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MICHAEL MANDEL AND ELLIOTT LONG
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SUMMARY

India is one of the premier technology countries in the world. According to one forecast, India will overtake the US as the world's largest developer population center by 2024.¹ India is also one of the leading countries for mobile app downloads, due to its more than 500 million smartphone users.²

At the same time, as we will show in this report, India also has a very strong App Economy. We estimate that India has 1.674 million App Economy jobs, as of August 2019. That's up from 1.208 million as of 2016, a 39 percent increase. By comparison, the United States had 2.246 million App Economy jobs as of April 2019, and the European Union (plus Switzerland and Norway) had 2.093 million App Economy jobs as of July 2019.

BACKGROUND

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, or "apps", that could run on smartphones anywhere. These apps became an essential part of daily life for most people, and an indispensable tool for business.

The rise of the App Economy has unleashed an abundance of "app developers." These workers create, maintain, and support an ever-expanding range of apps. Mobile games are

the most visible part of the App Economy, but not the most important. Mobile apps include such key uses as shopping applications, home banking programs, smart automobile interfaces, healthcare apps for monitoring patients, and sophisticated apps for running manufacturing plants.

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 an important sense, the App Store was a key 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.

Today, the growth of the App Economy workforce in a country reflects how quickly that country is embracing the next stage of the Information Revolution, which depends on mobile technology to digitize physical industries such as manufacturing and healthcare. 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

As the App Economy grows in significance globally, it becomes essential to have a consistent set of App Economy job estimates so that policymakers can compare their country's performance with that of other countries. However, official economics statistics do not provide an easy way to measure the size of the App Economy.

In response, PPI developed a methodology based on a systematic analysis of online job postings. In particular, we look for job postings that call for app-related skills such as knowledge of iOS or Android. This methodology can be applied to a wide variety of countries, languages, and economic environments.³

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 in some cases 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.

For this study, a worker is in the App Economy if he or she works 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, and described in detail in the methodology appendix. The source of the data is Indeed.co.in, which allows us to use Boolean search to identify App economy-related job postings. (The appendix discusses why we use Indeed.co.in instead of Naukri.com, a much better-known Indian job aggregator).

Job postings are a powerful source of information about the skills being required by employers. 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.

However, the number of job postings does not immediately translate into employment levels. The process for estimating the relationship between jobs postings and employment was initially described in a series of papers starting in 2012, when we produced the first-ever estimate of the U.S. App Economy. We use an improved version of that methodology here, including a conservative set of multipliers relating indirect and spillover jobs to core App Economy jobs.

RESULTS

Table 1 presents an estimate of App Economy jobs in India. We estimate that India has 1.674 million App Economy jobs as of August 2019. This figure includes a conservative estimate of indirect and spillover jobs. That’s a 39 percent gain compared to 1.208 million App Economy jobs in May 2016, the first estimate we made of India’s App Economy.

Our methodology also allows us to estimate the relative share of mobile operating systems in India’s App Economy. We find that the iOS ecosystem includes 873,000 jobs, and the Android ecosystem includes 1.359 million jobs. The two sum to more than the total because many App Economy jobs belong to both ecosystems.

TABLE 1: INDIA'S APP ECONOMY (THOUSANDS OF JOBS)

	APP ECONOMY JOBS, MAY 2016	APP ECONOMY JOBS, AUGUST 2019
TOTAL	1,208	1,674
IOS ECOSYSTEM	641	873
ANDROID ECOSYSTEM	922	1,359

Data: PPI, Indeed.com

iOS and Android jobs sum to more than total because many App Economy jobs are in both ecosystems

Table 2 compares India's App Economy with the United States and the European Union

(we currently do not have a public estimate for China).

TABLE 2: HOW INDIA'S APP ECONOMY COMPARES INTERNATIONALLY

COUNTRY	MILLIONS OF APP ECONOMY JOBS	DATE OF ESTIMATE
INDIA	1.674	August 2019
UNITED STATES	2.246	April 2019
EUROPEAN UNION*	2.093	July 2019

*28 EU countries plus Switzerland and Norway

Data: Progressive Policy Institute, Indeed.com

How do these figures compare to other estimates? In April 2015, the Indian Council for Research on International Economic Relations (ICRIER) released a well-researched report on the Indian App Economy.⁴ Based on industry estimates, ICRIER put the number of app developers in India at 75,000 in 2014, projecting that the number would rise to 150,000 to 160,000 by 2016. This is what ICRIER calls direct employment. By contrast, our estimate

for core app economy employment in 2016 was roughly 400,000.

In making a comparison between ICRIER's estimate and ours, the key point is that ICRIER focused mainly on the app developer industry. By comparison our definition of a core app economy job included a broader set of occupations that require knowledge of iOS or Android, including ICT professionals developing

apps within large non-tech companies such as banks, media companies and retailers; ICT professionals focused on improving security for mobile applications, an increasingly important task; and help desk workers for mobile applications. In other words, our set of core App Economy workers does not stop at people working for app developer companies. That may explain part of the difference.

TABLE 3. TOP TEN STATES AND TERRITORIES FOR APP EMPLOYMENT, AUGUST 2019

	THOUSANDS OF APP ECONOMY JOBS
Karnataka	368
Maharashtra	283
Delhi*	248
Tamil Nadu	142
Telangana	133
Gujarat	114
Uttar Pradesh	108
Haryana	94
Kerala	61
West Bengal	49

*Includes jobs in urban area out to 50 km
Data: Progressive Policy Institute, Indeed.com

REGIONAL RESULTS AND EXAMPLES

Our methodology allows us to estimate App Economy employment by state and territory, or urban area, by looking at the distribution of App Economy job postings. Table 3 below reports the top 10 states and territories, as ranked by App Economy employment. Table 4 reports on App Economy employment for the ten largest cities in India.

TABLE 4: APP JOBS IN INDIA'S TEN LARGEST CITIES, AUGUST 2019

	THOUSANDS OF APP ECONOMY JOBS
Bangalore	362
New Delhi	248
Mumbai	137
Hyderabad	128
Pune	113
Chennai	101
Ahmedabad	66
Kolkata	43
Jaipur	27
Surat	24

*Based on jobs within 50 km of city
Data: Progressive Policy Institute, Indeed.com

We can see that the Indian App Economy is creating jobs across a wide range of industries and geographies. As of August 2019, digital studio Cotech Innovations was hiring a mobile app developer with Android experience in Bengaluru, Karnataka. Web development company Detecvision was seeking a hybrid mobile app developer proficient in iOS and Android in Delhi. IBM was searching for iOS and Android application developers in Hyderabad, Telangana. Software company Highprosoft was looking for a mobile app developer with experience in iOS and Android in Kanpur, Uttar Pradesh. IT consulting firm Alian Software was hiring a junior mobile app developer with Android experience in Anand, Gujarat.

Looking at the state of Karnataka in particular, JP Morgan Chase was seeking a software engineer with knowledge of iOS in Bengaluru. Ride hailing company GrabTaxi was searching for a mobile software engineer with experience in Android in Bengaluru. Consulting firm Accenture was looking for an iOS application developer in Bengaluru. Media-tech startup ZAPR was hiring an Android developer in Bengaluru. Education technology company PowerSchool was seeking a software engineer with knowledge of iOS and Android in Bengaluru. Workforce technology company tapplent was searching for an Android developer in Bengaluru.

In Maharashtra, marketing technology firm Crowdfire was looking for a mobile developer with experience in iOS and Android in Navi Mumbai. Banking company HSBC was hiring an iOS developer in Pune. Travel fare aggregator Priceline.com was seeking a senior iOS developer in Mumbai. Credit Suisse was searching for an iOS developer in Pune. Consulting firm Capgemini was looking for an Android developer in Pune. Barclays was

searching for a senior Android developer in Pune. As of June 2019, sports-focused digital firm Sportz Interactive was hiring an Android developer in Mumbai.

Customer experience platform Genesys was seeking Android and iOS mobile application developers in Chennai, Tamil Nadu. Transportation and logistics software company NDOT was searching for an Android developer in Coimbatore, Tamil Nadu. Logistics company Pegasus Industries and Packaging was looking for a mobile application developer with knowledge of Android in Chennai. Elevator company KONE was hiring a senior mobile project manager with experience in iOS and Android in Chennai.

In Telangana, transportation firm Best Bus was seeking an Android developer in Hyderabad. Media company Thomson Reuters was searching for an iOS developer in Hyderabad. Transportation and defense technology firm Cubic Corporation was looking for a software engineer with experience in developing mobile applications in Hyderabad. Gaming studio Must Play Games was hiring Android developers in Hyderabad. As of July 2019, entertainment software company Electronics Arts was searching for a QA project lead with experience in Android and iOS in Hyderabad.

Taxi technology company Insigno Quipment Technologies was seeking a software engineer with experience in Android in Ahmedabad, Gujarat. Fintech startup Tarrakki was looking for an iOS developer in Ahmedabad. MasterCard was hiring a senior engineer with experience in iOS and Android in Vadodara, Gujarat. Banking software company MakTech was searching for an Android application developer in Surat, Gujarat.

In Uttar Pradesh, logistics company Pitney Bowes was seeking a database developer with knowledge of iOS and Android in Noida. As of July 2019, online food community TagTaste was looking for an Android developer in Noida. Medical clinic aggregator Medihub was hiring an Android developer in Lucknow, Uttar Pradesh. Software company Adobe was searching for an Android engineer in Noida.

In the union territory of Delhi, personal finance app Faayda was seeking senior Android developers in New Delhi. Coupon provider MyDala was looking for a QA engineer in Saket. As of July 2019, education technology firm Learnix Edutech Private Limited was hiring an Android developer in Delhi. Social media company eSocial was searching for a backend developer with experience in Android and iOS in Delhi.

CONCLUSION

We anticipate fast-growing demand for a new generation of apps to act as the human interface for increasingly-digitized physical industries. Companies will need internal apps for their workers, and external apps for their suppliers and customers. For example, digital manufacturing will rely on mobile devices and apps to help workers interact with networked machinery in factories.

From that perspective, the App Economy could be a potential source of jobs for India going forward, especially given current government goals for economic and employment growth. Moreover, mobile apps can be shipped overseas easily, helping to boost India's export earnings.

Methodology Appendix

Since 2012, we have developed and improve our methodology for estimating App Economy employment. The methodology uses online job postings for workers with app-related skills as a real-time measure of App Economy employment. This methodology can be applied to a wide variety of countries, languages, and economic environments.

As noted in the paper, an ICT-related job that uses App Economy skills—the ability to develop, maintain, or support mobile applications—is a “core” App Economy 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.

The key quantities that we need to estimate are:

Postings(App) = number of job postings for core App Economy jobs

Postings (ICT) = number of job postings for ICT jobs

Jobs(ICT) = number of ICT jobs

Jobs (App) = number of core App Economy jobs.

We use the first three quantities to estimate the number of core app economy jobs:

$$(1) \text{Jobs(App)} = \text{Postings(App)} / \text{Postings(ICT)} * \text{Jobs(ICT)}$$

In other words, the share of core app economy job postings in ICT job postings is used to estimate the share of core app economy jobs in the total number of ICT jobs. To put it another way, if jobs that require App Economy skills are 19% of ICT job postings, we assume that they are 19% of ICT jobs as well.

By rearranging terms, this is equivalent to saying that the ratio of ICT jobs to ICT job postings is the same as the ratio of core app economy jobs to core App Economy job postings:

$$(2) \text{Jobs(ICT)} / \text{Postings(ICT)} = \text{Jobs(App)} / \text{Postings(App)}$$

This is a reasonable assumption if the labor market process generating job postings for core app economy jobs is roughly similar to the labor market process generating job postings for ICT jobs. To put it another way, the assumption is that companies go about looking for app developers the same way they go about looking for software developers.

Note that the ratio of jobs to job postings (equation 2) can differ greatly across countries and across occupational sectors of the economy. It can also change over time.

DATA

The source of the job posting data is Indeed.co.in, which is the Indian site for Indeed.com. Indeed, which calls itself the “#1 job site in the world,” has job sites in more than sixty countries. For each country, Indeed provides an API that accepts Boolean search expressions, and outputs the number of job postings in that country fitting those criteria.

We tend to use Indeed wherever possible because it gives us the ability to use the same search terms in different countries and know that they will behave consistently. This cross-country comparability is very important for our project.

We compared Indeed.co.in with Naukri.com, which calls itself “India’s No. 1 Job Site.” It’s worth noting that all job aggregators typically have access to the same publicly available universe of job postings. For our purposes, job aggregators globally differ by how aggressively they remove duplicate ads, the algorithm they use for removing older jobs, and by how consistently they implement Boolean search (including delimiters and nested parentheses). Note that because job postings often appear on multiple sites, the choice of how aggressively to ‘deduplicate’ similar but not identical postings can make an enormous difference in counts.

For a set of IT-related search terms, we compared the job posting counts generated by Indeed.co.in and Naukri.com on their default settings. In some cases, Indeed.co.in, produced more listings and in some cases Naukri.com produced more listings. Table 5 shows results for selected terms.

TABLE 5: JOB POSTING COUNTS FOR SELECTED TERMS AS OF AUGUST 27, 2019

	INDEED.CO.IN	NAUKRI.COM	PERCENTAGE DIFFERENCE
DATABASE	34003	54678	61%
JAVA	48907	44869	-8%
LINUX	16638	20441	23%
'MACHINE LEARNING'	6137	5200	-15%
PYTHON	18217	24787	36%
'ROBOTIC PROCESS AUTOMATION'	678	605	-11%
SQL	39408	65078	65%

Across the full set of IT-related search terms that we tested, Naukri.com counts averaged about 30 percent higher than Indeed.co.in counts. It's not clear whether that's because Naukri does less aggressive deduplication, or is picking up jobs that Indeed.co.in is missing.

However, there are two important points. The key equation for our methodology (1) relies on a ratio of job postings. If both Postings(APP) and Postings(ICT) are 30 percent higher, the ratio will still stay the same.

Second, Naukri's search algorithm appears to often automatically expand the term 'app' to 'application'. This may be helpful for job seekers, but it is a problem for our methodology. Since in this context apps are a specific subset of application, this property of Naukri's search algorithm makes it much more difficult to identify job postings that specifically reference app development, as opposed to application development. For that reason, we stayed with the globally comparable Indeed.co.in counts.

The methodology consists of seven distinct steps.

1. Identification and validation of core 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.” For each country, we use the same English keyword list, appending national language terms as appropriate. In India, after exploration using Hindi terms, we stayed with the English keyword list.

By the nature of the data, a keyword search for core 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.

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 a core App Economy worker. This validation ratio yields us an estimate of Postings(App).

2. Identification and validation of ICT job postings

Our methodology relies on benchmarking information and communications technology (ICT) job postings against an estimate of ICT occupations. We construct a keyword list to identify ICT job postings. For each country, we use the same English keyword list, appending national language terms as appropriate. In India, after preliminary analysis using Hindi terms, we stayed with the English keyword list.

As in the previous step, we manually examine a sample of the job postings to eliminate those that do not fit our criteria of an ICT occupation. This validation ratio yields us an estimate of Postings(ICT).

3. Calculation of core app economy job postings as share of all ICT job postings

We calculate $\text{Postings(App)}/\text{Postings(ICT)}$, which gives us core app economy job postings as a share of all ICT job postings. This percentage differs between countries, but tends to be relatively stable over time.

4. Estimation of benchmark ICT employment

The question in India is what figure to use for Jobs(ICT). For over sixty countries, the ILO reports the total number of information and communications technology professionals (ISCO-08). For other countries, such as Canada, the national statistics agencies collect comparable figures. This category notably excludes “help desk workers,” so we uniformly adjust this number by a small percentage upwards.

India's Periodic Labour Force Survey yields a figure of roughly 2.7 million, including computing professionals, computer associate professionals, and statisticians, plus the small upward adjustment that we use globally. However, the structure of Indian ICT employment is significantly different than the US and European countries, with a lot more emphasis on back office operations.

To get a comparable estimate for India, we draw on the Labour Force Survey and two other pieces of data. First, NASSCOM pegs Indian IT-BPM employment as roughly 4 million.⁵ Alternatively, an analysis of Github accounts by country suggests that India has roughly 2 million ICT professionals.⁶ Combining these three figures judgmentally gives us an estimate of roughly 3 million for Jobs(ICT).

5. Estimation of core and total App Economy jobs

Using equation (1) at the beginning of the methodology section, we estimate core App Economy jobs. Then we use a conservative estimate of the multiplier effect. We assume that each core App Economy job is associated with one indirect job at the same company, and one spillover job elsewhere in the local area. To put it another way, we assume that each job in the tech sector (core + indirect) generates 0.5 jobs elsewhere in the economy, for a 1.5 multiplier. This assumption is consistent with the latest research on employment multipliers.⁷

6. Estimation of the jobs that belong to the iOS or Android ecosystems

Out of the set of job postings containing the terms iOS or Android, we identify the share that contain terms belonging to the iOS ecosystem (containing one of the terms Apple, iPad, iPhone, or iOS) and the share belonging to the Android ecosystem (containing one of the terms Android or Google). We also do the same for the shrinking Windows Mobile/Phone and Blackberry ecosystems, but do not report these results.

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 states, union territories, and urban areas

We calculate the raw App Economy job postings in a state, territory or urban areas 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.

ABOUT THE AUTHORS

Dr. Michael Mandel is the chief economic strategist at the Progressive Policy Institute and a senior fellow at Wharton's Mack Institute for Innovation Management. Elliott Long is senior economic policy analyst at the Progressive Policy Institute.

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<https://www.nasscom.in/knowledge-center/publications/strategic-review-it-bpm-sector-india-2019-decoding-digital>
- 6 <https://www.benfrederickson.com/github-developer-locations/> provides a count of Github accounts by country. An analysis shows a relationship between the number of Github accounts in a country and the number of ICT professionals, as reported by the ILO. In particular, Mexico has just under 12 ICT professionals for every Github account. If we apply this ratio to the number of India's Github accounts, we get an estimated 2 million ICT professionals in India.
- 7 Timothy J. Bartik and Nathan Sotherland. 2019. "Realistic Local Job Multipliers." Policy Brief, W.E. Upjohn Institute for Employment Research. <https://doi.org/10.17848/pb2019-8>.

The authors conservatively conclude that employment multipliers are around 2.0 at the state level in the United States, and about 1.5 at the local level.



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PROGRESSIVE POLICY INSTITUTE
1200 New Hampshire Ave NW,
Suite 575
Washington, DC 20036

Tel 202.525.3926
Fax 202.525.3941

info@ppionline.org
progressivepolicy.org