In number three France, digital services company Orkeis was hiring an SQL Developer in Nantes in July 2014 to develop applications such as virtual reality and augmented reality and mobile applications. Digital transformation firm Intitek was hiring an Android Engineer with IoT experience in Rambouillet to work on the connected car. Automotive manufacturer Renault was hiring a Software Architect with Android experience in Guyancourt to work on the connected car. And startup Piink Technology was hiring a Developer in Toulouse with mobile experience to work on the IoT and augmented reality.

In the Netherlands, number four for App Economy jobs in Europe, online daily fantasy football platform Teamleague was hiring a Mobile Developer with experience in iOS development in Amsterdam. eBay was hiring a Senior Backend Developer with some exposure

to iOS development in Amsterdam. Online invoice startup Moneybird was hiring a Mobile Developer with experience developing iOS and Android apps. And eHealth company MobiHealth was hiring a Mobile Software Developer in Zwolle in September 2017.

In Italy, startup GlassUp, who is working on connecting eyeglasses to the smartphone, was hiring a Developer with experience in Android and computer vision and image and video recognition in Modena. Also in Modena, Startup Pikkart was hiring a Developer with Android and iOS experience to work on smart glasses.

In Sweden, Spotify was hiring an Android Engineer with iOS and Android experience in Stockholm. Furniture retailer IKEA was hiring an iOS Developer in Helsingborg. Online invoice app Qliro was hiring an Android Developer in Stockholm. And healthcare IT firm ASCOM was hiring an Android Developer in Gothenburg.

In Spain, entertainment company Mahei was hiring Engineers in Pamplona with knowledge of iOS and Android platforms and artificial intelligence. Betting company RETAbet was hiring iOS and Android Developers in Zamudio. Cabify, an online platform connecting people with private cars, was hiring a Ruby Engineer in Madrid to work on iOS and Android projects.

In Norway, management consulting firm Acando was hiring a Java Developer in Oslo in September 2017 with experience in machine learning to develop its digital mobile workplace. MazeMap AS, who provides indoor maps and navigation services, was hiring Software Engineers with experience in iOS and Android mobile development in Trondheim.

Integrated software firm Y Soft was hiring a Senior QA Engineer for IoT with a deep knowledge of programming in Prague, Czech Republic. Prague Startup Centre was hiring an iOS Developer with interest in IoT and augmented reality. Sharry Europe Ltd. was hiring an Android Developer in Prague with to work on mobile applications for intelligent office buildings via the IoT.

In Switzerland, online classifieds site tutti.ch was hiring an Android Developer in Zurich. Axon VIBE, who manufactures smart technology that anticipates human behavior and needs, was hiring a Senior Mobile Engineer.

In Portugal, tech studio EVOKE IT was hiring a Software and Electronics Developer in Aveiro with a focus on mobile apps and IoT. Creativesystems was hiring a Java Software Developer in with experience in mobile to work in areas including IoT in St. John's Wood. IT People Innovation was hiring a Xamarin Mobile Developer in Lisbon to create apps and integrate them with augmented reality solutions.

In Austria, Wikitude was hiring a Software Engineer in Salzburg to work on augmented reality for mobile devices. Commercial and investment bank Raiffeisen Bank International was hiring a Mobile Developer with development experience in iOS and Android in Wien. And online flea market Shpock was hiring a Senior Android Developer in Vienna.

And here's a few examples from other countries: In Finland, employee knowledge sharing platform Smarp was hiring iOS and Android Mobile Engineers in Helsinki. In Poland, Volvo Group was hiring a Mobile Developer in Wroclaw. In Switzerland, gaming company Gbanga was a Unity Developer in Zurich with experience in development experience and augmented and virtual reality.

Online retailer Jet.com was hiring a Mobile Apps Engineer in Dublin, Ireland. Energy management and automation firm Schneider Electric was hiring Junior and Senior App Developers in Kolding, Denmark. And in Luxembourg, Amazon Web Services was hiring an IoT Prototype Developer with iOS and Android development experience and an understanding of end-to-end IoT implementation.

CONCLUSION

Our analysis shows Europe's companies and workers have leveraged the App Economy boom in terms of employment. Using our new globally-consistent methodology, we estimate that the 28 countries of the European Union plus Switzerland and Norway have been able to create more App Economy jobs than the United States since the App Store was introduced in 2008. This suggests a positive role for technological innovation in creating new jobs and economic growth around the world.

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METHODOLOGY APPENDIX

As noted earlier in this paper, we have developed a new, standardized methodology for estimating App Economy employment.

This methodology can be applied to a wide variety of countries, languages, and economic environments. The methodology uses online job postings for workers with app-related skills as a real-time measure of App Economy employment. We benchmark this data against official government statistics in order to eliminate many of the well-known problems connected with using big data to measure economic variables.

Our new globally uniform methodology is built on a strong base of previous research, starting with the widely cited 2012 paper, "Where the Jobs Are: The App Economy" (see full list of previous studies at end of document). For this study, a worker is in the App Economy if he or she is in:

- An ICT-related job that uses App Economy skills—the ability to develop, maintain, or support mobile applications. We will call this a "core" App Economy job.
- A non-ICT job (such as human resources, marketing, or management) that supports app developers in the same enterprise. We will call this an "indirect" App Economy job.
- A job in the local economy that is supported by core or indirect App Economy jobs. We will call this a "spillover" job.

How do we tell which jobs require App Economy skills? The key is to look at help wanted ads—also called job postings—where enterprises actually describe the skills and knowledge they are looking for. Our data source is the Indeed job search site, which lists online job postings for each country. These various Indeed job search sites can be found at www.indeed.com/worldwide.[13]

Our goal is to estimate App Economy employment for the 28 members of the European Union, plus Norway and Switzerland. Indeed tracks job postings for 21 of these 30 countries. The 21 countries are: Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, and United Kingdom. These 21 countries include roughly 95 percent of ICT professional job in the 30-country area.

How do we tell which jobs require App Economy skills? The key is to look at help wanted ads—also called job postings—where enterprises actually describe the skills and knowledge they are looking for.

The heart of the analysis is the list of key words and phrases generally associated with App-Economy-related skills. In previous studies we have built up extended keyword lists. However, because we intend this analysis to be repeatable across a wide range of countries, we simplified the search terms.

The methodology consists of eight distinct steps.

1. **Identification of App Economy job postings**
   Using summary statistics generated by searches on the Indeed website, we identify online job postings containing one of the following key words: "iOS" or "Android" or "Blackberry" or "Windows Phone" or "Windows Mobile" or "app."

2. **Validation**
   By the nature of the data, a keyword search for App Economy workers will typically include some irrelevant job postings. For example, the word "app" can appear in a job posting for a truck driver who needs to use an app on the job. The term "iOS" can also refer to an island in Greece.

   In order to adjust for these and other irrelevant job postings, we manually examine a sample of the job postings from step 1 to eliminate those that do not fit our criteria of an App Economy worker. This is a crucial part of the process. This allows us to estimate a validation ratio that we apply to the full results of step 1.

3. **Benchmarking ICT job postings against official ICT employment statistics**
   Our methodology relies on benchmarking information and communications technology (ICT) job postings against official statistics. Benchmarking against official statistics is an essential step in any use of big data for economic analysis. It allows us to adjust for biases in the underlying job posting data, both geographically and over time.

   For each country, we construct a keyword list to identify ICT job postings in that country. We start with a common base of search terms in English, and then, for each country, add a set of corresponding search terms in that country's main language or languages (in the case of countries such as Belgium, Luxembourg, and Switzerland). For example, the search terms for Germany ICT job postings include such terms as "web-entwickler" and "netzwerkadministrator."

   For our European analysis, we benchmark the job postings against figures on the number of ICT professionals per country, drawn from the International Labor Organization (ILO) database, which in turn gets its numbers from national surveys. We then use a conservative assumption comparing the number of ICT professionals to the size of the whole ICT workforce in the country.[14] After validation, this allows us to calculate the ratio of job postings to employment for overall ICT occupations for each country.[15]

4. **Estimation of App Economy core jobs for European countries**
   We assume the ratio of online job postings to employment for overall ICT occupations calculated in step 3 also holds for core App Economy jobs. This is the key step in the estimation process.

   We multiply the ratio generated in step 3 and the validated number of App Economy job postings generated in step 2. The result gives us the estimate of core App Economy jobs.

5. **Estimation of total App Economy employment for European countries**
   Using the same multipliers as in our previous work we estimated the total number of App Economy jobs in each European country. We assume each core App Economy job is associated with two additional jobs (indirect and spillover jobs combined). Once again, this is a conservative assumption compared to other studies.

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6. **Estimation of the jobs that belong to the iOS, Android, Blackberry, or Windows Mobile/Phone ecosystems in European countries**
   Out of the set of job postings containing the terms iOS, Android, Windows Mobile, Windows Phone, or Blackberry, we identify the share that contain terms belonging to the iOS ecosystem (Apple, iPad, iPhone, iOS); the share belonging to the Android ecosystem (Android, Google); the share belonging to the Blackberry ecosystem (Blackberry); and the share belonging to the Windows Mobile/Phone ecosystem ("Windows Mobile," "Windows Phone"). Then those shares were applied to all App Economy employment. Note that these shares add up to more than 100 percent, because many job postings specify more than one mobile operating system (i.e., looking for an iOS/Android developer). Thus, a single job can belong to multiple ecosystems.

7. **Estimating App Economy jobs for EU-28 plus 2**
   This methodology allows us to estimate App Economy jobs for the 21 countries covered by Indeed. There are nine countries in our target set that Indeed does not cover. These are Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia. In total, these countries account for only a small share of the total target population, so we account for their effect by assuming they have the same app intensity as the average for the other 21 countries.

> This methodology allows us to estimate App Economy jobs for the 21 countries covered by Indeed.

8. **Estimating App Economy jobs for cities**
   Our definition of an urban area is a 50-kilometer radius around a city (or 30 miles for U.K. cities), within the same country. In some cases, two cities were relatively close, and then we combined them. For example, the figures for Rotterdam include The Hague, while the figures for London include Reading.

   We calculate the raw App Economy job postings in an urban area as a share of App Economy job postings for the entire country. Then we apply the resulting percentage to the number of App Economy jobs in the country, as reported in Figure 2.

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12 We assume that each core App Economy job is associated with two additional jobs (combined indirect and spillover). This assumption is low compared to the typical job multiplier found in the literature, which can go as high as 5 or even higher. See, for example, "Job Multipliers: Silicon Valley vs. The Motor City."

13 Indeed calls itself "the world's #1 job site, with over 180 million unique visitors every month." Indeed is currently available for 56 countries, which helps make the globally-consistent methodology more straightforward.

14 ICT professionals correspond to ISCO-08 code 25. For the U.S., we benchmarked job postings to the sum of computer and information systems managers (SOC code 11-3020) and computer and mathematical occupations (SOC 15).

15 Note that this ratio accounts for duplicate job postings, as well as job openings that are not publicly posted.

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Progressive Policy Institute
1200 New Hampshire Ave NW,
Suite 575
Washington, D.C. 20036

Tel 202.525.3926
Fax 202.525.3941

info@ppionline.org
progressivepolicy.org