

# The App Economy in Europe: Leading Countries and Cities

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In this report, we estimate that the European Union, plus Switzerland and Norway, has a surprising 1.64 million App Economy jobs as of January 2016—a sign of a growing and vital tech sector. We identify the leading App Economy countries in Europe, and provide a ranking of the top App Economy cities, with London ranked first.

In January 2016, we used the same methodology to estimate that the United States had 1.66 million App Economy jobs, only slightly above Europe. While Europe still lags by other measures, it's clear that European companies and workers have been able to take advantage of the global App Economy boom in a very positive way.

Our policy agenda, in writing these reports, is to show how innovation can create jobs globally, a point that is of great interest to both workers and policymakers. Moreover, by developing this data set, we hope to link app-related job growth to government policies in different countries, to

understand what can be done to spur innovation-related jobs in the future.

We focus on the App Economy because the introduction of the iPhone in 2007, followed by the opening of the innovative App Store in 2008, created a profound and almost unprecedented economic force. It was a match made in heaven—handheld powerful computers that were always connected to the Internet, combined with the ability for developers to write and maintain the mobile applications that made smartphones useful.

The App Store was the rare case of an innovation with a clear starting point and immediate global adoption. Moreover, the innovative design of the App Store lowered the barriers to entry for mobile app developers all around the world. It created a low-cost mechanism for distributing apps to users that allowed even the smallest of software developers to reap global economies of scale. In

## About the author

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some sense, the App Store was an important step in fostering a global entrepreneurial culture.

At the same time, large companies have realized that mobile apps are the new “front door” to their business, a way of reaching customers and potential customers. Similarly, we have reached a tipping point where more and more people of all income levels have smartphones, allowing governments and nonprofits to use mobile apps to deliver social services and as an interface for important citizen interactions. This change, while slow, has reached a tipping point.

**We estimate that the European Union, plus Switzerland and Norway, has a surprising 1.64 million App Economy jobs as of January 2016—a sign of a growing and vital tech sector.**

Looking forward, the growth of the App Economy is likely to continue, as people increasingly use mobile apps as their interface to their home, cars, schools, and healthcare providers. Indeed, the rise of the Internet of Things will guarantee the need for more and more highly functional and sophisticated apps, serving an essential role in interacting with our environment.

**MEASURING THE APP ECONOMY**

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.” Over the past several years, we have documented the enormous number of jobs created by the App Economy in developed countries such as the United States and Australia, and developing countries such as Vietnam and Indonesia. Other researchers have estimated App Economy employment for Europe and elsewhere.

But as the App Economy grows in significance globally, it becomes essential to have a consistent set of App Economy job estimates so that policymakers

FIGURE 1: THE EUROPEAN APP ECONOMY (JANUARY 2016)

	Millions of jobs
EU-28 plus Norway and Switzerland	1.64
EU-28	1.57

*Data: Progressive Policy Institute, Indeed, public job postings*

can compare their country’s performance with that of other countries. 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.<sup>1</sup>

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.

This preliminary report on Europe’s App Economy represents the second 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.

**RESULTS**

Our analysis shows that the European App Economy includes 1.64 million jobs as of January 2016. Companies employing workers with App Economy skills include large and small app developers; software and media companies; financial and retail companies; industrial companies; health and education enterprises; leading European and

non-European tech companies; nonprofits and government suppliers; and large accounting and consulting firms.

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

- An information and communications technology (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. 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-ICT job (such as human resources, marketing, or sales) 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 the income flowing to core and indirect App Economy workers. These “spillover” jobs include local retail and restaurant jobs, construction jobs, and all the other necessary services.

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.

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 that we are actually counting job postings that correspond to core App Economy jobs. We use a conservative estimate of the indirect and spillover effects.<sup>2</sup>

### 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. The United Kingdom ranks first, followed by Germany and France.

As noted in the methodology appendix, we do not have separate data for Bulgaria, Croatia, Cyprus,

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The growth of the App Economy is likely to continue, as people increasingly use mobile apps as their interface to their home, cars, schools, and health providers

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Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia. However, these countries are included in the aggregate numbers.

Before Apple opened the App Store in July 2008, there was no such thing as an App Economy job. No employer was posting want ads looking for iOS or Android developers; no one was talking about the shortage of mobile app coders. This has been an incredibly rapid transformation of the job market, paralleling the astounding growth of smartphone usage.

What’s more, the explosion of App Economy jobs came during the deepest recession in more than

FIGURE 2: APP ECONOMY JOBS BY COUNTRY (JANUARY 2016)

Country	App Economy jobs, thousands	Country	App Economy jobs, thousand
United Kingdom	321.2	Denmark	33.4
Germany	267.9	Switzerland	28.5
France	228.9	Portugal	27.4
Netherlands	125.2	Belgium	23.2
Italy	97.5	Czech Republic	19.7
Poland	84.3	Romania	19.3
Spain	78.2	Hungary	15.3
Sweden	67.1	Ireland	13.2
Finland	47.4	Austria	11.9
Norway	41.6	<b>European Union</b>	<b>1572</b>
		<b>30-country total</b>	<b>1642</b>

*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.*

*Data: Progressive Policy Institute, Indeed, ILO*

75 years. Indeed, these 30 countries are now just making it back to the level of employment that existed in the middle of 2007. The demand for App Economy skills drove companies to hire new ICT workers—and retain the ones they already had—even during the depth of the recession and the sluggish recovery that followed.

How important has the App Economy been for the European labor market? That is a tough question to answer quantitatively. But we do note that France has 229,000 App Economy jobs, only slightly less than the 289,000 net new jobs generated in the country between 2007 and 2015.

## COMPARISONS

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. As noted at the beginning of the study, Europe has generated App Economy

jobs at roughly the same pace as the United States, 1.64 million versus 1.66 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 1.2%. By comparison, the European app intensity is 0.7% (Figure 3).

We can do a similar comparison, ranking European countries by app intensity. Figure 4 ranks European countries by app intensity. Finland takes top place with a 1.9% app intensity, showing it to be a small country with a big presence in mobile apps, led by world-class companies such as mobile game makers Rovio Entertainment (maker of the mobile game hit Angry Birds) and Supercell. Norway ranks second, followed by the Netherlands. By way of a measuring stick, the top U.S. state by app intensity is California, at 2.4%.

FIGURE 3: APP ECONOMY MATCHUP:  
EUROPE VS THE UNITED STATES

	App Economy Jobs (mil- lions)	App Intensity *
Europe**	1.64	0.7%
United States	1.66	1.2%

\*App Economy jobs as a share of all jobs.

\*\*EU-28 plus Switzerland and Norway.

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 0.4%.

## PERSPECTIVE

We estimate that the European Union plus Norway and Switzerland has 1.64 million App Economy jobs—does this number make sense? This figure corresponds to roughly 547,000 core App Economy jobs. By comparison, we estimate this 30-country area has roughly 5.9 million workers in all ICT occupations.<sup>3</sup>As a result, roughly 9% of ICT jobs in Europe are associated with the App Economy.

A similar calculation for the U shows roughly 11% of ICT jobs associated with the App Economy. Based on informal discussions with tech executives, neither of these numbers seem out of line. They suggest that Europe is developing a vibrant App Economy, just at a somewhat slower rate than the United States. Moreover, there is plenty of room for the number of App Economy jobs to continue to rise as apps take a central role in the Internet of Things.

## MOBILE OPERATING SYSTEMS

Many App Economy job postings list a mobile operating system or multiple mobile operating systems that the job candidate is expected to be familiar with. 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 2016, we estimate that 75% of App Economy workers in Europe (1.2

FIGURE 4: RANKING EUROPEAN COUNTRIES BY APP INTENSITY

Country	App Intensity*
Finland	1.9%
Norway	1.6%
Netherlands	1.5%
Sweden	1.4%
Denmark	1.2%
United Kingdom	1.0%
France	0.9%
Ireland	0.7%
Germany	0.7%
Luxembourg	0.6%
Switzerland	0.6%
Portugal	0.6%
Poland	0.5%
Belgium	0.5%
Spain	0.5%
Italy	0.4%
Czech Republic	0.4%
Hungary	0.4%
Austria	0.3%

\*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

million jobs) 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 also accounts for 75% of App Economy workers in Europe (also 1.2 million after

FIGURE 5: EUROPEAN APP ECONOMY JOBS BY OPERATING SYSTEM

	App Economy jobs (thousands)	Share of all App Economy jobs
iOS ecosystem	1227	75%
Android ecosystem	1223	75%
Blackberry ecosystem	105	6%
Windows Phone/Mobile ecosystem	150	9%

Data: Progressive Policy Institute, Indeed

rounding). The Blackberry ecosystem accounts for 6%, while the Windows Phone or Windows Mobile ecosystem accounts for 9%.

The numbers sum to more than 100% 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.

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.

### 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 136,000 App Economy workers, followed by Paris and Amsterdam. We then provide examples of App Economy jobs across European cities.

FIGURE 6: APP ECONOMY JOBS BY COUNTRY AND MAJOR OPERATING SYSTEM

	Total App Economy jobs (thousands)	Jobs belonging to iOS ecosystem (thousands)	Jobs belonging to Android ecosystem (thousands)
Austria	12	9	10
Belgium	23	18	16
Czech Republic	20	12	15
Denmark	33	24	26
Finland	47	36	41
France	229	163	172
Germany	268	209	201
Hungary	15	12	11
Ireland	13	11	9
Italy	97	75	79
Netherlands	125	96	99
Norway	42	32	33
Poland	84	49	60
Portugal	27	22	22
Romania	19	12	14
Spain	78	61	66
Sweden	67	54	52
Switzerland	29	23	23
United Kingdom	321	242	206

Data: Progressive Policy Institute, Indeed

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).

FIGURE 7: TOP APP ECONOMY CITIES IN EUROPE (JANUARY 2016)

Rank	City	App Economy employment (thousands)	Rank	City	App Economy employment (thousands)
1	London	136	16	Rotterdam**	21
2	Paris	99	17	Oxford	18
3	Amsterdam	73	18	Stuttgart	18
4	Berlin	56	19	Birmingham	17
5	Munich	47	20	Copenhagen	17
6	Stockholm	37	21	Manchester	16
7	Helsinki	35	22	Lisbon	16
8	Madrid	30	23	Bristol	16
9	Barcelona	28	24	Utrecht	16
10	Oslo	26	25	Brussels	15
11	Cologne*	24	26	Cracow	15
12	Milan	24	27	Zurich	15
13	Warsaw	22	28	Rome	14
14	Frankfurt	22	29	Eindhoven	13
15	Hamburg	21	30	Lyons	13

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

\*Includes Dusseldorf \*\*Radius around Rotterdam is only 45 kilometers to avoid overlap with Amsterdam

Data: Progressive Policy Institute, Indeed

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. Germany has five areas, led by Berlin. France, on the other hand, has only one.

Here are the top 30 App Economy cities in Europe.

### EXAMPLES

Just like the United Kingdom is Europe's leading App Economy country, London is Europe's leading App Economy city. The diversity of App Economy

jobs in London and the surrounding areas is immense, going far beyond the usual gaming and consumer-facing apps. For example, as of January 2016 the BBC was looking for a software engineer to join the BBC Mobile Apps team, which "develops native mobile apps for internal staff use." SAM Labs, a startup company that produces Internet of Things learning kits, was looking for a senior iOS Developer.

As befitting its role as a global financial capital, London is strong in App Economy jobs in both small financial technology (fintech) firms and large

financial services companies. Expend, a fintech payments company, was posting for an iOS developer in January 2016. Meanwhile the Investment Bank division of Goldman Sachs was looking for an “analyst developer” to contribute to internal tools include iOS and Blackberry apps.

Of course, App Economy jobs in the United Kingdom are not simply restricted to the greater London region. Other areas with high concentrations of App Economy jobs include Oxford, Birmingham, and Manchester. In Oxford, NaturalMotion, which specializes in creating animation technology, was looking for an Android Technology/Engine Programmer in January 2016. In Birmingham, Fitnexus, which produces a mobile platform that allows health clubs to connect with their members, was looking for a Senior Mobile Developer. In Manchester, Reality Mine, a company that “develops innovative technology solutions for collecting consumer behavior and market research data,” was posting for a mobile developer.

In Paris, second on the list of App Economy cities in Europe, both multinationals and smaller companies are hiring App Economy workers. For example, as of January 2016, Thales, a global leader in aerospace, transport, defense, and security, was looking for a “Multimedia Software Development Engineer” with knowledge of iOS and Android. Orange Business Services, part of the French telecom giant, was looking for a Mobile Development Software Engineer in Paris with knowledge of iOS, Android and/or Windows Mobile.

Oodrive, a growing French cloud computing company, was looking for an iOS software engineer and an Android developer in Paris. BlaBlaCar, a long-distance ridesharing platform, was looking for both iOS and Android Mobile Application Engineers.

The third leading App Economy city, Amsterdam, is the center of App Economy jobs for the Netherlands. For example, the giant bank ABN AMRO was seeking a Security Solution Designer to help with the protection of mobile apps. Air France KLM was seeking a Senior E-Business Mobile Developer with Android skills. The airline builds both customer-facing apps and also software for flight-related systems, such as crew check-in check in crew and iPad on board.

Also in Amsterdam, Mirabeau, a company “creating digital world changing experiences,” was seeking an Android Developer. Qardio, a San Francisco-headquartered company that creates wearable health monitoring devices, was looking to hire senior iOS and Android developers in Amsterdam.

By the way, this situation—where U.S.-based companies hire app developers in Europe—is far more common than one might think. This is a win-win for European cities. The well-paying jobs are located in Europe. Moreover, the developers have access to the best global knowledge, contributing to growth and innovation in the local economy.

Other App Economy cities in the Netherlands include Utrecht, where Blendle, a pay-per article online news platform, was posting for both iOS and Android developers in January 2016. In Rotterdam, Label A, a company that builds, designs and manages online tools, applications and portals, was looking for iOS and Android developers.

Germany’s App Economy is unique because it is widely distributed across the country. The number four App Economy city in Europe is Berlin, where SinnerSchrader Mobile, a full-service agency, was looking for an iOS software developer. Socioromantic, a display advertising firm founded in Berlin in 2009, was looking for an iOS developer. Mobile Event Guide, which creates apps for conferences and tradeshow, was posting for an iOS developer in Berlin.

But Munich, fifth on the list of European App Economy cities, is not far behind Berlin. Munich-based CHECK24, which offers consumer comparisons in areas such as insurance and travel, was looking for Android and iOS developers. Delightex, a Munich-based start-up in the field of personal development, was looking for an iOS/Android Developer. Travian Games was looking for a senior mobile developer with Android experience. Catchys, a vintage fashion site, was looking for an iOS developer in Munich. And auto giant BMW was looking for software developers to help develop new digital services for smartphone-based applications on iOS, Android and Windows Mobile.

Other strong App Economy cities in Germany include Cologne—No. 11 on the list—Frankfurt,

Hamburg, and Stuttgart. In Cologne, Hubert Burda Media, one of Europe's largest publishers, was hiring mobile app developers for various divisions in January 2016. In Frankfurt, Shopgate, an e-commerce platform that develops mobile websites and native apps for online merchants, was posting for a senior Android Developer. In Hamburg, NuBon, a mobile platform offering services to businesses such as digital loyalty cards, was searching for multiple Android Developers. And in Stuttgart, USU Group, an IT service provider, was looking for a developer for Android/iOS/Windows Phone.

In Sweden the key App Economy hub is Stockholm, sixth on the list. In that city, world-renowned appliance manufacturer Electrolux was seeking a Digital Apps Project Manager, to help create mobile apps which can do remote monitoring and control of connected appliances. Tink, a fintech startup, was seeking an iOS Engineer in Stockholm. iZettle, a Stockholm-based mobile payments company with customers around the world, was posting for Android and iOS developers.

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**As of January 2016, we estimate that 75% of App Economy workers in Europe (1.2 million jobs) belong to the iOS ecosystem.**

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A 50-kilometer radius around Finland's capital city Helsinki, seventh on the list, includes Espoo, headquarters of Rovio Entertainment. Rovio developed the immensely successful mobile game Angry Birds. But the Finnish App Economy is far more than games. For example, as of January 2016, Siili, a software integrator and digital services provider, was looking for an iOS/Android Mobile Architect.

Spain has two roughly comparable App Economy hubs, Madrid at eighth and Barcelona at ninth. In Madrid, eDreams ODIGEO, one of Europe's largest e-commerce companies, was looking for an iOS Technical Team Lead. In Barcelona, Social Point, a creator of social games for Facebook and mobile devices, was searching for a Mobile Architect. As of

May 2016, the food multinational Nestle had a job posting for a Mobile Development Solution Designer in Barcelona with iOS and Android experience.

And here are a selection of recent job postings from other App Economy cities in Europe: In Milan (12th on the list), Deloitte was looking for an "Apple Expert" with deep knowledge of iOS. As of April 2016, also in Milan, Unicredit was looking for an ICT Security specialist with "advanced developing skills for mobile apps." In Rome, IQUII, a digital communications company, was posting for an iOS developer.

Copenhagen-based MovieStarPlanet was looking for a Game Client Architect to help develop its games on iOS, Android, and Kindle. In Oslo, Bakken & Bæck, a digital product development studio, was posting for an iOS developer and an Android developer. In Krakow (Poland), Miquido, an mobile UX and development company, was looking for an iOS developer and an Android developer. Finally, in Brussels, home of the European Union, ABS Creative Group is looking to hire a mobile & front-end developer.

## CONCLUSION

Our analysis shows Europe's companies and workers have been able to take advantage of the App Economy boom. Using our new globally-consistent methodology, we estimate that the 28 countries of the European Union plus Switzerland and Norway have been able to generate nearly as many App Economy jobs as the United States since the App Store was introduced in 2008. This suggests a positive role for innovation in producing new jobs and new opportunities around the world.

## APPENDIX: METHODOLOGY

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](http://www.indeed.com/worldwide).<sup>4</sup>

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, Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden,

Switzerland, and United Kingdom. These 21 countries include roughly 95% of ICT professional job in the 30-country area.

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 includes 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.<sup>5</sup> After validation, this allows us to calculate the ratio of job postings to employment for overall ICT occupations for each country.<sup>6</sup>

#### 4. Estimation of App Economy core jobs for European countries

We assume that 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 that 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.

#### 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 which 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 that they have the same app intensity as the average for the other 21 countries.

#### 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 UK 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.

### FINAL METHODOLOGY NOTE

This methodology is an example of how big data produced by the private sector can be combined with existing government statistics to gain insight into a new and rapidly growing sector of the global economy. Moreover, because Indeed collects data about online job postings globally, the same methodology, with small adjustments, can be used to

compare App Economy employment in countries and regions across the world.

## PAST APP ECONOMY WORK

### Broad Studies

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## ENDNOTES

1. Steve Lohr, “Google Flu Trends: The Limits of Big Data,” New York Times, March 28, 2014, <http://bits.blogs.nytimes.com/2014/03/28/google-flu-trends-the-limits-of-big-data/>.
2. 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,” <http://www.economicmodeling.com/2012/08/31/job-multipliers-silicon-valley-vs-the-motor-city/>
3. This figure includes ICT managers, ICT professionals and ICT technicians. We derive it from Figure 2.8 in OECD Digital Economy Outlook 2015, <http://www.oecd.org/internet/oecd-digital-economy-outlook-2015-9789264232440-en.htm>.
4. 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.
5. ICT professionals correspond to ISCO-08 code 25. For the US, we benchmarked job postings to the sum of computer and information systems managers (SOC code 11-3020) and computer and mathematical occupations (SOC 15).
6. Note that this ratio accounts for duplicate job postings, as well as job openings that are not publicly posted.

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