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This work proposes an analysis of the statistical properties and distributional characteristics of Burning Glass Technologies' (BGT) data on online job openings from platforms and companies, at the occupation level. BGT data are compared to official data on employment by occupation to assess their occupation-specific representativeness. This work further proposes weighting schemes aimed at making BGT-based analysis fully representative at the occupation and country levels, where appropriate.

The analysis encompasses six economies – Australia, Canada, New Zealand, Singapore, the United Kingdom and the United States – for the period 2010-19. Overall, it finds that BGT data exhibit good statistical properties and are a useful source of timely information about labour market demand, especially for high-skill occupations and recruitment processes that are more likely to happen online.

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Executive Summary

This work assesses the statistical properties and distributional characteristics of online job posting data from Burning Glass Technologies (BGT). The aim is to investigate the representativeness of such data for policy-relevant work. It is motivated by the potential of using online vacancy data to improve the timeliness, coverage and depth of analysis related to labour markets, skills, industry, innovation and entrepreneurship dynamics.

BGT collects data by web scraping over 40 000 distinct job boards and company websites. It claims to cover the near-universe of all online job postings and provides detailed information on labour and skill demand posted online, on a daily basis.

The present analysis is performed at the occupational group level. It encompasses all economies for which BGT data are available over time, namely Australia, Canada, New Zealand, Singapore, the United Kingdom and the United States, and covers the period 2010-19 for the United States and 2012-2019 for the other countries.

The main findings of the analyses and their implications for policymaking are:

- *BGT data exhibit good statistical properties for most years and countries considered*. In some cases, though, it is important to carefully deal with some of the properties of these data, especially in indicators and analysis work whose results are to be generalised at the country level.

- Compared to official employment by occupation statistics, *BGT data coverage appears to vary across occupations and over time*, although overall trends are consistent with official data.

- *Some occupations,* whose recruitment processes are known only seldom to happen online (e.g. construction workers) *may be importantly underrepresented in online job posting data such as BGT.* This calls for the need to carefully identify the year and country-specific data that can be used each time, depending on the purpose of the analysis.

- Comparing BGT data with official employment data shows that occupational categories, such as "managers", "professionals" and "technicians and associated professionals", are relatively better represented in BGT data as compared to other occupational categories. This implies that using BGT data at face value to shed light on aggregate skills and labour dynamics may lead to results that are disproportionally based on these - mostly high-skilled - occupations. Results may conversely be less relevant for other - mostly low-skilled - occupations.

- As can be expected, given the very nature of such occupations and the low likelihood of job openings of this type to be posted online, the occupational category *"skilled agricultural, forestry and fishery workers" is not well represented in BGT data*. Analysts may want to consider removing data related to this occupational group from the analysis. This would not impinge upon the overall representativeness of the analysis, as the share of workers generally employed in this occupational category is low (only about 1% of the employed population, on average, in the countries considered).

- *The representation of some of occupational groups varies over time*, compared to levels observed in official employment statistics. It is important to account for such a feature of the data in trend-related indicators and analysis work focusing on labour

and skill demand. In the absence of adjustments, the observed patterns may reflect changes in the representativeness of different occupational groups over time, rather than real labour market dynamics. Possible solutions are using representativeness weights, focusing the analysis on specific occupational groups, or using econometric methods accounting for such feature of the data.

- Representativeness is generally stable over time for the occupations such as "managers", "professionals", "technicians and associate professionals" and "clerical support workers". Time trend analysis can be implemented without adjustments for these occupations.

- We propose weighting schemes aimed at making BGT-based analysis maximally representative at the overall occupation and country levels. These weights are to be used in analysis aimed to generalise results, to inform policy. Failing to do so, may lead to drawing the policy conclusions that are excessively informed by a subset of the population and/or influenced by changes in the representativeness of different occupational groups, over time. This may impinge upon the soundness of the policy implications drawn from any analysis using these kind of data, not only BGT but also other data suppliers collecting information from the web.

Overall, BGT generally appears as a good source of information for timely labour market-related analysis, especially focusing on labour demand and job patterns. When aiming to generalise results at the country level for the entire working population, it would nevertheless be advisable to address the differences that emerge in the extent to which different occupational categories are represented in online job postings data.

Section 1. Introduction

OECD work carried out in recent years to inform the policy discussion of the OECD Committee on Industry, Innovation and Entrepreneurship (CIIE) has provided evidence about jobs and skills supply-related issues. These include skill endowment and skill distances across occupations (Bechichi et al., 2019[1]); the training required to move individuals across occupations (Bechichi et al., 2018[2])); and the cost that such re-qualification or upskilling of the workforce may entail for countries (Andrieu et al., 2019[3]).

This work has provided solid elements in support of policy making about the type of human capital that firms and industries may rely upon to produce, innovate and perform and about the possibilities for workers to enter and remain in the labour market, in a view to foster the development of competitive and inclusive economies and societies. Getting a more complete picture of how firms and industries shape labour market dynamics through labour demand is nevertheless key, and a much-needed complement to supply-based analyses. Getting a better understanding of how firm and industry structure and dynamics shape and are shaped by labour market dynamics requires not only shedding light - in a timely fashion - on job demand-related issues, but doing so in relation to the digital transformation and the diffusion of new technologies, including Artificial Intelligence.

To this end, and to try and address also the need for more timely data and analysis, we started work relying on a private database produced by Burning Glass Technologies (BGT), which collects information from job posting platforms and companies' websites.

However, as all private data that are not collected by National Statistical Offices - and therefore may not be representative by design - it is important to assess the statistical properties and the extent to which analysis based on such data can be generalised for policy purposes, ahead of using them. This work aims to perform such an assessment, and to investigate the statistical and representativeness properties of BGT's data at the occupational level and over time.

It first assesses the representativeness of BGT data, by means of comparing BGT and official data related to employment by occupation. It then proposes an approach aimed at identifying those occupational categories for which BGT data exhibit good statistical properties and representativeness, and may thus be suitable for use in policy-relevant analysis. It finally devises a weighting scheme aimed at making BGT data maximally representative for policy-relevant analytical purposes.

This statistical analysis is performed over data from six countries, namely Australia, Canada, New Zealand, Singapore, the United Kingdom, and the United States, for a period ranging between 2010-19. These are the countries for which coverage is more extensive over time, in a view to also inform trend-related analyses.[1]

Overall, the evidence gathered shows that BGT data provide overall good and much needed up-to-date information about jobs and skills demand. It further highlights the need to account for and suitably deal with some of these data's characteristics, which are nevertheless common to many other data sources relying on online job postings information. Failing to account for some of the statistical properties of online job postings type of data in fact constrains the possibility to generalise indicator and analysis work at different levels, especially when overall labour and skills market dynamics are under investigation. This may impinge upon the ability of analysis to draw sound policy implications and thus mislead decisions.

The remainder of this paper is as follows. We first provide an overview of BGT data, including coverage, type of information contained and a summary of what other studies have found in terms of representativeness of these data. We then explain how the representativeness exercise is performed and the rationale behind the approach proposed, and discuss the pros and cons of possible alternatives. The paper continues proposing an assessment of the representativeness of BGT data on a country-by-country basis, starting from the United States. When analysing United States' data, we also describe the steps pursued in order to make BGT data representative of (parts) of the labour force and the weighting approach we propose. Upon repeating the representativeness exercise on a country basis and proposing country and time specific weights, we perform a cross-country comparison, before concluding.

Section 2. An overview of Burning Glass Technologies' data

2.1. BGT data collection process and main features

Burning Glass Technologies (BGT) collects data on job postings by web scraping over 40 000 distinct job boards and company websites, on a daily basis. BGT further de-duplicates vacancies appearing on multiple websites and parses the text of advertised positions to categorise online job postings and structure them according to variables, such as geographical location, occupation, industry, required skills, and education and experience levels. Some of the variables are standardised according to official classifications, e.g. occupation and location, thus making it possible to link these data to other datasets.

They say to find around 3.4 million unique active postings at any given time and that today 85% of all jobs in the United States are posted online. Of those, they believe to be covering a near-universe. For a more detailed description of BGT's data collection process, see Carnevale et al. (2014[4]).

One of the advantages of BGT data is that they cover a wide range of vacancy sources and offer a high level of detail. Each ad gets categorised into over 70 variables, a granular level that makes it possible to study variation in jobs and skills demand within occupations and regions, rather than just across such dimensions, as is usually the case with traditional survey-based data.

BGT data have become increasingly informative over time. Hershbein and Kahn (2018[5]) find that already in 2015, vacancies were 12% more likely to include educational and experience requirements, and to detail some of the cognitive skills sought, than they were in 2007. Additionally, Manyika et al. (2015[6]) argue that more and more jobs are advertised online. This coupled with BGT's search algorithms having improved over time, yields more postings for the later years. Such improvements nevertheless should not affect the categorisation of postings, as the company says to apply updates also retroactively, i.e. to all postings in the database.

While greater and possibly better coverage is obviously a positive feature of these data, the increased number of postings published and web-scraped over time calls for analysis about the evolution of job postings over time to be performed with care, and to avoid comparing absolute figures[2].

Hershbein and Kahn (2018[5]) support this assumption. They study the representativeness of BGT data across occupations by comparing the BGT data against the Current Population Survey's (CPS) new jobs data. They find that differences in occupational shares remained sufficiently stable over time or slightly decreased since 2007. They found the largest differences in 2007 to emerge in relation to computer and mathematical occupations (relatively overrepresented by about 11 percentage points) and construction (relatively underrepresented by about 7 percentage points).

2.2. Online job posting data: general considerations and specific BGT features

As all data, BGT data also have shortcomings, some of which are independent of BGT itself. First, not all vacancies are published online, and therefore BGT data cannot be fully representative of such "offline" job openings and vacancies, independently of their data

gathering process. Moreover, the likelihood that a job is posted online is seemingly correlated with the educational degree sought in the advert.

Carnevale, Jayasundera and Repnikov (2014[4]) estimate that 80-90% of postings requiring at least a Bachelor's degree can be found online, whereas only 40-60% of ads requiring a high school degree are channelled through the internet. This share is lowest for college or Associate's degree holders, at 30-40%.

In line with the above, BGT states that jobs in small businesses as well as lower-income and lower-skill jobs are underrepresented in their dataset (Burning Glass Technologies, 2020[7]). Hershbein and Kahn (2018[5]) show that, at the Metropolitan Statistical Areas (MSAs) and occupation levels, education requirements strongly correlate with the average education levels of employed workers. Blair and Deming (2020[8]) account for compositional changes over time by weighting all results by the employment share of each occupation as well as the size of the labour force in each city.

Heterogeneity of workers and firms in their search behaviours further represent a source of concern. If, as it seems likely to be the case based on what is known about different industries, certain industries are less likely to post job ads online, such lower posting frequency could be misinterpreted as lack of labour demand, if online job postings are taken at face value. Similarly, if some groups of workers submit more unsolicited applications, firms might post fewer job ads for these types of workers, without this necessarily implying a lower labour demand for such type of workers.

Moreover, firms might advertise only one job, but actually recruit several applicants for the same type of job. Conversely, they may post (one or more) job openings but not employ anyone at all, for example when they plan to hire at a later date, but already want to get an idea of the available labour supply (Carnevale, Jayasundera and Repnikov, 2014[4]).

In addition, jobs differ in tenure and turnover rates. In a study of Job Openings and Labor Turnover Survey (JOLTS) vacancy data, Davis, Faberman and Haltiwanger (2013[9]) find that growing firms tend to be overrepresented in relation to the average firm. This may also be the case for labour demand that tends to have seasonal characteristics, e.g. salespersons before Thanksgiving or Christmas time or hotel staff ahead of peak holiday periods. This may ultimately translate into an overrepresentation of some occupational titles in the database, as compared to the yearly average employment statistics of the occupations considered.

Additionally, the specific data collection methods and the natural language processing devices used shape any online data collection, including BGT's data collection efforts. Carnevale, Jayasundera and Repnikov (2014[4]) tested BGT's parsing accuracy for the United States and found that when education requirements are published in the ad, which is true for about half of the postings, BGT managed to identify them correctly about 85% of the time.

For geographical variables, skills, occupation title, and for two-digit occupation codes, BGT seemingly manages to classify them at a greater than 80% accuracy levels and 2-digit level industry classifications appear 76% accurate. Shares drop to 73% for the most granular occupation classification (i.e. 6-digit Standard Occupational Classification (SOC)) and the authors argue that accuracy declines for more refined industry classifications.

Industries exhibit a lower representativeness than occupations at the 6-digit level, as they are best derived from the employer's firm name, which is missing for 20% of the data for the United States. In those cases, the industry is inferred from a short description of the firm in the posting, making it less precise. Occupations on the other hand are derived from the job title, which are usually given in the online job ad.

When comparing online job ads to lagged job openings and new hires in JOLTS, Carnevale, Jayasundera and Repnikov (2014[4]) find the two to follow a similar trend, with correlation coefficients of up to 0.75. Those results are especially remarkable when considering that JOLTS data and BGT measure slightly different things. While BGT captures as many new online job postings as possible every day, JOLTS data capture labour demand in a random sample of establishments at a certain day every month, potentially repeating vacancies that have not been filled within a 5-month period. Moreover, JOLTS data exclude openings for independent contractors. As could have been expected, the authors further find job ads data to be more volatile than JOLTS data[3].

In conclusion, existing studies suggest that, when comparing the relative frequency of postings in BGT data to survey-based data such as JOLTS, the Occupational Employment Survey, and the Current Population Survey, BGT data manage to reflect labour demand reasonably well. When this does not happen, the differences that emerge nevertheless appear relatively stable over time (Carnevale, Jayasundera and Repnikov, 2014[4]; Hershbein and Kahn, 2018[5]) and may often be driven by factors that are independent of BGT itself.

Section 3. Key variables in Burning Glass Technologies' data

Burning Glass Technologies' (BGT) data have been supplied to the OECD grouped into six main categories, namely: "Skills", "Posting Identifiers", "Geography Variables", "Occupation and Industry Identifiers", "Credentials & Requirements", "Salary and Job Type":

- Skills-related variables, which are amongst the most used variables of BGT data (e.g. Hershbein and Kahn (2018[5]); Deming and Kahn (2018[10]); Alekseeva (2019[11])), are grouped into progressively more aggregated levels, as follows: "skill", "skill cluster" and "skill cluster family". Skills are also tagged as "specialised", "baseline" or "software skill", based on BGT's skills taxonomy. Examples of "baseline skills" are communication, problem solving, and creativity. Examples of "technical skills" are welding, software development, and financial analysis and examples of "software skills" are Adobe Photoshop, SQL and AutoCAD.

- "Posting Identifiers" encompass the "Job ID number", which is provided by BGT and is uniquely assigned to each record in the database, and the "Job date", i.e. the date in which the relevant job advert has been posted online.

- "Geography Variables" provide information about the "Metropolitan Statistical Area (MSA)", the "City", the "State" and the "Country" in which the job has been posted.

- BGT data contains several occupation and industry categories, as well as occupational and industry titles. BGT created its own occupational class named "BGTOcc", which is available for all the countries. In addition, BGT data contains the commonly used occupational variable given in Labour Force Statistics (LFS) for the specific country considered. Examples are the Standard Occupational Classification (SOC) and Occupational Information Network (O*NET) for the United States, the United Kingdom SOC (UK SOC), the National Occupational Classification (NOC) for Canada, the Singapore SOC (SSOC) and the Australia and New Zealand SOC (ANZSCO).

- There are four variables in the "Credentials & Requirements" part of the database, namely: the minimum and maximum years of education required for the job, as well as minimum and maximum years of experience required. In addition, BGT data provides the required educational degree name, if available.

- The final group of variables in BGT is "Salary and Job Type". This group contains information on: the salary offered, in a variable called "Salary"; the hours of work required ("Job hours"); and whether the job is an internship or not.

In what follows, we present an assessment of the representativeness and statistical properties of BGT data on a country basis, starting from the country featuring the highest number of job openings, i.e. the United States. The order in which the other five economies follow mirrors the number of job postings available, i.e. from the highest to the less numerous ones. All years for which data are available for the considered economy are taken into account in the analysis. This means that the time period considered differs depending on the economy analysed, namely 2010-2019 for the United States and 2012-2019 for the other economies.

The assessment proposed relies on overall data availability, whereas a variable-based discussion of the representativeness of BGT data is proposed in the last section of the paper.

Section 4. Why comparing flows with stocks may be better than comparing flows with flows

To assess the representativeness of online job postings data, a first best would be to compare such data with official vacancy data, and possibly official online job posting-related statistics. In what follows, we explore this option and discuss the differences characterising the data that could be used for the purpose. We conclude that it may be challenging to meaningfully compare official vacancy data with Burning Glass Technologies' data, and that comparing BGT data with employment data may represent a better option, for a number of reasons.

Official vacancy data should help shed light on (new) trends in labour demand, with the caveat that the number of vacancies depends on how often people change jobs in different occupations. Data from the United States Bureau of Labour Statistics (2018[12]) show that the median years of tenure with the current employer varies substantially across occupations, ranging e.g. between less than 3 years for service occupations to more than 6 years for managers. Evidently, other things being equal and holding employment levels fixed, the observed turnover rate for service occupations should be twice as high as the one for managers. This should translate into observing twice the number of vacancies relative to service-related employment in the data, as compared to managers.

Evidently, not taking into account these labour market features may mislead analysts to think that e.g. job opportunities in service-related occupations are greater than those in management when, in fact, this may or may not be the case. Being aware of and accounting for such dynamics becomes especially important if the aim is to inform policymakers about e.g. workforce-related patterns and skills needs.

Another important challenge that needs to be addressed when comparing online job posting-based statistics (such as those one can build using BGT data) with vacancy data is cross-country comparability. First, turnover rates may vary importantly across countries. For example, the annual separation rate is one third for the United States while it takes two years before a third of workers change employer in the United Kingdom (BLS, 2018[12]; ONS, 2019[13]). Second, and perhaps most importantly, official vacancy data differ along a number of important dimensions and with respect to data such as BGT. Vacancies are often measured differently in different countries. For example, vacancy-related surveys in most countries ask to report how many vacancies are open on the day the survey is conducted, whereas in Canada companies are also asked to report vacancies that will open in the coming month. Definitional features like these make it challenging to get to cross-country comparable vacancy measures and would require analysts to make a number of assumptions when using them, with the risk of introducing measurement error.

Among others, an important difference between BGT data and official vacancy statistics is that while BGT data only contain online vacancies, official statistics also include vacancies posted "offline", e.g. in newspapers or on companies' site. In addition, comparisons in Figure 2 show that official vacancy data are somewhat more volatile compared to employment data and this makes it hard to assess changes in representativeness over time.

Also, depending on the industrial structure of the country and on the way businesses operate in different countries, direct hiring may represent a variable part of vacancies, which by definition do not get included in official vacancy data (nor in BGT data, in fact). While official vacancy data would suffer from such a shortcoming, official employment statistics

should not. It should rather be able to capture total labour demand, independently of the hiring procedure followed.

BGT data contain unique job postings for an entire reference month, but do not provide information about how many vacancies are open at one point in time. In contrast, official vacancy data generally offer a snapshot of the number of vacancies that are open at one point in time (i.e. once a month, for most countries). In other words, BGT data offer information about the flows of vacancies whereas official vacancy data inform about the stock of vacancies at one point in time. This may lead, for instance, to official statistics overlooking vacancies that were opened just after the survey was conducted and filled before the next survey. At the same time, vacancies reported in the first survey, which are not filled before the second survey is carried out, may be reported in both surveys. This would happen as vacancies are generally counted, independently of the posting date, in so far as they have not been filled yet at the time of the survey.

As said, comparing BGT data with official job opening statistics would require making assumptions about e.g. average hiring times or delays. In addition to representing a non-trivial task, especially in the absence of statistics about such hiring features, this would require making assumptions that may end up creating noise or measurement error.

Given all the above, while in principle it may seem ideal to compare BGT data with vacancy data, so that flows compare with flows, the challenges that need to be overcome for such a comparison to become feasible make it preferable to compare BGT data (i.e. flows) with employment data (i.e. stocks).

We are aware that this somewhat shifts the focus of the comparison from being representative of vacancies to being representative of the overall employed population. We nevertheless argue that, in light of the constraints mentioned above, the latter may be even more relevant and/or accurate when addressing policy-relevant questions related to industry, innovation, employment and skills dynamics.

In what follows we propose some charts comparing BGT data with official vacancy data, to provide further evidence in support of our choice to compare BGT data with employment statistics. This is done also in order to allow readers to see how these results compare to our main results, presented later in the paper.

Figure 1 shows the share of the BGT data relative to official vacancy data. For the purpose we assume that the average hiring time is one month, a duration that is roughly in line with findings of Chamberlain (2015[14]). The United Kingdom and Singapore emerge as being the economies with the best coverage in BGT data relative to official vacancy data, with shares that range between 70-105%. Such shares conversely range between 20-50% for the United States, Canada and Australia. In all cases, changes over time may, at least in part, be related to changes in the BGT job postings' coverage.

Figure 1. BGT data as share of official vacancy data, 2012-2018
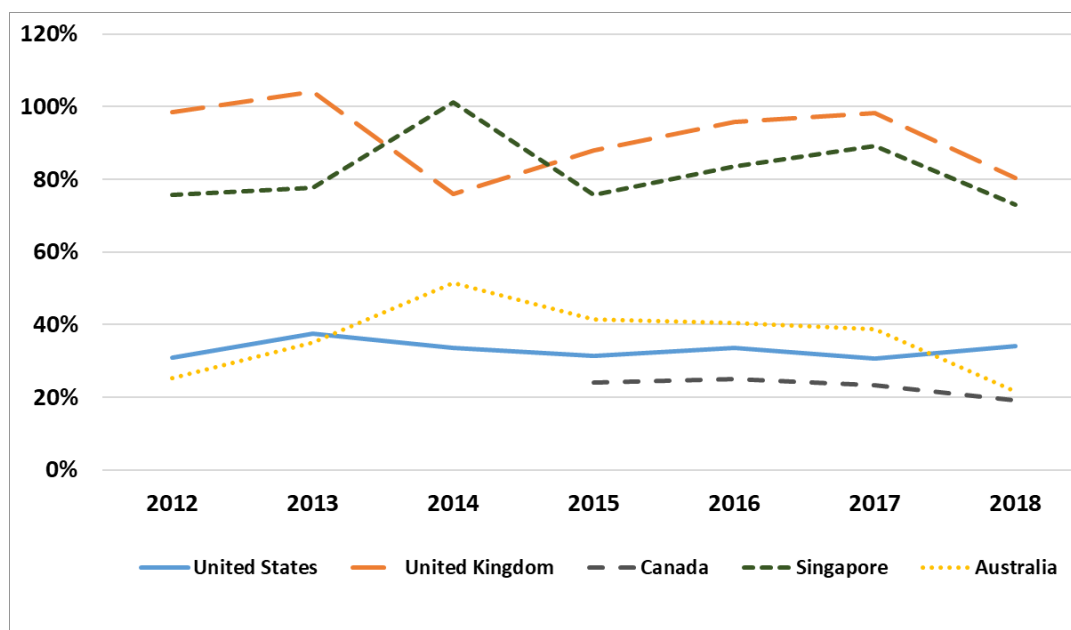
Note: Vacancy data for Canada are only available from 2015 onwards.
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and official vacancy data from JOLTS (2020), ONS Vacancy Survey (2020), Statistics Canada Job Vacancy and Wage Survey (JVWS), Singapore Labour Market Survey, Manpower Research & Statistics (2020) and ABS (2020).

Figure 2 compares BGT job openings data with data from the United States' Job Openings and Labor Turnover Survey (JOLTS) data on job openings, hires and separations. The correlation between the BGT data and JOLTS hires is 0.65; between BGT data and JOLTS separations it is 0.61; and between BGT data and JOLTS Job openings data is 0.80. Figure 3 further shows the monthly growth rates in both BGT data and official vacancy data (JOLTS job openings), for which the correlation between the two is 0.31, raising the question about the two sets of data representing two sides of the same coin. A similar correlation is found between growth rates in BGT data and JOLTS data on separations (0.33) and a somewhat larger correlation, of 0.47, is found between growth rates in BGT data and JOLTS data on new hires.

Figure 2. Comparison between BGT data and JOLTS data, United States, 2012-2018
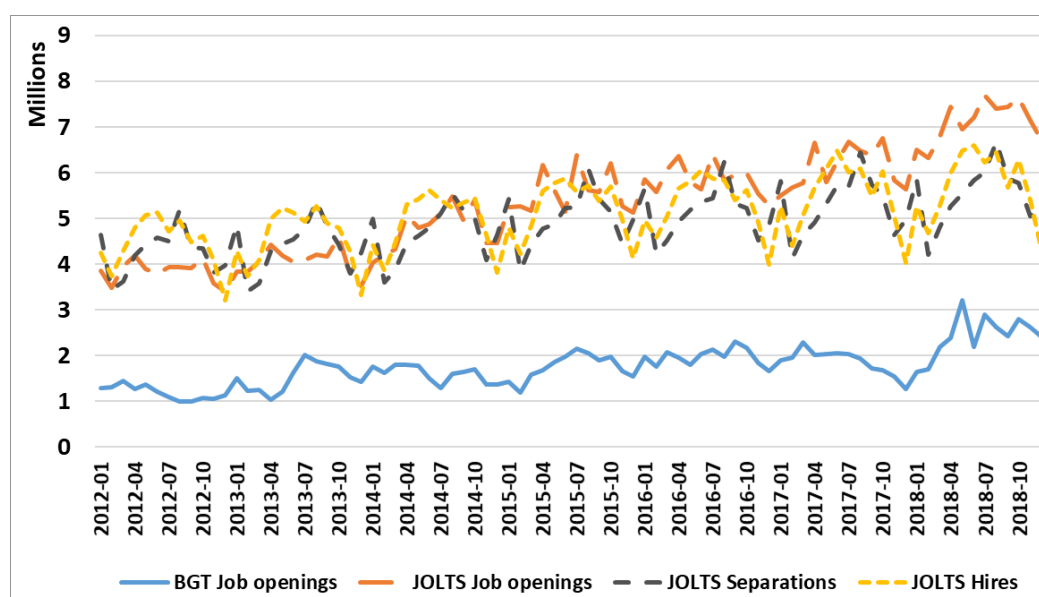
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and JOLTS (2020).

Figure 3. Monthly growth rates in BGT data and official vacancy data for, United States, 2012, 2018
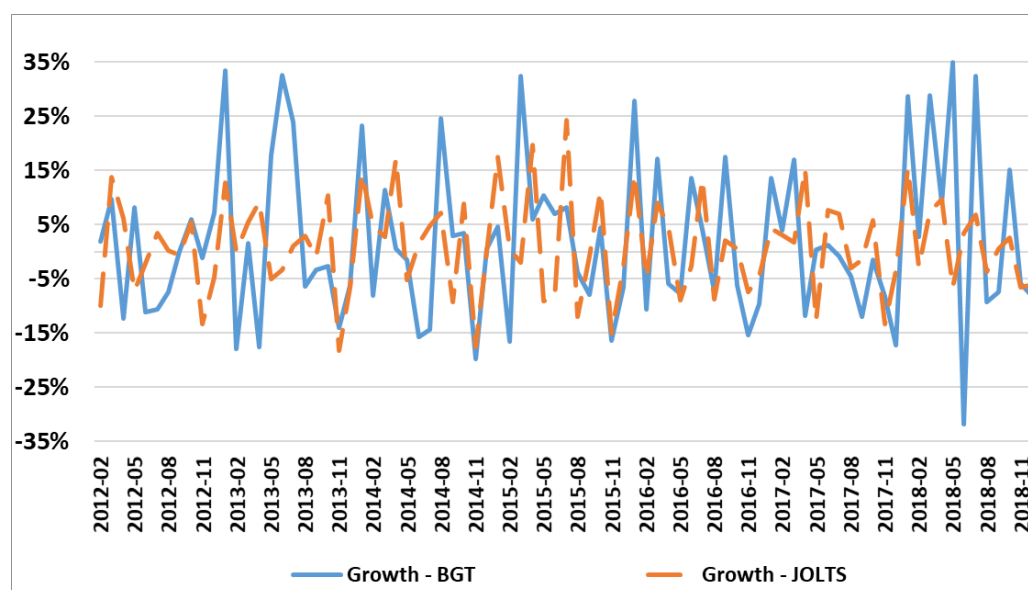
Source: Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and JOLTS (2020).

Differently from what was done above in Figure 2 and Figure 3 in the case of the United States, we also perform a comparison exercise, which stems from the simple consideration that (online) job postings should eventually translate into new hiring outcomes, in most cases. Hence, by comparing online job posting data with data about new hires, one might be able to get an idea of the soundness of statistics based on online job postings. To this end, Table 1 compares BGT job openings with new hires (< 3 months) data at the occupational level for Canada for the period 2012-2019. The shares of BGT data in relation

to new hires is presented according to the 1-digit NOC level with cells containing higher shares, i.e. signalling better representativeness, being coloured in progressively darker tones.

As can be seen in Table 1, job openings for "Management occupations" and "Natural and applied sciences and related occupations" are relatively more frequently posted online[4]. This is similar to what is displayed in Table 23, which shows the occupations for which job postings are more frequent in BGT data for Canada, as compared to its employment levels.

Table 1. Share BGT data relative to new hires (< 3 months) by occupation figures, Canada, 2012-19

	NOC	2012	2013	2014	2015	2016	2017	2018	2019
0	Management occupations	68.4%	86.3%	151.1%	130.4%	129.7%	140.6%	126.2%	171.0%
1	Business, finance and administration occupations	15.6%	20.8%	36.8%	33.4%	29.5%	33.5%	33.5%	37.3%
2	Natural and applied sciences and related occupations	43.5%	46.1%	74.7%	53.7%	55.9%	58.7%	47.3%	52.8%
3	Health occupations	12.7%	19.7%	35.9%	30.9%	28.2%	29.2%	21.6%	26.3%
4	Occupations in education, law and social, community and government services	7.3%	13.3%	23.7%	25.7%	21.1%	25.2%	24.6%	31.2%
5	Occupations in art, culture, recreation and sport	6.2%	9.6%	16.6%	15.2%	14.8%	13.9%	11.9%	14.8%
6	Sales and service occupations	6.0%	11.3%	20.6%	20.0%	21.2%	20.6%	19.5%	23.8%
7	Trades, transport and equipment operators and related occupations	3.8%	9.0%	18.2%	17.4%	16.6%	15.9%	17.5%	22.1%
8	Natural resources, agriculture and related production occupations	0.5%	2.0%	5.9%	6.8%	7.1%	5.8%	6.8%	9.7%
9	Occupations in manufacturing and utilities	4.4%	8.6%	15.6%	15.1%	15.2%	15.3%	14.4%	18.4%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and < 3 months tenure data from Labour Force Survey Canada (2020).

While using new hires' data may represent an appealing approach, and one that may allow the comparison of flows with "quasi-flows", the exercise nevertheless suffers from a number of drawbacks. Perhaps the most important is availability. Data on new hires by occupation are often not available and, even if they were available (e.g. by deriving them from the microdata), new hires data would not contain information on e.g. unfilled vacancies or about the period between the publication of the vacancy and the hiring. This would make it challenging to establish a suitable reference period, for comparison purposes with BGT data. This is less of an issue for the comparison with employment by occupation data as these are more stable over time. Concerns exist also about the cross-country comparability of these data, given some of the challenges outlined above.

Finally, and while we argue that comparing BGT data with employment data is the best option we have, our analysis of BGT data's representativeness does not rely only on such a comparison. As we explain in more details in the next section, we look at features such as e.g. "volatility" over time, e.g. to identify whether breaks in the series exist, by comparing BGT growth rates by occupation with the average increase in coverage of overall BGT data. For this part of the analysis, employment data are only used to account for employment growth, which nevertheless appears to play only a minor role.

Overall, the analysis above and the pros and cons discussed about the different approaches that may be pursued argue in favour of comparing online BGT job openings with employment by occupation data, as we do in the rest of the paper.

Section 5. Assessing the representativeness of Burning Glass Technologies' data: country-level analysis

5.1. United States

5.1.1. Assessing the representativeness of BGT data

We first assess the coverage of Burning Glass Technologies' (BGT) data for the United States for the period 2010-19.[5] Table 2 presents an overview of the distribution of job postings according to the 1-digit level of the 2008 International Standard Classification of Occupations (ISCO-08).[6] In addition to showing the numbers of job openings, Table 2 further presents a "heat map" of such coverage, whereby cells are coloured in progressively darker tones of grey the higher the number of job postings related to the considered occupation.

The total number of job openings in BGT data for the United States is large, varying from more than 11 million job openings in 2010 to almost 34 million job openings in 2019. The majority of job openings in the United States in BGT relate to ISCO-08 occupational groups 1-3, i.e. "Managers" (ISCO-08 group 1), "Professionals" (ISCO-08 group 2), and "Technicians and associated professionals" (ISCO-08 group 3), which altogether account for more than half of the job ads.

Table 2. BGT data - Frequency by occupational group and year (United States)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	1,480,770	1,909,714	1,803,380	2,177,532	2,169,301	2,401,514	2,510,283	2,334,031	3,086,532	3,851,379
2	Professionals	4,150,170	5,003,224	5,021,891	5,547,600	5,664,921	7,035,325	7,293,256	7,294,723	8,717,788	10,488,337
3	Technicians and associate professionals	2,262,839	2,722,423	2,697,757	3,297,766	3,336,330	3,650,861	4,042,338	3,788,307	4,935,182	6,326,963
4	Clerical support workers	958,350	1,160,887	1,173,467	1,677,971	1,738,374	1,848,449	2,061,839	2,000,215	2,603,024	3,228,848
5	Service and sales workers	1,341,279	1,532,990	1,515,425	2,630,114	3,003,466	2,731,082	3,095,169	2,879,438	4,091,517	5,175,168
6	Skilled agricultural, forestry and fishery workers	6,994	8,273	9,091	14,942	13,828	14,630	17,950	16,589	25,215	42,913
7	Craft and related trades workers	479,979	569,728	566,302	760,453	802,799	741,120	884,262	783,642	1,125,058	1,404,157
8	Plant and machine operators, and assemblers	343,996	454,696	432,314	687,590	904,643	1,060,455	1,978,796	1,603,702	1,758,929	1,382,004
9	Elementary occupations	375,999	476,682	501,247	731,391	848,436	798,804	977,345	965,427	1,588,383	2,072,560
	Total	11,400,377	13,838,617	13,720,873	17,525,359	18,482,097	20,282,239	22,861,237	21,666,073	27,931,626	33,972,329

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

To investigate the representativeness of BGT data, BGT job openings figures by occupation are compared against employment by occupation figures calculated by the OECD using data from the Occupational Employment Statistics (OES) Survey (OES, 2020[15]). We do so as we are interested in identifying those occupations and years for which representativeness allows generalising analysis and results for policy-relevant purposes.

As mentioned before, this is the most robust assessment possible, despite it entailing comparing flows (i.e. the BGT data) with stocks (i.e. the official statistics), and making a number of implicit assumptions about the relationships underpinning employment levels, turnover rates and job postings. Figures of this type nevertheless help assess how well BGT data manage to proxy job demand, and to uncover occupation-specific patterns.[7]

Table 3 shows the number of BGT job openings by 1-digit occupation as a share of employment in that occupation. As can be seen, job openings for "Managers" are the ones that appear to be relatively more frequently posted online. Figures range between one vacancy captured in BGT for every four managers employed in 2010, to one online vacancy for every two managers employed in 2019.

Job adverts related to "Professionals, technicians and associate professionals" are also among the most often observed in BGT data. Conversely, "Skilled agricultural, forestry and fishery workers" is the occupational group standing out in terms of being rarely observed in online posting data (between 2% -9% over the period 2010-19).

Table A 1 shows again BGT data in relation to employment by occupation figures, but now at a 2-digit occupation level. As expected, the occupations within the "Managers" and "Professionals, technicians and associate professionals" occupation groups are among the most observed, whereas the occupation groups within the 1-digit "Skilled agricultural, forestry and fishery workers" group are less well represented. Substantial differences nevertheless emerge between the different 2-digit occupation groups belonging to the same 1-digit occupation cluster. For example, some 2-digit occupation groups within "Plant and machine operators, and assemblers" and "Elementary occupations" are also standing out in terms of being rarely observed in BGT data, as compared to OES employment statistics.

These figures are very much in line with expectations related to: a) the type of jobs that get channelled through the internet and, b) the fact that jobs requiring relatively higher levels of skills and more advanced educational background are more likely to be (also) posted online[8]. In line with what we observe, BGT states that jobs in small businesses as well as lower-income and lower-skill jobs tend to be underrepresented in their dataset (BGT, 2020).

As mentioned above, comparing job openings with employment figures implicitly entails assuming the existence of a positive correlation between the two. However, relatively lower numbers of job openings in relation to employment do not necessarily reflect lower coverage. For instance, if turnover on the job is low in some occupations as people change jobs less often, this may automatically translate in observing a relatively lower number of job openings in relation to those occupations. This being the case, BGT data would provide a fair representation of job openings in those very occupations despite observing relatively low shares of BGT data over employment by occupation figures.

Table 3. Share, BGT data in relation to employment by occupation figures, 2010-19 (United States)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	25.2%	31.7%	28.9%	34.1%	33.0%	35.5%	36.3%	32.9%	41.6%	49.2%
2	Professionals	21.8%	26.3%	21.5%	23.3%	23.6%	28.6%	28.8%	27.6%	32.3%	36.4%
3	Technicians and associate professionals	12.3%	14.8%	13.7%	16.5%	16.4%	17.7%	19.2%	19.3%	24.7%	30.0%
4	Clerical support workers	5.5%	6.6%	6.5%	9.2%	9.4%	9.8%	10.8%	10.5%	13.8%	17.6%
5	Service and sales workers	4.9%	5.5%	5.1%	8.6%	9.6%	8.6%	9.6%	8.7%	12.2%	15.2%
6	Skilled agricultural, forestry and fishery workers	1.8%	2.1%	2.2%	3.6%	3.2%	3.4%	4.1%	3.7%	5.5%	9.2%
7	Craft and related trades workers	5.0%	5.9%	5.8%	7.5%	7.8%	7.0%	8.2%	7.2%	10.0%	12.2%
8	Plant and machine operators, and assemblers	4.1%	5.3%	5.0%	7.7%	10.0%	11.6%	21.4%	21.1%	22.7%	14.3%
9	Elementary occupations	3.0%	3.8%	3.9%	5.5%	6.3%	5.8%	7.0%	6.9%	11.3%	14.1%

Note: BGT shares are calculated dividing BGT data frequencies by employment by occupation figures at 1-digit ISCO-08 occupational levels.
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

In addition to shedding light on levels, BGT data may also be used to investigate demand-related growth patterns and trends over time, of both labour and skill demand. The fact that BGT data are available for very recent years may also help address the need for timely data, to inform policymaking.

To this end, and to assess the extent to which BGT data may help capture changes in labour demand over time, we compute and compare employment by 1-digit ISCO-08 occupation growth rates using BGT data and official data, namely OES data, in the case of the United States. The numbers in Table 4 mirror BGT data-based labour demand growth figures by 1-digit ISCO-08 occupational groups. These figures show that the online job posting coverage may vary widely over time, as differences emerge in terms of growth rates when comparing BGT data with employment by occupation growth figures calculated using OES data (displayed in Figure 4 and Figure 5).

This heterogeneity in coverage seems to more importantly concern occupational categories including "Services and sales workers" (ISCO-08 group 5) and "Plant and machine operators, and assemblers" (ISCO-08 group 8) for which BGT yearly growth rates of 70% or more emerge, at times.

Table 4. Growth rates in BGT data (United States)

		2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	29.0%	-5.6%	20.7%	-0.4%	10.7%	4.5%	-7.0%	32.2%	24.8%
2	Professionals	20.6%	0.4%	10.5%	2.1%	24.2%	3.7%	0.0%	19.5%	20.3%
3	Technicians and associate professionals	20.3%	-0.9%	22.2%	1.2%	9.4%	10.7%	-6.3%	30.3%	28.2%
4	Clerical support workers	21.1%	1.1%	43.0%	3.6%	6.3%	11.5%	-3.0%	30.1%	24.0%
5	Service and sales workers	14.3%	-1.1%	73.6%	14.2%	-9.1%	13.3%	-7.0%	42.1%	26.5%
6	Skilled agricultural, forestry and fishery workers	18.3%	9.9%	64.4%	-7.5%	5.8%	22.7%	-7.6%	52.0%	70.2%
7	Craft and related trades workers	18.7%	-0.6%	34.3%	5.6%	-7.7%	19.3%	-11.4%	43.6%	24.8%
8	Plant and machine operators, and assemblers	32.2%	-4.9%	59.0%	31.6%	17.2%	86.6%	-19.0%	9.7%	-21.4%
9	Elementary occupations	26.8%	5.2%	45.9%	16.0%	-5.8%	22.4%	-1.2%	64.5%	30.5%
	Total of all occupations (weighted)	21.4%	-0.9%	27.7%	5.5%	9.7%	12.7%	-5.2%	28.9%	21.6%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 5 shows the growth rates in employment by occupation based on OES data. As could be expected from data related to real labour market dynamics, smaller and less volatile

employment growth rates emerge, as compared to those calculated over BGT data - with a top growth rate of 24.2% versus 87% in BGT. Comparing the numbers in Table 4 and Table 5, no evident relationship or correlation emerges at the occupational/year level between growth rates in BGT data and growth rates in employment by occupation as they emerge from official statistics.

Table 5. Growth rates in employment by occupation (United States)

		2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	2.6%	3.3%	2.3%	3.0%	2.9%	2.2%	2.7%	4.5%	5.7%
2	Professionals	0.1%	22.8%	1.9%	0.7%	2.5%	2.8%	4.5%	2.2%	6.8%
3	Technicians and associate professionals	-0.1%	7.5%	1.4%	1.6%	1.6%	2.0%	-7.0%	2.0%	5.3%
4	Clerical support workers	0.6%	3.0%	1.0%	1.4%	1.4%	1.2%	-0.2%	-0.5%	-2.8%
5	Service and sales workers	1.6%	8.1%	2.1%	1.9%	2.1%	2.0%	2.3%	1.3%	1.5%
6	Skilled agricultural, forestry and fishery workers	0.2%	5.1%	2.3%	2.8%	1.9%	1.3%	1.2%	2.0%	2.8%
7	Craft and related trades workers	-0.1%	2.0%	3.5%	1.4%	2.9%	1.9%	1.0%	3.5%	1.6%
8	Plant and machine operators, and assemblers	1.8%	2.1%	1.8%	2.0%	1.2%	0.9%	-17.9%	2.2%	24.2%
9	Elementary occupations	-0.1%	3.0%	2.2%	2.8%	2.2%	1.1%	-0.5%	0.9%	4.8%
	Total of all occupations (weighted)	0.7%	7.9%	1.9%	1.7%	2.0%	1.9%	-0.8%	1.7%	4.3%

Note: The relatively larger growth rate for "Plant and machine operators, and assemblers" (SOC occupation 8) in 2019 can be explained by the United States official employment data using a hybrid form of SOC classifications, combining SOC 2010 and SOC 2018. More information about what is explaining these changes can be found in Table A 1, which presents the data at the 2-digit level.
Source: Authors' own calculations based on United States Occupational Employment Statistics (OES) Survey (2020).

This can be better appreciated by comparing the statistics offered in Figure 4 and Figure 5, which show, respectively: growth rates calculated over BGT data (Figure 4) and growth rates calculated over official employment by occupation data (Figure 5), always at 1-digit ISCO-08 occupational groups. Figure A 1 provides a comparison of the two over time for managers and professionals.

A negative relationship emerges when correlating the growth rates calculated using BGT data and those calculated over official OES employment data. This means that relatively larger real (i.e. OES-based) employment growth rates are associated with relatively smaller BGT growth rates in employment by occupation. This warns about the need to design and implement a statistical approach aimed at making BGT data suitable for policy-relevant analysis related to labour demand growth by occupation. If BGT data were to be used at face value, overlooking e.g. the employment-by-occupation fluctuations that emerge, this may lead to drawing the wrong policy implications and advice (variations in growth rates are more important in BGT data as compared to those observed in employment by occupation data, as can be seen from the figures below).

Figure 4. Growth rates by occupation, BGT data, United States, 2011-19
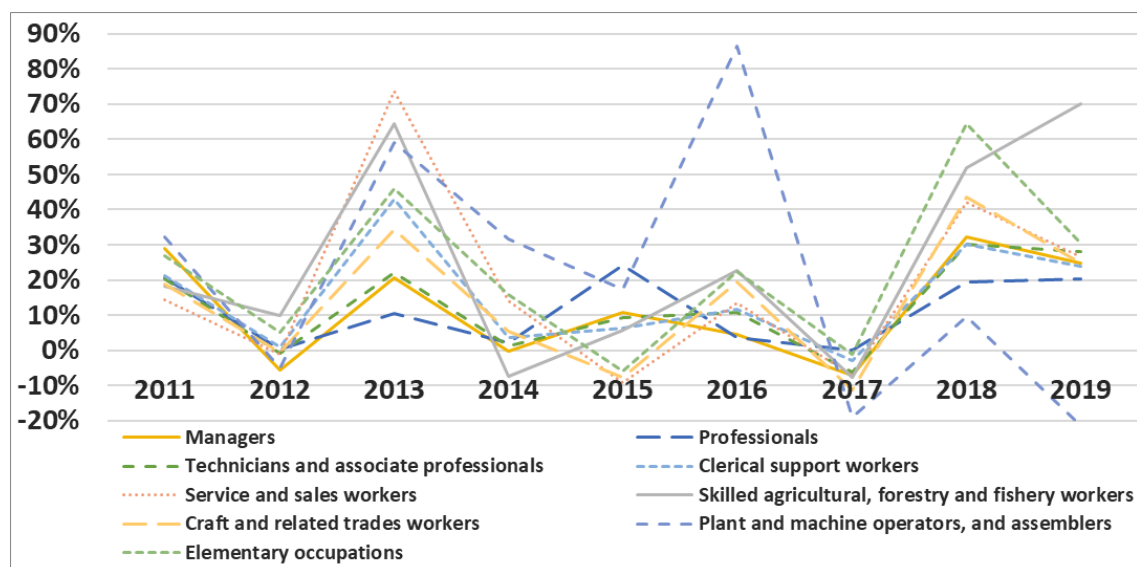
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

Figure 5. Growth rates by occupation, US Occupational Employment Statistics data, 2011-19
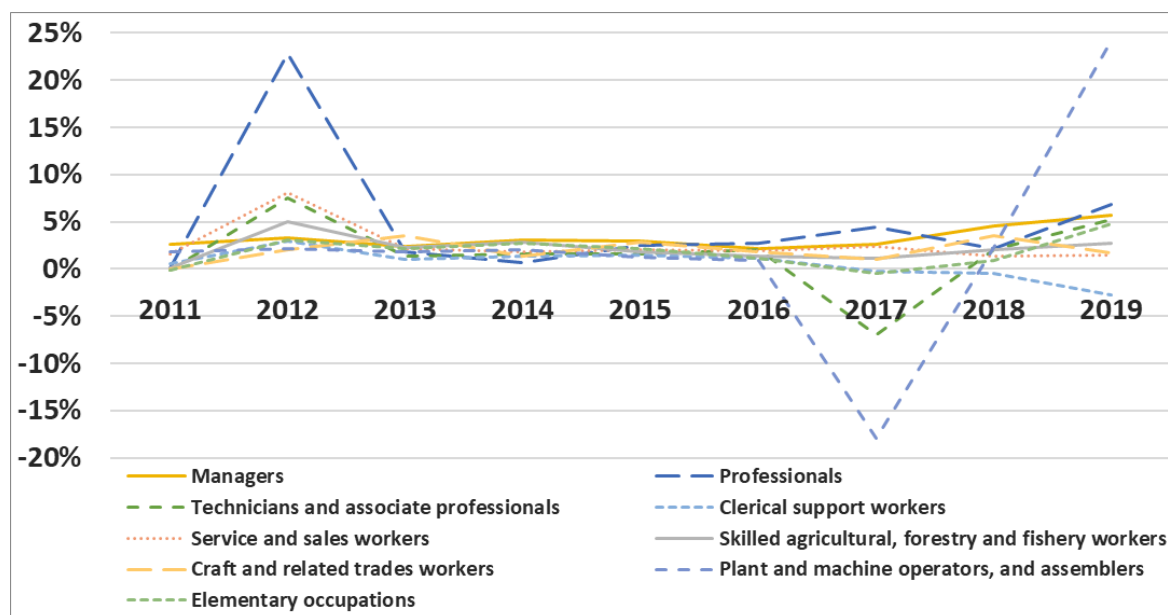
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

Table A 2 and Table A 3 in the appendix show that the differences between the growth rates in BGT data and OES employment data remain when we calculate the growth rates using two base years or using 3-year moving averages.[9] This is done to see whether and to what extent volatility emerges when considering moving averages of two or three years and avoid that year-specific shocks may be biasing our analysis. The shades of grey in the heat map are the same observed for the different occupation-year cells we observe when we use two base years. The main difference is that growth rates are seemingly deflated in

Table A 2-Table A 3 and that larger growth rates appear relatively less important, also in relative terms. In any case, both conventional growth rates and those calculated as three years moving averages convey the same message. We thus continue to rely on conventional growth rates, to aid interpretation.

5.1.2. Identifying changes in representativeness by occupation and possible drivers

In what follows, we try to identify and measure what may contribute to explain the observed differences in the "representativeness" or coverage of BGT data by occupation. In a first step, we try to disentangle how much BGT occupation-specific statistics deviate from the occupation-specific official statistics. This in practice entails comparing the differences in real employment growth, as they emerge from OES statistics, with the differences emerging when calculating growth rates on BGT data.

In a second step, we try to assess how much of the variation observed in BGT coverage rate can be explained by the differences in the growth rates for the occupational group considered relative to the general increase observed in total BGT data. We do so aware that BGT has been striving to improve coverage and data search algorithms over time. We thus need to disentangle the possible differences that may have been triggered by efforts to improve coverage from those of different origin.

The first decomposition mentioned above entails dividing overall BGT growth rates by OES overall employment growth rates, following Equation 1, detailed here below:

$$y_{it} = \left(\frac{\left(\frac{Q_{b_{it}}}{Q_{b_{it-1}}} \right)}{\left(\frac{Q_{e_{it}}}{Q_{e_{it-1}}} \right)} - 1 \right) * 100$$

Equation 1

where

- y_{it} = growth in BGT data over growth in OES employment data for occupation i in year t, in percentage

- $Q_{b_{it}}$ = number of job postings in BGT related to occupation i in year t

- $Q_{e_{it}}$ = OES employment figures related to occupation i in year t

Table 6 shows the results of this step and displays, in percentage terms, the difference in BGT growth rates that cannot be considered as stemming from growth in real employment.

To facilitate reading the table, data are displayed as a heat map whereby darker tones of grey characterise larger differences, in percentage points. Table 6 clearly highlights that only a relatively small part of the changes observed using BGT data may be explained by changes in real employment (as reflected in OES data). Differences look especially larger in 2013 and 2018, a fact that may possibly signal relatively more important time specific shocks in the data gathering process.

Table 6. Growth rates in BGT data corrected for employment growth (United States)

		2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	25.6%	-8.6%	18.0%	-3.3%	7.6%	2.3%	-9.4%	26.5%	18.1%
2	Professionals	20.4%	-18.3%	8.5%	1.4%	21.2%	0.9%	-4.3%	17.0%	12.7%
3	Technicians and associate professionals	20.5%	-7.8%	20.6%	-0.5%	7.7%	8.6%	0.8%	27.7%	21.8%
4	Clerical support workers	20.4%	-1.8%	41.6%	2.2%	4.8%	10.2%	-2.8%	30.7%	27.6%
5	Service and sales workers	12.5%	-8.6%	70.0%	12.1%	-10.9%	11.1%	-9.1%	40.2%	24.6%
6	Skilled agricultural, forestry and fishery workers	18.1%	4.6%	60.7%	-10.0%	3.9%	21.1%	-8.7%	49.0%	65.6%
7	Craft and related trades workers	18.8%	-2.5%	29.7%	4.1%	-10.3%	17.1%	-12.3%	38.7%	22.8%
8	Plant and machine operators, and assemblers	29.9%	-6.9%	56.3%	29.0%	15.8%	84.9%	-1.2%	7.3%	-36.7%
9	Elementary occupations	26.9%	2.1%	42.8%	12.9%	-7.9%	21.0%	-0.8%	63.1%	24.5%
	Total of all occupations (weighted)	20.5%	-8.1%	25.4%	3.7%	7.5%	10.7%	-4.5%	26.8%	16.6%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

Among others, Table 6 confirms that increases in coverage are uneven across different occupational groups. This is an important data feature, especially in analysis exploiting the time dimension of the data. Statistics and analysis may be biased if different groups of occupations are better represented in some years and others in other years, and such a feature is not suitably dealt with.

Motivated by such a concern, in the second step detailed below, we decompose growth rates with the aim to identify and measure what can be considered as a selective increase in coverage. By the latter we mean an increase of data related to some occupational categories rather than others due to e.g. scanning some companies' information (but not others), or adding data supplied by a provider specialised in some occupations (only or mainly). Table 7 displays the results of what remains when subtracting BGT yearly average growth rates (those calculated across all occupations) from BGT yearly growth rates by occupation.[10]

$$F_{it} = y_{it} - \left(\left(\frac{\left(\frac{Q_{btotal_t}}{Q_{btotal_{t-1}}} \right)}{\left(\frac{Q_{etotal_t}}{Q_{etotal_{t-1}}} \right)} - 1 \right) * 100 \right)$$

Equation 2

Or after substituting y_{it}:

$$F_{it} = \left(\left(\frac{\left(\frac{Q_{b_{it}}}{Q_{b_{it-1}}} \right)}{\left(\frac{Q_{e_{it}}}{Q_{e_{it-1}}} \right)} - 1 \right) - 1 \right) * 100 - \left(\frac{\left(\frac{Q_{btotal_t}}{Q_{btotal_{t-1}}} \right)}{\left(\frac{Q_{etotal_t}}{Q_{etotal_{t-1}}} \right)} - 1 \right) * 100$$

where

- F_{it} = selective growth rate, i.e. residual growth in BGT data once growth in real employment (OES) data and in BGT data coverage are accounted for

- y_{it} = growth in BGT data over growth in OES employment data for occupation *i* in year *t,* in percentage

- $Q_{b_{it}}$ = number of job postings in BGT related to occupation *i* in year *t*

- $Q_{e_{it}}$ = OES employment figures related to occupation *i* in year *t*

- Q_{btotal_t} = overall number of job postings in BGT data in year t

- Q_{etotal_t} = OES overall employment figures in year t

Table 7. Deviation, BGT growth rates (United States)

		2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	5.1%	-0.5%	-7.4%	-7.0%	0.0%	-8.4%	-4.9%	-0.3%	1.5%
2	Professionals	-0.2%	-10.2%	-16.9%	-2.3%	13.6%	-9.8%	0.2%	-9.8%	-4.0%
3	Technicians and associate professionals	-0.1%	0.3%	-4.8%	-4.2%	0.2%	-2.1%	5.3%	0.9%	5.1%
4	Clerical support workers	-0.1%	6.3%	16.2%	-1.6%	-2.7%	-0.4%	1.7%	4.0%	10.9%
5	Service and sales workers	-8.1%	-0.5%	44.6%	8.4%	-18.4%	0.5%	-4.6%	13.4%	8.0%
6	Skilled agricultural, forestry and fishery workers	-2.4%	12.7%	35.4%	-13.7%	-3.7%	10.4%	-4.1%	22.2%	49.0%
7	Craft and related trades workers	-1.8%	5.6%	4.4%	0.4%	-17.8%	6.5%	-7.7%	11.9%	6.2%
8	Plant and machine operators, and assemblers	9.3%	1.2%	30.9%	25.2%	8.3%	74.3%	3.3%	-19.5%	-53.3%
9	Elementary occupations	6.4%	10.2%	17.5%	9.1%	-15.4%	10.3%	3.7%	36.4%	7.9%

Note: BGT growth rates minus OES-based employment growth rates, corrected for average increase in coverage of overall BGT data. Figures in Table 7 are calculated taking the growth rates corrected for employment growth (in Table 6) and subtracting the corrected growth rates calculated over total BGT data (lowest row in Table 6).
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

Table 8 shows the absolute values of the growth rates displayed in Table 7, to facilitate observing the extent to which BGT data depart from the mean. In Table 8, different colours denote relatively larger differences. The average difference per year (across occupations) is presented at the bottom of the table, whereas the average difference per occupation (across years) is presented on the right hand side of the table.

The relevant years or occupational groups are labelled as green, yellow or red when the average difference is between 0% and 10%, between 10% and 15%, and more than 15%, respectively. On average, all years except 2013 and 2019 belong to the green group, as the average difference is less than 15%.[11]

Conversely, when looking at BGT data from an occupation perspective, occupation group 6 ("Skilled agricultural, forestry and fishery workers") and group 8 ("Plant and machine operators, and assemblers") are flagged as red. Excluding 2013 data and calculating the average deviation over the remaining years leads to having only occupation group 8 flagged as red, whereas occupation group 6, gets labelled green.

Differences of individually considered occupation-year cells are flagged as light blue if between 20% and 25% and dark blue if larger than 25%. Doing so leads to identifying eight individual occupation/year cells as being dark blue, i.e. as exhibiting differences that are larger than 25% in absolute terms. When data related to the years 2013 and 2019 are left out because they are marked in red, only a high deviation remains for occupation 8 for the years 2014 and 2016 and occupation 9 for the year 2018.

Based on the observed year and occupation group-specific differences, it would be advisable to duly take the break between 2012 and 2013 into account when using BGT data over time, and maintain caution when drawing conclusions for occupation group 8. The OES-based employment data show that 6.5% of the employed population is in occupation 8, suggesting that the BGT data still refer to 93.5% of the employed population when only occupational group 8 is left out.

Table 8. Deviation, BGT data, absolute numbers (United States)

		2011	2012	2013	2014	2015	2016	2017	2018	2019		Avg.	Avg. y. w/o b.	Pop. Share in %
1	Managers	5.1	0.5	7.4	7.0	0.0	8.4	4.9	0.3	1.5		3.9	3.7	5%
2	Professionals	0.2	10.2	16.9	2.3	13.6	9.8	0.2	9.8	4.0		7.4	6.6	18%
3	Technicians and associate professionals	0.1	0.3	4.8	4.2	0.2	2.1	5.3	0.9	5.1		2.6	1.9	15%
4	Clerical support workers	0.1	6.3	16.2	1.6	2.7	0.4	1.7	4.0	10.9		4.9	2.4	14%
5	Service and sales workers	8.1	0.5	44.6	8.4	18.4	0.5	4.6	13.4	8.0		11.8	7.7	23%
6	Skilled agricultural, forestry and fishery workers	2.4	12.7	35.4	13.7	3.7	10.4	4.1	22.2	49.0		17.1	9.9	0.3%
7	Craft and related trades workers	1.8	5.6	4.4	0.4	17.8	6.5	7.7	11.9	6.2		6.9	7.4	8%
8	Plant and machine operators, and assemblers	9.3	1.2	30.9	25.2	8.3	74.3	3.3	19.5	53.3		25.0	20.2	7%
9	Elementary occupations	6.4	10.2	17.5	9.1	15.4	10.3	3.7	36.4	7.9		13.0	13.1	10%
	Average deviation in %	3.7	5.3	19.8	8.0	8.9	13.6	4.0	13.1	16.2				

Note: BG growth rates minus OES-based employment growth rates, corrected for average increase in coverage of overall BGT data. The representativeness for the year or occupational group is labelled as green, yellow or red when the average deviation is 0-10, 10-15 and 15+, respectively. Deviations for individual occupation-year groups are marked in light blue if larger than 20% and darker blue if larger than 25%. "y. w/o b." gives the average for the years considered excluding breaks, i.e. excluding 2013 and 2019 data.
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

5.1.3. *How to make BGT data representative of (parts) of the labour force? A weighting approach*

Given that different occupational groups are represented to a different extent in BGT data and that labour market dynamics or better BGT coverage may only contribute to explain part of the patterns observed, we propose time varying and occupational group-specific weights to be used in statistics and analysis aimed at generalising results (e.g. the entire working population or parts thereof).

The proposed weights are constructed using information about the number of occupational group-specific observations relative to the total number of observations in both BGT data and in real employment data (i.e. in OES in the case of the United States).

Table 9 shows the distribution of occupation-specific job openings in BGT in the form of shares, i.e. the number of occupational group-specific observations in BGT relative to the total number of observations in BGT, by year. Similarly, Table 10 shows how employment is distributed across occupational groups, by year, based on official OES labour statistics.

Table 9. Share, occupational group out of total BGT data, 2010-19 (United States)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	13.0%	13.8%	13.1%	12.4%	11.7%	11.8%	11.0%	10.8%	11.1%	11.3%
2	Professionals	36.4%	36.2%	36.6%	31.7%	30.7%	34.7%	31.9%	33.7%	31.2%	30.9%
3	Technicians and associate professionals	19.8%	19.7%	19.7%	18.8%	18.1%	18.0%	17.7%	17.5%	17.7%	18.6%
4	Clerical support workers	8.4%	8.4%	8.6%	9.6%	9.4%	9.1%	9.0%	9.2%	9.3%	9.5%
5	Service and sales workers	11.8%	11.1%	11.0%	15.0%	16.3%	13.5%	13.5%	13.3%	14.6%	15.2%
6	Skilled agricultural, forestry and fishery workers	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
7	Craft and related trades workers	4.2%	4.1%	4.1%	4.3%	4.3%	3.7%	3.9%	3.6%	4.0%	4.1%
8	Plant and machine operators, and assemblers	3.0%	3.3%	3.2%	3.9%	4.9%	5.2%	8.7%	7.4%	6.3%	4.1%
9	Elementary occupations	3.3%	3.4%	3.7%	4.2%	4.6%	3.9%	4.3%	4.5%	5.7%	6.1%
	Total of all occupations (weighted)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 10. Share, occupational group out of total employment data, 2010-19 (United States)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	4.9%	5.0%	4.8%	4.8%	4.9%	4.9%	5.0%	5.1%	5.3%	5.3%
2	Professionals	16.0%	15.9%	18.1%	18.1%	17.9%	18.0%	18.2%	19.1%	19.2%	19.7%
3	Technicians and associate professionals	15.5%	15.3%	15.3%	15.2%	15.2%	15.1%	15.1%	14.2%	14.2%	14.4%
4	Clerical support workers	14.7%	14.7%	14.0%	13.9%	13.8%	13.8%	13.7%	13.7%	13.5%	12.5%
5	Service and sales workers	22.9%	23.1%	23.2%	23.2%	23.2%	23.2%	23.3%	24.0%	23.9%	23.3%
6	Skilled agricultural, forestry and fishery workers	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
7	Craft and related trades workers	8.1%	8.0%	7.6%	7.7%	7.7%	7.8%	7.8%	7.9%	8.0%	7.8%
8	Plant and machine operators, and assemblers	7.1%	7.1%	6.7%	6.7%	6.8%	6.7%	6.6%	5.5%	5.5%	6.6%
9	Elementary occupations	10.6%	10.5%	10.0%	10.0%	10.1%	10.1%	10.1%	10.1%	10.0%	10.1%
	Total of all occupations (weighted)	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on the United States Occupational Employment Statistics (OES) Survey (2020).

A quick glance at Table 10 suggests that the occupational category 6 ("Skilled agricultural, forestry and fishery workers"), which got generally flagged as red - given the volatility of the growth patterns observed -, only accounts for 0.3% of total employment. This share goes down to about 0.1% in BGT data, as shown in Table 9. This is good news, as this means that leaving aside occupation group 6 would anyway allow generalising results based on BGT job openings data to the entire population.

Comparing Table 9 and Table 10 above, it is also possible to see that the share of "Professionals" is between 50 and 100% larger in BGT data as compared to employment data. The reverse is true in the case of occupational group 7, "Craft and related trades workers", whose shares in OES employment by occupation data are almost twice as large as those observed in BGT data[12].

In order to "re-balance" BGT data and to make them better reflect the real composition of the labour market, so that, e.g. overall labour-market demand for labour and skills can be properly assessed, weights are constructed at the occupational group-year level. To this

end, OES based employment shares (detailed in Table 10 are divided by the BGT job openings shares (shown in Table 9), to obtain weights by occupational group i in year t, i.e. W_{i_t}, as detailed in Equation 3 below:

$$W_{it} = \frac{\left(\frac{Q_{e_{it}}}{Q_{etotal_t}}\right)}{\left(\frac{Q_{b_{it}}}{Q_{btotal_t}}\right)}$$

Equation 3

where

- W_{i_t} = Weight for occupation i in year t

- $Q_{e_{it}}$ = OES employment figures related to occupation i in year t

- Q_{etotal_t} = OES overall employment figures in year t

- $Q_{b_{it}}$ = number of job postings in BGT related to occupation i in year t

- Q_{btotal_t} = overall number of job postings in BGT data in year t

Table 11. Occupational group and time-specific representativeness weights (United States)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	0.38	0.36	0.37	0.39	0.42	0.42	0.45	0.48	0.48	0.47
2	Professionals	0.44	0.44	0.49	0.57	0.58	0.52	0.57	0.57	0.62	0.64
3	Technicians and associate professionals	0.78	0.78	0.78	0.81	0.84	0.84	0.86	0.81	0.81	0.77
4	Clerical support workers	1.75	1.75	1.64	1.45	1.47	1.51	1.52	1.49	1.44	1.32
5	Service and sales workers	1.95	2.09	2.10	1.55	1.43	1.73	1.72	1.81	1.63	1.53
6	Skilled agricultural, forestry and fishery workers	5.28	5.39	4.73	3.69	4.25	4.40	4.03	4.21	3.58	2.52
7	Craft and related trades workers	1.92	1.95	1.84	1.78	1.77	2.12	2.00	2.18	1.99	1.89
8	Plant and machine operators, and assemblers	2.34	2.17	2.14	1.72	1.38	1.28	0.77	0.74	0.88	1.62
9	Elementary occupations	3.20	3.04	2.73	2.40	2.21	2.57	2.36	2.27	1.76	1.65

Note: Table A 4 in the appendix shows the weights using the Standard Occupational Classification (SOC) code for the period 2010-19.
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and the United States Occupational Employment Statistics (OES) Survey (2020).

Table 11 displays the weights that would be advisable to use in analysis and statistics aimed at drawing policy-relevant conclusions for the entire labour force of for selected parts thereof (e.g. high-skills workers). Table A 4 in the appendix shows the weights obtained using the SOC code for the period 2010-19. Given the relatively higher frequency of job postings in BGT related to occupational groups 1 to 3 (i.e. "Managers", "Professionals" and "Technicians and associate professionals") estimated weights are relatively low for these three occupational categories. The reverse is true for occupational groups 4 to 9. "Managers" and "Professionals" exhibit the lowest weights and "Skilled agricultural, forestry and fishery workers" the highest weights.

Generally, weights change more between occupations than within occupations over time, although some non-negligible differences emerge also over time. Weights slowly converge towards the value 1 between 2010 and 2019, thus suggesting that BGT data becomes more representative over time.

In addition to using weights in any statistics or analysis whose results are to be generalised, we would advise to also pay attention to variable-specific missing values. Many of the key variables are only available for some job openings. The subsample for which variable-specific information may be available may not align with the broader representativeness of BGT data for a certain occupational group or year. This would call for the need to calculate subsample-specific weights in a similar fashion to the process detailed above, i.e. following on Equation 3 for the subsample for which the data on this specific variable are available. An example of how this can be implemented in practice is provided in the section of the paper focusing on testing the weights, where we look at minimum educational requirements over time for the United Kingdom.

5.2. United Kingdom

5.2.1. Assessing the representativeness of BGT data

To assess the representativeness of BGT data for the United Kingdom over the years 2012-2019 we follow the same approach and steps implemented in the US-based analysis. These steps are rapidly outlined below, for the sake of brevity.

Table 12 shows the number of BGT job openings per ISCO-08 occupational group and year. The total number of job openings in the United Kingdom in the BGT dataset increases from 5.5 million in 2012 to 9 million in 2017, and decreases again to 6.8 million in 2019. Job postings related to "Professionals" emerge as the largest group, whereas the group "Skilled agricultural, forestry and fishery workers" again accounts for the smallest number of job adverts - similarly to what is observed for the US.

Table 13 shows the shares corresponding to BGT job openings by occupation divided by LFS employment by occupation figures. BGT appears to contains relatively higher numbers of job openings in relation to "Managers", "Professionals", and "Technicians and associate professionals", as compared to occupational groups 4-9 (i.e. 4 "Clerical support workers"; 5 "Service and sales workers"; 6 "Skilled agricultural, forestry and fishery workers"; 7 "Craft and related trades workers"; 8 "Plant and machine operators, and assemblers"; 9 "Elementary occupations").

Table 12. BGT data - Frequency by occupational group and year (United Kingdom)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	712,584	797,600	749,931	945,476	1,044,927	1,138,942	1,014,799	798,809
2	Professionals	2,179,535	2,519,466	2,373,492	3,103,012	3,369,606	3,669,871	3,240,843	2,489,457
3	Technicians and associate professionals	814,433	937,988	864,395	1,103,883	1,233,361	1,344,165	1,284,778	1,043,163
4	Clerical support workers	479,816	536,767	486,774	613,679	756,133	811,937	817,987	665,684
5	Service and sales workers	813,110	981,033	811,917	979,389	1,101,728	1,176,800	1,118,001	932,613
6	Skilled agricultural, forestry and fishery workers	7,411	9,020	8,556	9,176	9,658	9,306	12,050	11,063
7	Craft and related trades workers	207,822	278,784	208,360	279,839	323,687	342,896	358,754	306,573
8	Plant and machine operators, and assemblers	128,266	173,890	129,391	178,689	195,476	216,563	251,942	201,047
9	Elementary occupations	197,282	269,063	191,240	260,266	288,179	314,983	363,701	328,778
	Total	5,540,259	6,503,611	5,824,056	7,473,409	8,322,755	9,025,463	8,462,855	6,777,187

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 13. Share, BGT data in relation to employment by occupation figures, 2012-19 (United Kingdom)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	23.4%	25.3%	23.3%	28.3%	30.4%	31.7%	28.1%	20.8%
2	Professionals	32.2%	36.4%	33.4%	42.7%	44.7%	48.4%	41.4%	30.5%
3	Technicians and associate professionals	22.8%	26.2%	24.0%	29.9%	33.3%	35.5%	33.4%	27.3%
4	Clerical support workers	16.7%	18.7%	16.6%	20.1%	25.5%	26.2%	26.5%	22.4%
5	Service and sales workers	14.8%	17.7%	14.4%	17.2%	19.5%	20.7%	19.8%	16.5%
6	Skilled agricultural, forestry and fishery workers	2.2%	2.6%	2.4%	2.5%	2.6%	2.6%	3.3%	2.9%
7	Craft and related trades workers	8.7%	11.4%	8.2%	11.1%	13.1%	13.5%	14.4%	12.3%
8	Plant and machine operators, and assemblers	9.0%	12.1%	8.8%	11.8%	12.3%	13.8%	16.0%	12.9%
9	Elementary occupations	7.8%	10.6%	7.3%	9.7%	10.8%	11.7%	13.5%	12.4%

Note: BGT shares are calculated dividing BGT data frequencies of employment by occupation figures at 1 digit ISCO-08 occupational levels.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and United Kingdom's Labour Force Survey (2020) data.

Table 14 contains the growth rates calculated over BGT job openings data per ISCO-08 occupational group, whereas Table 15 shows employment growth rates by occupation based on Labour Force Survey data. As done in the case of the United States, and in order to enhance the readability of tables, cells are coloured in progressively darker tones of grey, the higher the share. Comparing these two heat maps, no clear correlation emerges between BGT and LFS growth rates, as in the case of the US. In particular, one can observe variations in BGT-based growth rate over the years, with on average negative coefficients being observed for the years 2014 and 2018 in particular.

Table 14. Growth rates in BGT data (United Kingdom)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	11.9%	-6.0%	26.1%	10.5%	9.0%	-10.9%	-21.3%
2	Professionals	15.6%	-5.8%	30.7%	8.6%	8.9%	-11.7%	-23.2%
3	Technicians and associate professionals	15.2%	-7.8%	27.7%	11.7%	9.0%	-4.4%	-18.8%
4	Clerical support workers	11.9%	-9.3%	26.1%	23.2%	7.4%	0.7%	-18.6%
5	Service and sales workers	20.7%	-17.2%	20.6%	12.5%	6.8%	-5.0%	-16.6%
6	Skilled agricultural, forestry and fishery workers	21.7%	-5.1%	7.2%	5.3%	-3.6%	29.5%	-8.2%
7	Craft and related trades workers	34.1%	-25.3%	34.3%	15.7%	5.9%	4.6%	-14.5%
8	Plant and machine operators, and assemblers	35.6%	-25.6%	38.1%	9.4%	10.8%	16.3%	-20.2%
9	Elementary occupations	36.4%	-28.9%	36.1%	10.7%	9.3%	15.5%	-9.6%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 15. Growth rates in employment by occupation (United Kingdom)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	3.4%	2.1%	3.8%	3.1%	4.4%	0.4%	6.3%
2	Professionals	2.3%	2.9%	2.2%	3.7%	0.6%	3.3%	4.2%
3	Technicians and associate professionals	0.0%	0.6%	2.7%	0.2%	2.4%	1.6%	-0.7%
4	Clerical support workers	-0.1%	1.6%	4.6%	-3.0%	4.3%	-0.4%	-3.5%
5	Service and sales workers	0.6%	1.7%	1.0%	-0.3%	0.2%	-0.4%	-0.2%
6	Skilled agricultural, forestry and fishery workers	0.5%	5.3%	0.8%	1.6%	-3.1%	0.7%	3.9%
7	Craft and related trades workers	2.6%	3.6%	-0.2%	-2.1%	2.9%	-2.1%	0.4%
8	Plant and machine operators, and assemblers	0.3%	2.3%	3.4%	5.0%	-1.8%	0.4%	-1.2%
9	Elementary occupations	0.5%	2.6%	2.8%	-0.3%	0.7%	0.3%	-1.5%

Source: Authors' own calculations based on United Kingdom's Labour Force Survey (2020) data.

5.2.2. Identifying changes in representativeness by occupation and possible drivers

Table 16 shows the growth rates for the United Kingdom BGT data taking into account (i.e. subtracting) the growth rate calculated over LFS data. We do so to remove the part of the growth rate in BGT data that may actually mirror real increases or decreases in employment, and thus should not represent a source of concern when assessing the representativeness of online job posting data. Doing so nevertheless hardly changes the BGT growth rates by occupational group observed in Table 14.

Table 16. Growth rates in BGT data corrected for employment growth (United Kingdom)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	8.2%	-7.9%	21.5%	7.2%	4.4%	-11.3%	-26.0%
2	Professionals	13.0%	-8.5%	27.9%	4.7%	8.3%	-14.5%	-26.3%
3	Technicians and associate professionals	15.2%	-8.4%	24.3%	11.5%	6.5%	-5.9%	-18.3%
4	Clerical support workers	12.0%	-10.8%	20.5%	27.1%	3.0%	1.1%	-15.7%
5	Service and sales workers	20.0%	-18.6%	19.4%	12.8%	6.6%	-4.6%	-16.4%
6	Skilled agricultural, forestry and fishery workers	21.1%	-9.9%	6.4%	3.6%	-0.6%	28.6%	-11.6%
7	Craft and related trades workers	30.7%	-27.8%	34.6%	18.2%	2.9%	6.8%	-14.9%
8	Plant and machine operators, and assemblers	35.2%	-27.2%	33.5%	4.2%	12.8%	15.9%	-19.3%
9	Elementary occupations	35.6%	-30.7%	32.4%	11.1%	8.5%	15.2%	-8.2%
	Total of all occupations (weighted)	15.9%	-12.4%	25.4%	10.3%	6.8%	-7.0%	-20.9%

Source: Authors' own calculations based on Burning Glass Technologies (2020) and the United Kingdom's Labour Force Survey (2020) data.

Table 17 exhibits the growth rate per occupation relative to the overall growth rate per year, with occupation-specific growth rates and the overall growth rates already corrected for real employment growth. As mentioned when discussing Table 7 in the United States' case, this is done to see whether occupation and/or year specific representativeness concerns exist. Again, Table 18 displays the absolute values of the numbers in Table 17, since we are interested in the size of deviations from the mean, regardless of whether they are negative or positive in sign.

This analysis leads us to tag all averages across occupations and across years as green or yellow, thus suggesting generally good representativeness. The first five occupational groups are green, whereas occupations 6-9 as tagged as yellow. The only individual

occupation-year cell for which the deviation is larger than 25% is again occupation 6 "Skilled agricultural, forestry and fishery workers", in 2018.

Table 17. Deviation, BGT growth rates (United Kingdom)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	-7.7%	4.4%	-3.9%	-3.1%	-2.4%	-4.3%	-5.1%
2	Professionals	-2.8%	3.9%	2.5%	-5.6%	1.5%	-7.5%	-5.4%
3	Technicians and associate professionals	-0.7%	4.0%	-1.1%	1.2%	-0.3%	1.1%	2.6%
4	Clerical support workers	-3.9%	1.6%	-4.9%	16.7%	-3.8%	8.1%	5.2%
5	Service and sales workers	4.1%	-6.2%	-6.0%	2.5%	-0.1%	2.4%	4.5%
6	Skilled agricultural, forestry and fishery workers	5.3%	2.5%	-19.0%	-6.7%	-7.4%	35.6%	9.3%
7	Craft and related trades workers	14.8%	-15.5%	9.2%	7.8%	-3.9%	13.8%	6.0%
8	Plant and machine operators, and assemblers	19.3%	-14.9%	8.1%	-6.1%	6.1%	22.9%	1.6%
9	Elementary occupations	19.8%	-18.3%	7.1%	0.8%	1.7%	22.2%	12.7%

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. Figures in Table 17 are calculated by taking the growth rates corrected for employment growth (in Table 16) and subtract the corrected growth rates in the total BGT data (lowest row in Table 16).
Source: Authors' own calculations based on Burning Glass Technologies (2020) and the United Kingdom's Labour Force Survey (2020) data.

Table 18. Deviation, BGT data, absolute numbers (United Kingdom)

		2013	2014	2015	2016	2017	2018	2019	Average	Average y. w/o b.	Pop. share
1	Managers	7.7	4.4	3.9	3.1	2.4	4.3	5.1	4.4	4.4	11.3%
2	Professionals	2.8	3.9	2.5	5.6	1.5	7.5	5.4	4.2	4.2	24.6%
3	Technicians and associate professionals	0.7	4.0	1.1	1.2	0.3	1.1	2.6	1.6	1.6	12.3%
4	Clerical support workers	3.9	1.6	4.9	16.7	3.8	8.1	5.2	6.3	6.3	9.9%
5	Service and sales workers	4.1	6.2	6.0	2.5	0.1	2.4	4.5	3.7	3.7	18.7%
6	Skilled agricultural, forestry and fishery workers	5.3	2.5	19.0	6.7	7.4	35.6	9.3	12.2	12.2	1.2%
7	Craft and related trades workers	14.8	15.5	9.2	7.8	3.9	13.8	6.0	10.1	10.1	8.3%
8	Plant and machine operators, and assemblers	19.3	14.9	8.1	6.1	6.1	22.9	1.6	11.3	11.3	5.0%
9	Elementary occupations	19.8	18.3	7.1	0.8	1.7	22.2	12.7	11.8	11.8	8.8%
	Average deviation in %	8.7	7.9	6.9	5.6	3.0	13.1	5.8			

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. The representativeness for the year or occupational group is labelled as green, yellow or red when the average deviation is 0-10, 10-15 and 15+, respectively. Deviations for individual occupation-year groups are marked in light blue if larger than 20% and darker blue if larger than 25%. "y. w/o b." gives the average for the years considered excluding breaks.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and United Kingdom's Labour Force Survey (2020) data.

5.2.3. Weights

Similarly to what is done in the case of the United States, occupation-specific time-varying weights are calculated using information about the share of observations per occupation out of the total number of observations, for both BGT data and employment data (following Formula 3). Table 19 displays the share of observations per occupational group out of total

BGT data whereas Table 20 shows the share of employed people per occupational group, out of total employment.

"Professionals" emerge as the group that can be considered to be relatively more represented in BGT data. About 40% of BGT data relate to professionals, whereas this occupational group account for about 25% of real employment, according to LFS. Little representation of occupation 6, "Skilled agricultural, forestry and fishery workers" is again the largest, as in the United States' case, with only 0.1% of BGT data related to this occupational group against 1.2% in employment figures, according to LFS. Also, the share of occupational groups 7-9 in BGT is only about half the share observed in LFS-based statistics.

Table 19. Share, occupational group out of total BGT data, 2012-19 (United Kingdom)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	12.9%	12.3%	12.9%	12.7%	12.6%	12.6%	12.0%	11.8%
2	Professionals	39.3%	38.7%	40.8%	41.5%	40.5%	40.7%	38.3%	36.7%
3	Technicians and associate professionals	14.7%	14.4%	14.8%	14.8%	14.8%	14.9%	15.2%	15.4%
4	Clerical support workers	8.7%	8.3%	8.4%	8.2%	9.1%	9.0%	9.7%	9.8%
5	Service and sales workers	14.7%	15.1%	13.9%	13.1%	13.2%	13.0%	13.2%	13.8%
6	Skilled agricultural, forestry and fishery workers	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%
7	Craft and related trades workers	3.8%	4.3%	3.6%	3.7%	3.9%	3.8%	4.2%	4.5%
8	Plant and machine operators, and assemblers	2.3%	2.7%	2.2%	2.4%	2.3%	2.4%	3.0%	3.0%
9	Elementary occupations	3.6%	4.1%	3.3%	3.5%	3.5%	3.5%	4.3%	4.9%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies (2020) and United Kingdom's Labour Force Survey (2020) data.

Table 20. Share, occupational group out of total employment data, 2012-19 (United Kingdom)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	10.7%	10.9%	10.9%	11.1%	11.3%	11.6%	11.6%	12.2%
2	Professionals	23.8%	24.0%	24.2%	24.1%	24.8%	24.5%	25.1%	25.9%
3	Technicians and associate professionals	12.6%	12.4%	12.2%	12.3%	12.2%	12.3%	12.4%	12.1%
4	Clerical support workers	10.1%	10.0%	9.9%	10.2%	9.8%	10.0%	9.9%	9.4%
5	Service and sales workers	19.3%	19.2%	19.1%	18.9%	18.6%	18.4%	18.1%	17.9%
6	Skilled agricultural, forestry and fishery workers	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
7	Craft and related trades workers	8.4%	8.5%	8.6%	8.4%	8.1%	8.2%	8.0%	7.9%
8	Plant and machine operators, and assemblers	5.0%	5.0%	5.0%	5.0%	5.2%	5.1%	5.0%	4.9%
9	Elementary occupations	8.9%	8.8%	8.9%	8.9%	8.8%	8.7%	8.7%	8.4%
	Total of all occupations	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies (2020) and United Kingdom's Labour Force Survey (2020) data.

Table 21. Occupational group and time-specific representativeness weights (United Kingdom)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	0.83	0.89	0.85	0.88	0.90	0.92	0.97	1.03
2	Professionals	0.60	0.62	0.59	0.58	0.61	0.60	0.66	0.70
3	Technicians and associate professionals	0.85	0.86	0.82	0.83	0.82	0.82	0.81	0.79
4	Clerical support workers	1.17	1.21	1.19	1.24	1.07	1.11	1.02	0.96
5	Service and sales workers	1.32	1.27	1.37	1.44	1.41	1.41	1.37	1.30
6	Skilled agricultural, forestry and fishery workers	9.04	8.64	8.41	9.91	10.54	11.33	8.20	7.34
7	Craft and related trades workers	2.23	1.98	2.40	2.24	2.09	2.17	1.89	1.75
8	Plant and machine operators, and assemblers	2.17	1.86	2.25	2.11	2.23	2.11	1.69	1.66
9	Elementary occupations	2.50	2.14	2.70	2.56	2.54	2.50	2.02	1.74

Note: Table A 5 in the appendix shows the weights using the United Kingdom's Standard Occupational Classification (UKSOC) code for the period 2012-19.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and United Kingdom's Labour Force Survey (2020) data.

Table 21 shows the weights calculated by dividing the occupational share in LFS employment data by the occupational share in BGT data. As mentioned in previous analysis, it would be advisable to use these weights when the aim is to generalise the analysis, in a view to draw policy-relevant advice related to the full workers' population.

Weights change much more across occupations than over the years. Occupations 1-3 have weights that are smaller than one, as these classes are somewhat overrepresented in BGT compared to the other occupational categories. The other occupations exhibit weights larger than one, i.e. they correct for the fact that these occupations are relatively underrepresented in BGT as compared to the shares observed in Labour Force Survey data. The weights for occupations 6-9 are larger than 2 for most years and reach even about 10 for occupational group 6 "Skilled agricultural, forestry and fishery workers", signalling that very few jobs related to agriculture, forestry and fishery are normally posted online, as compared to the employment level in the sector.

5.3. Canada

5.3.1. Assessing the representativeness of BGT data

Table 22 presents a heat map of the number of job openings in BGT by occupational group and year for Canada. The total number of BGT job openings related to Canada ranges from about 500 thousand in 2012 to 1.5 million in 2019.

The occupational classification we use in the case of Canada is the 2016 National Occupational Classification (NOC) as both BGT data and employment data are available in NOC and mapping NOC classes to ISCO-08 categories is not straightforward. To the best of the authors' knowledge, no crosswalk exists with sufficient information to convert all the occupational information to ISCO-08 without introducing biases.

One of the differences between NOC and ISCO-08 is that NOC starts with "0" for managers, whereas the ISCO-08 code starts with "1" for managers. As in ISCO, NOC starts with occupations related to managers, professionals and technicians and continues with occupations like sales, trades, agriculture and manufacturing, but different classification names and groupings are used, making it hard to compare the figures with the results for the United States and the United Kingdom. For the purpose of international comparison, we therefore add a column with manually matched 1-digit ISCO-08 codes when we assess differences between BGT and occupational data for Canada in Table 28.

In a similar fashion to what done in the case of the United States and the United Kingdom, Table 23 shows the number of BGT job openings by occupation divided by employment by occupation. The largest number of job openings per employed person is found for managers. This number reaches 14% in some years, i.e. there seems to exist one BGT job opening for seven managers employed in that very year. This would imply that one in seven managers may change job on a yearly basis or that the number of managers may increase by a seventh from that year to the next, which seems a bit high.[13] The statistics in Table 23 may warn about the existence of possible (and numerous) job opening duplicates and for further investigation aimed at removing possible duplications from BGT data.

Table 22. BGT data - Frequency by occupational group and year (Canada)

		2012	2013	2014	2015	2016	2017	2018	2019
0	Management occupations	100,962	133,611	229,634	189,326	175,419	207,477	201,869	237,294
1	Business, finance and administration occupations	85,132	112,161	193,305	181,161	168,552	203,728	215,467	225,892
2	Natural and applied sciences and related occupations	104,326	116,448	172,687	140,814	132,695	162,825	143,947	167,411
3	Health occupations	19,604	32,230	60,825	51,900	47,433	52,975	42,986	57,693
4	Occupations in education, law and social, community and government services	26,927	45,677	87,285	88,054	81,287	87,684	96,902	125,989
5	Occupations in art, culture, recreation and sport	10,611	16,275	29,553	27,492	25,193	26,306	23,406	29,423
6	Sales and service occupations	98,121	180,537	340,761	325,218	339,451	336,073	313,639	394,712
7	Trades, transport and equipment operators and related occupations	31,672	76,457	150,703	131,833	120,261	125,897	139,342	174,650
8	Natural resources, agriculture and related production occupations	952	3,900	11,309	11,762	11,284	10,572	12,036	16,495
9	Occupations in manufacturing and utilities	8,944	16,494	31,645	27,864	30,078	34,800	30,089	34,245
	Total all occupations	487,251	733,790	1,307,707	1,175,424	1,131,653	1,248,337	1,219,683	1,463,804

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 23. Share, BGT data in relation to employment by occupation figures, 2012-19 (Canada)

		2012	2013	2014	2015	2016	2017	2018	2019
0	Management occupations	5.9%	8.1%	14.3%	11.7%	10.9%	12.1%	11.8%	13.7%
1	Business, finance and administration occupations	3.0%	3.9%	6.8%	6.3%	5.8%	6.9%	7.2%	7.4%
2	Natural and applied sciences and related occupations	8.3%	8.9%	12.8%	10.0%	9.5%	11.4%	9.7%	10.7%
3	Health occupations	1.7%	2.7%	5.0%	4.1%	3.5%	3.8%	3.1%	4.1%
4	Occupations in education, law and social, community and government services	1.4%	2.3%	4.5%	4.3%	3.9%	4.3%	4.7%	5.9%
5	Occupations in art, culture, recreation and sport	2.1%	3.0%	5.4%	5.2%	4.5%	4.6%	4.2%	5.2%
6	Sales and service occupations	2.3%	4.1%	7.7%	7.4%	7.7%	7.5%	7.0%	8.6%
7	Trades, transport and equipment operators and related occupations	1.2%	2.9%	5.8%	5.0%	4.7%	4.8%	5.2%	6.3%
8	Natural resources, agriculture and related production occupations	0.3%	1.0%	2.9%	3.3%	3.2%	2.9%	3.1%	4.4%
9	Occupations in manufacturing and utilities	1.1%	2.0%	3.8%	3.4%	3.5%	4.0%	3.5%	4.0%

Note: BGT shares are calculated dividing BGT data frequencies by employment by occupation figures at 1 digit NOC 2016 occupational levels.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and Canadian Labour Force Survey (2020) data.

Table 24 and Table 25 display the growth rates for BGT job openings data and for LFS employment data, respectively. Again, no clear correlation is found between growth in BGT job openings and growth in real employment, as emerging from LFS data. Very large growth rates are observed for BGT data in 2013 and 2014, with occupation 8 (which is similar to ISCO-08 occupation 6), "Natural resources, agriculture and related production occupations" again emerging as an outlier, with a growth rate of 309.7% in year 2013. More generally, growth rates for BGT data vary over the years and are negative on average for the years 2015, 2016 and 2018.

Table 24. Growth rates in BGT data (Canada)

		2013	2014	2015	2016	2017	2018	2019
0	Management occupations	32.3%	71.9%	-17.6%	-7.3%	18.3%	-2.7%	17.5%
1	Business, finance and administration occupations	31.7%	72.3%	-6.3%	-7.0%	20.9%	5.8%	4.8%
2	Natural and applied sciences and related occupations	11.6%	48.3%	-18.5%	-5.8%	22.7%	-11.6%	16.3%
3	Health occupations	64.4%	88.7%	-14.7%	-8.6%	11.7%	-18.9%	34.2%
4	Occupations in education, law and social, community and government services	69.6%	91.1%	0.9%	-7.7%	7.9%	10.5%	30.0%
5	Occupations in art, culture, recreation and sport	53.4%	81.6%	-7.0%	-8.4%	4.4%	-11.0%	25.7%
6	Sales and service occupations	84.0%	88.7%	-4.6%	4.4%	-1.0%	-6.7%	25.8%
7	Trades, transport and equipment operators and related occupations	141.4%	97.1%	-12.5%	-8.8%	4.7%	10.7%	25.3%
8	Natural resources, agriculture and related production occupations	309.7%	190.0%	4.0%	-4.1%	-6.3%	13.8%	37.0%
9	Occupations in manufacturing and utilities	84.4%	91.9%	-11.9%	7.9%	15.7%	-13.5%	13.8%
	Total of all occupations (weighted)	50.6%	78.2%	-10.1%	-3.7%	10.3%	-2.3%	20.0%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 25. Growth rates in employment by occupation (Canada)

		2013	2014	2015	2016	2017	2018	2019
0	Management occupations	-3.0%	-2.7%	0.9%	-0.7%	6.4%	-0.4%	1.6%
1	Business, finance and administration occupations	0.6%	0.4%	0.9%	-0.1%	2.3%	1.7%	1.7%
2	Natural and applied sciences and related occupations	3.3%	3.3%	3.9%	0.1%	2.0%	3.4%	6.1%
3	Health occupations	1.9%	1.1%	4.3%	4.9%	3.8%	0.8%	1.6%
4	Occupations in education, law and social, community and government services	2.5%	0.3%	3.9%	1.9%	-2.2%	2.0%	3.3%
5	Occupations in art, culture, recreation and sport	8.5%	1.6%	-2.1%	4.2%	1.9%	-0.7%	1.3%
6	Sales and service occupations	2.2%	1.4%	-0.7%	0.7%	1.3%	0.6%	1.7%
7	Trades, transport and equipment operators and related occupations	0.3%	-0.3%	0.4%	-1.6%	1.6%	2.4%	2.7%
8	Natural resources, agriculture and related production occupations	6.5%	2.4%	-8.2%	0.2%	3.1%	4.3%	-2.6%
9	Occupations in manufacturing and utilities	1.2%	1.0%	-1.7%	4.1%	1.2%	-0.6%	-1.2%
	Total of all occupations (weighted)	1.5%	0.6%	0.8%	0.7%	1.9%	1.3%	2.1%

Source: Authors' own calculations based on Canadian Labour Force Survey (2020) data.

5.3.2. Identifying changes in representativeness by occupation and possible drivers

Table 26 shows the growth rates calculated over BGT data corrected for real employment growth based on Canadian LFS data. As mentioned, we do so to account for the part of the growth rate that may be related to a real growth rate in vacancies, based on the assumption that employment growth should be positively and linearly correlated with job openings. This correction hardly changes the growth rates of the BGT data observed in Table 24.

Table 26. Growth rates in BGT data corrected for employment growth (Canada)

		2013	2014	2015	2016	2017	2018	2019
0	Management occupations	36.4%	76.7%	-18.3%	-6.7%	11.2%	-2.3%	15.7%
1	Business, finance and administration occupations	31.0%	71.7%	-7.2%	-6.8%	18.2%	4.0%	3.0%
2	Natural and applied sciences and related occupations	8.1%	43.5%	-21.5%	-5.9%	20.3%	-14.5%	9.6%
3	Health occupations	61.3%	86.7%	-18.2%	-12.8%	7.6%	-19.5%	32.1%
4	Occupations in education, law and social, community and government services	65.5%	90.5%	-2.9%	-9.4%	10.3%	8.3%	25.9%
5	Occupations in art, culture, recreation and sport	41.3%	78.7%	-5.0%	-12.1%	2.4%	-10.4%	24.1%
6	Sales and service occupations	80.0%	86.1%	-3.9%	3.6%	-2.3%	-7.3%	23.7%
7	Trades, transport and equipment operators and related occupations	140.7%	97.7%	-12.9%	-7.3%	3.0%	8.1%	22.1%
8	Natural resources, agriculture and related production occupations	284.6%	183.3%	13.3%	-4.2%	-9.1%	9.1%	40.8%
9	Occupations in manufacturing and utilities	82.2%	90.0%	-10.4%	3.7%	14.3%	-13.0%	15.2%
	Total of all occupations (weighted)	48.4%	77.1%	-10.8%	-4.4%	8.3%	-3.6%	17.5%

Source: Authors' own calculations based on Burning Glass Technologies (2020) and Canadian Labour Force Survey (2020) data.

Table 27 finally displays BGT growth rates per occupation relative to the growth rate of the total data per year, where both the occupational growth rate and the total growth rate are already corrected for employment growth. Table 28 displays the absolute values of Table 27, as we are interested in the size of the observed deviations from the mean, regardless of their signs. The averages across occupations are marked red for 2013 and 2014 and the averages across years are marked red for the NOC occupations 2, 7 and 8.

This suggests that BGT job openings for Canada may suffer from representativeness concerns, and possibly more so than in the case of the United States or the United Kingdom. A more consistent picture emerges when removing data for the years 2012 and 2013 and looking at growth rates from the year 2015 onwards. For the period 2014-19, all years exhibit good representativeness for all occupations, with the exception of NOC group 8, "Natural resources, agriculture and related production occupations". Given the data limitations observed, it would be advisable to constrain BGT-base Canada-related analysis to the period 2014 onwards and to exclude NOC occupational group 8. Doing so would nevertheless see BGT data refer to 98% of the working population.

Table 27. Deviation, BGT growth rates (Canada)

		2013	2014	2015	2016	2017	2018	2019
0	Management occupations	-12.0%	-0.4%	-7.5%	-2.3%	2.9%	1.3%	-1.9%
1	Business, finance and administration occupations	-17.4%	-5.4%	3.7%	-2.4%	9.9%	7.6%	-14.5%
2	Natural and applied sciences and related occupations	-40.3%	-33.6%	-10.7%	-1.4%	12.0%	-10.9%	-7.9%
3	Health occupations	12.8%	9.6%	-7.4%	-8.4%	-0.7%	-15.9%	14.6%
4	Occupations in education, law and social, community and government services	17.1%	13.4%	8.0%	-5.0%	2.0%	11.9%	8.4%
5	Occupations in art, culture, recreation and sport	-7.1%	1.6%	5.9%	-7.6%	-5.8%	-6.9%	6.6%
6	Sales and service occupations	31.6%	9.0%	7.0%	8.1%	-10.6%	-3.7%	6.2%
7	Trades, transport and equipment operators and related occupations	92.3%	20.6%	-2.0%	-2.9%	-5.3%	11.7%	4.6%
8	Natural resources, agriculture and related production occupations	236.2%	106.2%	24.1%	0.2%	-17.4%	12.7%	23.3%
9	Occupations in manufacturing and utilities	33.7%	12.9%	0.4%	8.2%	6.0%	-9.4%	-2.3%

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. Figures in Table 27 are calculated taking the growth rates corrected for employment growth (in Table 26) and subtract the corrected growth rates in the total BGT data (lowest row in Table 26. Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and the Canadian Labour Force Survey (2020).

Table 28. Deviation, BGT data, absolute numbers (Canada)

M. ISCO	NOC		2013	2014	2015	2016	2017	2018	2019	Avg.	Avg. y. w/o b.	Pop. share
1	0	Management occupations	12.0	0.4	7.5	2.3	2.9	1.3	1.9	4.0	3.2	9.2%
2	1	Business, finance and administration occupations	17.4	5.4	3.7	2.4	9.9	7.6	14.5	8.7	7.6	16.1%
3	2	Natural and applied sciences and related occupations	40.3	33.6	10.7	1.4	12.0	10.9	7.9	16.7	8.6	7.7%
	3	Health occupations	12.8	9.6	7.4	8.4	0.7	15.9	14.6	9.9	9.4	7.2%
4	4	Occupations in education, law and social, community and government services	17.1	13.4	8.0	5.0	2.0	11.9	8.4	9.4	7.0	11.1%
	5	Occupations in art, culture, recreation and sport	7.1	1.6	5.9	7.6	5.8	6.9	6.6	5.9	6.6	3.0%
5	6	Sales and service occupations	31.6	9.0	7.0	8.1	10.6	3.7	6.2	10.9	7.1	24.4%
7	7	Trades, transport and equipment operators and related occupations	92.3	20.6	2.0	2.9	5.3	11.7	4.6	19.9	5.3	14.5%
6	8	Natural resources, agriculture and related production occupations	236.2	106.2	24.1	0.2	17.4	12.7	23.3	60.0	15.5	2.0%
8	9	Occupations in manufacturing and utilities	33.7	12.9	0.4	8.2	6.0	9.4	2.3	10.4	5.3	4.7%
		Average deviation in %	51.9	22.2	8.5	4.3	7.4	9.2	9.8			

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. For Canada we use NOC rather than ISCO-08 occupational classification. However, to allow for cross-country comparison we also add the manually matched ISCO-08 code to the right of the table. The order of the rows (occupations) is displayed in line with NOC. The representativeness for the year or occupational group is labelled as green, yellow or red when the average deviation is 0-10, 10-15 and 15+, respectively. Deviations for individual occupation-year groups are marked in light blue if larger than 20% and darker blue if larger than 25%. "y. w/o b." gives the average for the years considered excluding breaks, excluding 2013 and 2014 data.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and Canadian Labour Force Survey (2020) data.

5.3.3. Weights

We construct time-varying weights by occupation based on the share of observations per ISCO-08 occupational group out of the total number of observations, for both BGT data and LFS employment data. Table 29 shows the share of observations per occupational group out of total BGT data, whereas Table 30 shows the share of employed people per occupational group out of total employment.

As could be expected, occupation group "Managers" is the most represented, in relative terms, with a share of total BGT data between 16% and 21%, whereas only 9-10% of the employed people in LFS data are managers. In contrast, "Natural resources, agriculture and related production occupations" and "Occupations in manufacturing and utilities" feature lower shares in BGT data than in employment data.

Table 29. Share, occupational group out of total BGT data, 2012-19 (Canada)

		2012	2013	2014	2015	2016	2017	2018	2019
0	Management occupations	20.7%	18.2%	17.6%	16.1%	15.5%	16.6%	16.6%	16.2%
1	Business, finance and administration occupations	17.5%	15.3%	14.8%	15.4%	14.9%	16.3%	17.7%	15.4%
2	Natural and applied sciences and related occupations	21.4%	15.9%	13.2%	12.0%	11.7%	13.0%	11.8%	11.4%
3	Health occupations	4.0%	4.4%	4.7%	4.4%	4.2%	4.2%	3.5%	3.9%
4	Occupations in education, law and social, community and government services	5.5%	6.2%	6.7%	7.5%	7.2%	7.0%	7.9%	8.6%
5	Occupations in art, culture, recreation and sport	2.2%	2.2%	2.3%	2.3%	2.2%	2.1%	1.9%	2.0%
6	Sales and service occupations	20.1%	24.6%	26.1%	27.7%	30.0%	26.9%	25.7%	27.0%
7	Trades, transport and equipment operators and related occupations	6.5%	10.4%	11.5%	11.2%	10.6%	10.1%	11.4%	11.9%
8	Natural resources, agriculture and related production occupations	0.2%	0.5%	0.9%	1.0%	1.0%	0.8%	1.0%	1.1%
9	Occupations in manufacturing and utilities	1.8%	2.2%	2.4%	2.4%	2.7%	2.8%	2.5%	2.3%
	Total all occupations	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 30. Share, occupational group out of total employment data, 2012-19 (Canada)

		2012	2013	2014	2015	2016	2017	2018	2019
0	Management occupations	9.8%	9.4%	9.0%	9.1%	8.9%	9.3%	9.2%	9.1%
1	Business, finance and administration occupations	16.2%	16.1%	16.1%	16.1%	15.9%	16.0%	16.1%	16.0%
2	Natural and applied sciences and related occupations	7.2%	7.4%	7.6%	7.8%	7.8%	7.8%	7.9%	8.2%
3	Health occupations	6.8%	6.8%	6.9%	7.1%	7.4%	7.6%	7.5%	7.5%
4	Occupations in education, law and social, community and government services	10.9%	11.0%	11.0%	11.3%	11.5%	11.0%	11.1%	11.2%
5	Occupations in art, culture, recreation and sport	2.8%	3.0%	3.1%	3.0%	3.1%	3.1%	3.0%	3.0%
6	Sales and service occupations	24.5%	24.6%	24.8%	24.5%	24.5%	24.3%	24.2%	24.1%
7	Trades, transport and equipment operators and related occupations	15.0%	14.8%	14.7%	14.6%	14.3%	14.2%	14.4%	14.5%
8	Natural resources, agriculture and related production occupations	2.0%	2.1%	2.2%	2.0%	2.0%	2.0%	2.0%	2.0%
9	Occupations in manufacturing and utilities	4.7%	4.7%	4.7%	4.6%	4.7%	4.7%	4.6%	4.5%
	Total all occupations	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Canadian Labour Force Survey (2020) data.

Table 31. Occupational group and time-specific representativeness weights (Canada)

		2012	2013	2014	2015	2016	2017	2018	2019
0	Management occupations	0.47	0.51	0.52	0.56	0.58	0.56	0.55	0.56
1	Business, finance and administration occupations	0.93	1.05	1.09	1.04	1.07	0.98	0.91	1.04
2	Natural and applied sciences and related occupations	0.34	0.46	0.57	0.65	0.66	0.60	0.67	0.72
3	Health occupations	1.69	1.56	1.48	1.61	1.77	1.78	2.13	1.90
4	Occupations in education, law and social, community and government services	1.98	1.77	1.65	1.51	1.60	1.57	1.40	1.30
5	Occupations in art, culture, recreation and sport	1.30	1.37	1.35	1.27	1.38	1.46	1.57	1.49
6	Sales and service occupations	1.21	1.00	0.95	0.88	0.82	0.90	0.94	0.89
7	Trades, transport and equipment operators and related occupations	2.30	1.42	1.27	1.30	1.34	1.41	1.26	1.21
8	Natural resources, agriculture and related production occupations	10.40	4.02	2.51	1.98	1.97	2.35	2.08	1.73
9	Occupations in manufacturing and utilities	2.56	2.09	1.94	1.93	1.78	1.69	1.87	1.91

Source: Authors' own calculations based on Burning Glass Technologies (2020) and Canadian Labour Force Survey (2020) data.

Table 31 displays the weights obtained by dividing the occupational shares in employment data by the occupational shares in BGT data. It would be important to use these weights when the aim would be to generalise results to represent the full population of workers. As can be observed, weights generally differ more across occupations than across years and broadly converge to one between 2012 and 2014, to then remain constant, thus suggesting a somewhat better representativeness of online job posting data over time.

5.4. Australia

5.4.1. Assessing the representativeness of BGT data

In the case of Australia, the total number of job openings in BGT data varies between 530 thousand in 2012 and 928 thousand in 2019. Table 32 displays a heat map of the number of job openings in BGT, by occupational group, for the years 2012-2019.

The occupational classification used in the case of Australia and New Zealand is the Australian and New Zealand Standard Classification of Occupations (ANZSCO), as both BGT data and LFS employment data are available in ANZSCO.

While ANZSCO and ISCO-08 are largely similar at the 1-digit level, the order of the different occupational codes is not always the same. Creating a crosswalk at the 1 digit level between ANZSCO and ISCO-08 becomes cumbersome if one wants to ensure a certain degree of accuracy, as we do in the present analysis.

In what follows, we therefore maintain the order of ANZSCO in Table 32-Table 37 and Table 39-Table 41, and change the order of the 1 digit occupational titles only in Table 38, to ease comparison with corresponding statistics displayed for the other countries. It is also worth noting that ANZSCO data do not contain the occupational group "Craftsmen and related trades workers" (occupation group 7 in ISCO-08) and "Skilled agricultural, forestry and fishery workers" (occupation group 6 in ISCO-08). This is not a source of concern as, in any case, the analysis done so far for the other countries in BGT data has shown that not much is lost if occupation group 6 is missing. This category typically represents only about 1% of the employed population and is not well represented in BGT data anyway. The size of the group "Craftsmen and related trade workers" is conversely larger and contains mostly trade workers which are added to occupation group 3 "Technicians and Trades

Workers" in ANZSCO. In addition, ANZSCO features an occupational group named "Community and personal service workers" which does not exist in ISCO-08.

These three main differences between ANZSCO and ISCO-08 (at the 1-digit occupation level) would jeopardise the analysis if we were to produce statistics based on ISCO-08. This explains why we assess the representativeness of the BGT data for Australia using ANZSCO for both BGT and LFS employment data. However, this makes the cross-country comparison proposed at the end slightly more challenging.

Table 32. BGT data - Frequency by occupational group and year (Australia)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	75,171	88,631	124,381	109,046	116,982	121,458	118,365	138,106
2	Professionals	209,524	222,754	313,765	286,656	320,206	346,936	350,974	380,050
3	Technicians and Trades Workers	58,589	65,718	114,083	78,023	87,703	92,525	98,174	87,678
4	Community and Personal Service Workers	21,537	31,268	62,241	48,312	49,157	49,793	48,037	51,029
5	Clerical and Administrative Workers	82,423	94,867	136,756	132,301	132,362	139,143	130,717	132,906
6	Sales Workers	46,782	57,736	83,903	85,560	82,757	80,622	70,135	72,879
7	Machinery Operators and Drivers	17,088	18,378	27,505	22,167	25,725	30,979	33,692	29,176
8	Labourers	18,722	22,563	42,622	33,761	37,773	41,921	39,164	36,268
	Total	529,836	601,915	905,256	795,826	852,665	903,377	889,258	928,092

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 33 shows the number of BGT job openings by occupation divided by LFS employment by occupation data. The share of BGT data in relation to employment appears relatively equally distributed among different occupations. It varies between 2-4% for "Labourers" and 8-12% for "Professionals". However, the share of BGT data in relation to employment varies importantly over the years for which data are available, also in comparison to what we observe for the other countries in BGT data.

Table 33. Share, BGT data in relation to employment by occupation figures, 2012-19 (Australia)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	5.2%	6.1%	8.2%	7.1%	7.6%	7.9%	7.5%	9.0%
2	Professionals	8.3%	8.8%	12.1%	10.6%	11.5%	11.9%	11.7%	12.0%
3	Technicians and Trades Workers	3.5%	4.0%	6.8%	4.5%	5.2%	5.3%	5.5%	4.9%
4	Community and Personal Service Workers	2.0%	2.8%	5.4%	4.0%	3.9%	3.8%	3.6%	3.6%
5	Clerical and Administrative Workers	4.9%	5.7%	8.4%	8.0%	7.8%	8.5%	7.6%	7.5%
6	Sales Workers	4.5%	5.4%	7.7%	7.7%	7.5%	7.2%	6.3%	6.6%
7	Machinery Operators and Drivers	2.3%	2.4%	3.7%	3.0%	3.4%	4.0%	4.1%	3.4%
8	Labourers	1.6%	2.0%	3.8%	3.0%	3.2%	3.5%	3.2%	2.9%

Note: BGT shares are calculated dividing BGT data frequencies by employment by occupation figures at 1 digit ANZSCO occupational classification.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

Table 34 presents a heat map of the growth rates of BGT job openings data by occupational group and Table 35 shows the growth rates of LFS employment by occupation. The two heat maps again do not reveal any clear correlation between the growth rates in BGT job openings data and the growth rates in LFS employment data.

Table 34. Growth rates in BGT data (Australia)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	17.9%	40.3%	-12.3%	7.3%	3.8%	-2.5%	16.7%
2	Professionals	6.3%	40.9%	-8.6%	11.7%	8.3%	1.2%	8.3%
3	Technicians and Trades Workers	12.2%	73.6%	-31.6%	12.4%	5.5%	6.1%	-10.7%
4	Community and Personal Service Workers	45.2%	99.1%	-22.4%	1.7%	1.3%	-3.5%	6.2%
5	Clerical and Administrative Workers	15.1%	44.2%	-3.3%	0.0%	5.1%	-6.1%	1.7%
6	Sales Workers	23.4%	45.3%	2.0%	-3.3%	-2.6%	-13.0%	3.9%
7	Machinery Operators and Drivers	7.5%	49.7%	-19.4%	16.1%	20.4%	8.8%	-13.4%
8	Labourers	20.5%	88.9%	-20.8%	11.9%	11.0%	-6.6%	-7.4%
9	Total of all occupations (weighted)	13.6%	50.4%	-12.1%	7.1%	5.9%	-1.6%	4.4%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 35. Growth rates in employment by occupation (Australia)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	0.9%	3.4%	1.8%	0.5%	0.1%	1.8%	-2.5%
2	Professionals	0.4%	2.5%	4.4%	2.6%	5.1%	3.1%	5.0%
3	Technicians and Trades Workers	-0.1%	1.3%	1.9%	-2.0%	3.1%	3.7%	0.3%
4	Community and Personal Service Workers	5.3%	1.1%	5.5%	4.6%	3.4%	1.1%	6.4%
5	Clerical and Administrative Workers	0.0%	-2.0%	0.6%	2.5%	-2.5%	4.0%	3.4%
6	Sales Workers	2.3%	2.0%	0.8%	0.3%	0.9%	0.2%	-1.6%
7	Machinery Operators and Drivers	3.9%	-3.4%	-0.6%	1.5%	3.0%	6.6%	5.1%
8	Labourers	-1.5%	0.3%	-0.8%	3.8%	4.4%	1.4%	0.8%
	Total of all occupations (weighted)	1.0%	1.0%	2.1%	1.7%	2.3%	2.7%	2.3%

Source: Authors' own calculations based on Australian Labour Force Survey (2020) data.

5.4.2. Identifying changes in representativeness by occupation and possible drivers

Table 36 displays the growth rates in the BGT data corrected for employment growth in LFS data. As can be seen, this hardly changes the rates observed in Table 34.

Table 36. Growth rates in BGT data corrected for employment growth (Australia)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	16.9%	35.7%	-13.8%	6.8%	3.7%	-4.3%	19.6%
2	Professionals	5.9%	37.4%	-12.5%	8.9%	3.1%	-1.8%	3.1%
3	Technicians and Trades Workers	12.3%	71.4%	-32.9%	14.6%	2.3%	2.3%	-11.0%
4	Community and Personal Service Workers	37.9%	96.8%	-26.4%	-2.7%	-2.0%	-4.6%	-0.1%
5	Clerical and Administrative Workers	15.1%	47.1%	-3.8%	-2.4%	7.8%	-9.6%	-1.7%
6	Sales Workers	20.6%	42.5%	1.2%	-3.6%	-3.5%	-13.2%	5.6%
7	Machinery Operators and Drivers	3.5%	54.9%	-18.9%	14.4%	16.9%	2.0%	-17.6%
8	Labourers	22.3%	88.3%	-20.2%	7.7%	6.3%	-7.8%	-8.1%
9	Total of all occupations (weighted)	12.5%	48.9%	-13.9%	5.4%	3.5%	-4.2%	2.0%

Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

Table 37 displays the growth rates in BGT data by occupational group relative to the growth rate of the total BGT data per year, where both the occupational growth rate and the total

growth rate account for employment growth already. Table 38 takes the absolute values of Table 37 to make it easier to assess differences from the mean, independently of the signs of such differences.

Table 37. Deviation, BGT growth rates (Australia)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	4.4	-13.3	0.1	1.4	0.2	-0.1	19.6
2	Professionals	-6.6	-11.5	1.4	3.5	-0.4	2.3	3.1
3	Technicians and Trades Workers	-0.2	22.5	-19.0	9.3	-1.2	6.4	-11.0
4	Community and Personal Service Workers	25.4	47.9	-12.5	-8.1	-5.5	-0.4	-0.1
5	Clerical and Administrative Workers	2.6	-1.8	10.1	-7.8	4.3	-5.5	-1.7
6	Sales Workers	8.1	-6.4	15.1	-9.0	-7.0	-9.1	5.6
7	Machinery Operators and Drivers	-9.0	5.9	-5.0	9.0	13.4	6.1	-17.6
8	Labourers	9.9	39.4	-6.3	2.4	2.8	-3.7	-8.1

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. Figures in Table 37 are calculated taking the growth rates corrected for employment growth (in Table 36) and subtracting the corrected growth rates in the total BGT data (lowest row in Table 36).
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and the Australian Labour Force Survey (2020).

Table 38. Deviation, BGT data, absolute numbers (Australia)

M. isco	Ansco	ANZSCO occupation titles	2013	2014	2015	2016	2017	2018	2019	Avg.	Avg. y. w/o b.	Pop. share
1	1	Managers	4.4	13.3	0.1	1.4	0.2	0.1	19.6	5.6	4.3	12.6%
2	2	Professionals	6.6	11.5	1.4	3.5	0.4	2.3	3.1	4.1	2.9	23.0%
3	3	Technicians and Trades Workers	0.2	22.5	19.0	9.3	1.2	6.4	11.0	9.9	7.9	14.4%
4	5	Clerical and Administrative Workers	2.6	1.8	10.1	7.8	4.3	5.5	1.7	4.8	5.3	14.2%
5	6	Sales Workers	8.1	6.4	15.1	9.0	7.0	9.1	5.6	8.6	9.0	9.3%
8	7	Machinery Operators and Drivers	9.0	5.9	5.0	9.0	13.4	6.1	17.6	9.4	10.0	6.5%
9	8	Labourers	9.9	39.4	6.3	2.4	2.8	3.7	8.1	10.4	5.5	9.8%
	4	Community and Personal Service Workers	25.4	47.9	12.5	8.1	5.5	0.4	0.1	14.3	8.7	10.3%
		Average deviation in %	8.3	18.6	8.7	6.3	4.4	4.2	8.4			

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. For Australia we use ANZSCO rather than ISCO-08 occupational classification. However, we also add the manually matched ISCO-08 codes to the left of the table to allow for cross-country comparison. The representativeness for the year or occupational group is labelled as green, yellow or red when the average deviation is 0-10, 10-15 and 15+, respectively. Deviations for individual occupation-year groups are marked in light blue if larger than 20% and darker blue if larger than 25%. "y. w/o b." gives the average for the years considered excluding breaks, i.e. excluding 2014 data.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

This leads to a colour tagging of the years that shows all years to be green except for 2014, which is flagged red as there seems to exist a break in the series between 2013 and 2014. Furthermore, all occupations are tagged green or yellow, with the largest differences observed in the case of "community and personal service workers". Considering individual occupation-year cells, "community and personal service workers" emerges as an

occupational group that is tagged dark blue, suggesting a deviation of more than 25%, in the 2013 and 2014.

To summarise, in consideration of the break in the series between 2013 and 2014, it may be best to use 2014 and later BGT data for Australia when the aim is to look at trends and/or generalise results for the entire working population. Also, one may want to leave out of the analysis "labourers" and "community and service workers", as the differences observed in such cases are non-negligible.

5.4.3. Weights

As done for the other economies in the analysis, we propose time-varying occupation-specific weights based on the share of observations by occupational group out of total number of observations, in both BGT data and LFS employment data. Table 39 gives the share of observations by occupational group out of total BGT data. Table 40 gives the share of employed people by occupational group out of total employment. Comparing these two tables one sees that "Professionals" are somewhat more represented in BGT data also in the case of Australia, whereas "Community and personal workers", "Machinery operators and drivers" and "Labourers" are relatively less represented. The other occupations are represented to similar extents in BGT and LFS employment data.

Table 39. Share, occupational group out of total BGT data, 2012-19 (Australia)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	14.2%	14.7%	13.7%	13.7%	13.7%	13.4%	13.3%	14.9%
2	Professionals	39.5%	37.0%	34.7%	36.0%	37.6%	38.4%	39.5%	40.9%
3	Technicians and Trades Workers	11.1%	10.9%	12.6%	9.8%	10.3%	10.2%	11.0%	9.4%
4	Community and Personal Service Workers	4.1%	5.2%	6.9%	6.1%	5.8%	5.5%	5.4%	5.5%
5	Clerical and Administrative Workers	15.6%	15.8%	15.1%	16.6%	15.5%	15.4%	14.7%	14.3%
6	Sales Workers	8.8%	9.6%	9.3%	10.8%	9.7%	8.9%	7.9%	7.9%
7	Machinery Operators and Drivers	3.2%	3.1%	3.0%	2.8%	3.0%	3.4%	3.8%	3.1%
8	Labourers	3.5%	3.7%	4.7%	4.2%	4.4%	4.6%	4.4%	3.9%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies' data (2019.

Table 40. Share, occupational group out of total employment data, 2012-19 (Australia)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	12.8%	12.8%	13.1%	13.0%	12.9%	12.6%	12.5%	11.9%
2	Professionals	22.3%	22.1%	22.5%	23.0%	23.2%	23.8%	23.9%	24.5%
3	Technicians and Trades Workers	14.7%	14.5%	14.6%	14.6%	14.0%	14.2%	14.3%	14.0%
4	Community and Personal Service Workers	9.5%	9.9%	10.0%	10.3%	10.6%	10.7%	10.5%	10.9%
5	Clerical and Administrative Workers	14.8%	14.6%	14.2%	14.0%	14.1%	13.4%	13.6%	13.7%
6	Sales Workers	9.3%	9.4%	9.5%	9.4%	9.3%	9.1%	8.9%	8.6%
7	Machinery Operators and Drivers	6.6%	6.8%	6.5%	6.3%	6.3%	6.3%	6.6%	6.7%
8	Labourers	10.1%	9.8%	9.8%	9.5%	9.7%	9.9%	9.8%	9.6%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Australian Labour Force Survey (2020) data.

Table 41. Occupational group and time-specific representativeness weights (Australia)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	0.90	0.87	0.95	0.95	0.94	0.94	0.94	0.80
2	Professionals	0.56	0.60	0.65	0.64	0.62	0.62	0.61	0.60
3	Technicians and Trades Workers	1.33	1.33	1.16	1.49	1.37	1.38	1.29	1.48
4	Community and Personal Service Workers	2.35	1.91	1.45	1.69	1.83	1.94	1.95	1.99
5	Clerical and Administrative Workers	0.95	0.93	0.94	0.84	0.91	0.87	0.92	0.96
6	Sales Workers	1.05	0.98	1.02	0.87	0.95	1.02	1.13	1.09
7	Machinery Operators and Drivers	2.04	2.21	2.13	2.26	2.08	1.84	1.73	2.15
8	Labourers	2.86	2.63	2.08	2.24	2.19	2.13	2.22	2.46

Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

Table 41 displays the weights calculated by dividing the occupational share in employment by the occupational share in BGT, weight to be used for representativeness purposes in policy-relevant analysis. These weights seem to vary importantly over time, thus suggesting that the observed trends may at least in part reflect changes in the composition of BGT data rather than trends in the real world and stressing the need to avoid taking online job posting data at face value.

5.5. Singapore

5.5.1. Assessing the representativeness of BGT data

Table 42 shows a heat map related to the number of job openings in BGT data for Singapore, by occupational group and year. For this economy, the total number of job openings in BGT is rather constant over the years, i.e. between 400 and 500 thousand for all years, except for 2016 (featuring 700 thousand job openings).

In the case of Singapore, we rely on the Singapore Standard Occupational Classification (SSOC) 2015 to compile statistics, instead of relying on the ISCO-08 classification as done for the United States and the United Kingdom. We use SSOC because both BGT data and employment data are available in SSOC and 1 to 1 mapping with ISCO are not straightforward and may introduce biases. In any case, at the 1 digit level ISCO and SSOC are very similar and this allows us to do a cross-country comparison in a later section. The greatest alignment in terms of occupational titles is observed when comparing occupation titles used for Singapore with those for the United States, United Kingdom and Canada.

In the case of Singapore, no data can be found in BGT in relation to occupation group 6, i.e. "Skilled agricultural, forestry and fishery workers". However, this does not represent a major concern, given that in the other countries considered in the study such occupational group generally accounts for only about 1% of employed people and it is often not well represented in BGT data (and, as a consequence, needs being left aside anyway).

Table 43 shows the number of BGT job openings by occupation divided by employment by occupation. Again, most job openings in relation to employment are found for occupations 1-5 and somewhat lower rates of job openings are observed in relation to occupation groups 7 to 9.

Table 42. BGT data - Frequency by occupational group and year (Singapore)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Legislators, senior officials and managers	82,541	88,579	81,346	89,358	130,891	83,805	71,467	67,842
2	Professionals	136,024	138,579	128,040	149,436	226,563	164,107	142,023	146,512
3	Associate professionals and technicians	90,950	88,798	79,818	90,129	122,798	80,672	67,018	62,177
4	Clerical support workers	81,880	83,165	76,784	80,871	107,771	66,034	55,540	64,263
5	Service and sales workers	41,341	44,667	47,991	49,061	67,878	43,255	35,282	39,132
7	Craftsmen and related trades workers	7,579	7,228	6,703	6,723	10,431	6,962	5,546	5,606
8	Plant and machine operators and assemblers	10,450	10,906	10,754	10,215	13,313	9,984	8,159	10,161
9	Cleaners, labourers and related workers	15,741	17,146	18,732	17,574	24,024	16,653	15,378	20,815
	Total	466,506	479,068	450,168	493,367	703,669	471,472	400,413	416,508

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 43. Share, BGT data in relation to employment by occupation figures, 2012-19 (Singapore)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Legislators, senior officials and managers	23.8%	25.3%	23.8%	25.9%	40.3%	25.1%	22.1%	19.7%
2	Professionals	37.0%	37.8%	34.3%	38.0%	54.9%	37.7%	31.6%	31.4%
3	Associate professionals and technicians	25.8%	23.8%	19.5%	21.0%	27.0%	17.9%	13.9%	12.7%
4	Clerical support workers	31.2%	31.0%	28.9%	30.6%	44.7%	27.0%	23.4%	27.5%
5	Service and sales workers	16.0%	17.9%	19.3%	19.2%	25.3%	17.2%	13.3%	15.0%
7	Craftsmen and related trades workers	8.4%	8.8%	8.2%	8.0%	13.2%	9.2%	7.9%	8.3%
8	Plant and machine operators and assemblers	7.0%	7.4%	7.3%	7.0%	8.8%	6.5%	5.5%	6.6%
9	Cleaners, labourers and related workers	10.8%	11.4%	11.3%	11.0%	14.9%	10.4%	9.8%	13.9%

Note: BGT shares are calculated dividing BGT data frequencies by employment by occupation figures at 1 digit SSOC occupational levels.
Source: Authors' own calculations based on Burning Glass Technologies' (2020) and mid-year Singapore Labour Force Survey (2020) data.

Table 44 presents a heat map of the growth rates for BGT job openings data by SSOC 2015 occupational groups and Table 45 shows the growth rates for employment by occupation. These two heat maps confirm the lack of a clear correlation between growth rates in BGT job openings data and growth rates in employment, in line with what was generally observed before.

Table 44. Growth rates in BGT data (Singapore)

		2013	2014	2015	2016	2017	2018	2019
1	Legislators, Senior Officials & Managers	7.3%	-8.2%	9.8%	46.5%	-36.0%	-14.7%	-5.1%
2	Professionals	1.9%	-7.6%	16.7%	51.6%	-27.6%	-13.5%	3.2%
3	Associate Professionals & Technicians	-2.4%	-10.1%	12.9%	36.2%	-34.3%	-16.9%	-7.2%
4	Clerical Support Workers	1.6%	-7.7%	5.3%	33.3%	-38.7%	-15.9%	15.7%
5	Service & Sales Workers	8.0%	7.4%	2.2%	38.4%	-36.3%	-18.4%	10.9%
7	Craftsmen & Related Trade Workers	-4.6%	-7.3%	0.3%	55.2%	-33.3%	-20.3%	1.1%
8	Plant & Machine Operators & Assemblers	4.4%	-1.4%	-5.0%	30.3%	-25.0%	-18.3%	24.5%
9	Cleaners, Labourers & Related Workers	8.9%	9.2%	-6.2%	36.7%	-30.7%	-7.7%	35.4%
	Total of all occupations (weighted)	2.7%	-6.0%	9.6%	42.6%	-33.0%	-15.1%	4.0%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 45. Growth rates in employment by occupation (Singapore)

		2013	2014	2015	2016	2017	2018	2019
1	Legislators, Senior Officials & Managers	1.0%	-2.1%	0.9%	-6.0%	2.7%	-3.2%	6.4%
2	Professionals	-0.1%	1.8%	5.2%	5.1%	5.5%	3.2%	3.9%
3	Associate Professionals & Technicians	5.9%	9.4%	4.9%	6.2%	-0.9%	6.8%	1.6%
4	Clerical Support Workers	2.2%	-1.0%	-0.3%	-8.8%	1.3%	-2.7%	-1.7%
5	Service & Sales Workers	-3.2%	-0.4%	3.1%	4.7%	-5.9%	5.6%	-1.7%
7	Craftsmen & Related Trade Workers	-9.3%	0.0%	2.1%	-5.6%	-4.0%	-7.9%	-3.1%
8	Plant & Machine Operators & Assemblers	-1.4%	-0.9%	-0.1%	4.0%	1.0%	-2.5%	2.5%
9	Cleaners, Labourers & Related Workers	3.4%	10.5%	-3.4%	0.2%	-0.1%	-2.6%	-4.5%
	Total of all occupations (weighted)	0.8%	2.3%	2.2%	0.8%	0.6%	1.3%	1.5%

Source: Authors' own calculations based on mid-year Singapore Labour Force Survey (2020) data.

5.5.2. Identifying changes in representativeness by occupation and possible drivers

Table 46 displays the growth rates in BGT data corrected for employment growth. This correction hardly changes the numbers observed in Table 44.

Table 47 shows the growth rate per occupation relative to the growth rate of the total data per year, where both the occupational growth rate and the total growth rate account for employment growth already. Table 48 displays the absolute values of Table 47 to assess deviations from the mean, independently of them being negative or positive. Doing so, and tagging in green, yellow and red as done for the other countries, depending on absolute deviation values being between 0 and 10, between 10 and 15, and more than 15, respectively, we see what follows. All averages for occupations (across years) are green except for "Cleaners, labourers & related workers" which is tagged yellow. All averages for years (across occupations) are also green, with the exception of the years 2016 and 2019, which are tagged yellow again. This all together suggests a good representativeness of BGT data for Singapore.

Table 46. Growth rates in BGT data corrected for employment growth (Singapore)

		2013	2014	2015	2016	2017	2018	2019
1	Legislators, Senior Officials & Managers	6.3	-6.2	8.9	55.8	-37.6	-11.9	-10.8
2	Professionals	2.0	-9.2	10.9	44.3	-31.4	-16.2	-0.7
3	Associate Professionals & Technicians	-7.8	-17.9	7.7	28.3	-33.7	-22.2	-8.7
4	Clerical Support Workers	-0.6	-6.7	5.6	46.2	-39.5	-13.6	17.7
5	Service & Sales Workers	11.6	7.9	-0.8	32.2	-32.3	-22.7	12.8
7	Craftsmen & Related Trade Workers	5.1	-7.3	-1.7	64.4	-30.4	-13.5	4.4
8	Plant & Machine Operators & Assemblers	5.8	-0.5	-4.9	25.3	-25.7	-16.2	21.5
9	Cleaners, Labourers & Related Workers	5.4	-1.1	-2.8	36.4	-30.6	-5.2	41.7
	Total of all occupations (weighted)	1.9	-8.1	7.2	41.5	-33.4	-16.2	2.5

Source: Authors' own calculations based on Burning Glass Technologies (2020) and mid-year Singapore Labour Force Survey (2020) data.

Table 47. Deviation, BGT growth rates (Singapore)

		2013	2014	2015	2016	2017	2018	2019
1	Legislators, Senior Officials & Managers	4.4	1.9	1.7	14.2	-4.2	4.2	-13.3
2	Professionals	0.1	-1.1	3.7	2.7	2.0	0.0	-3.2
3	Associate Professionals & Technicians	-9.7	-9.7	0.4	-13.2	-0.3	-6.0	-11.2
4	Clerical Support Workers	-2.5	1.4	-1.6	4.7	-6.1	2.6	15.2
5	Service & Sales Workers	9.8	16.0	-8.0	-9.3	1.1	-6.6	10.3
7	Craftsmen & Related Trade Workers	3.2	0.9	-9.0	22.8	3.0	2.7	1.9
8	Plant & Machine Operators & Assemblers	4.0	7.6	-12.1	-16.3	7.7	0.0	19.0
9	Cleaners, Labourers & Related Workers	3.5	7.0	-10.1	-5.2	2.8	10.9	39.2

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. Figures in Table 47 are calculated taking the growth rates corrected for employment growth (in Table 46) and subtracting the corrected growth rates in the total BGT data (lowest row in Table 46).
Source: Authors' own calculations based on Burning Glass Technologies (2020) and mid-year Singapore Labour Force Survey (2020) data.

Table 48. Deviation, BGT data, absolute numbers (Singapore)

		2013	2014	2015	2016	2017	2018	2019	Avg.	Avg. y. w/o b.	Pop. share
1	Legislators, Senior Officials & Managers	4.4	1.9	1.7	14.2	4.2	4.2	13.3	6.3	6.3	16.4%
2	Professionals	0.1	1.1	3.7	2.7	2.0	0.0	3.2	1.8	1.8	19.7%
3	Associate Professionals & Technicians	9.7	9.7	0.4	13.2	0.3	6.0	11.2	7.2	7.2	20.7%
4	Clerical Support Workers	2.5	1.4	1.6	4.7	6.1	2.6	15.2	4.9	4.9	12.2%
5	Service & Sales Workers	9.8	16.0	8.0	9.3	1.1	6.6	10.3	8.7	8.7	12.4%
7	Craftsmen & Related Trade Workers	3.2	0.9	9.0	22.8	3.0	2.7	1.9	6.2	6.2	3.8%
8	Plant & Machine Operators & Assemblers	4.0	7.6	12.1	16.3	7.7	0.0	19.0	9.5	9.5	7.2%
9	Cleaners, Labourers & Related Workers	3.5	7.0	10.1	5.2	2.8	10.9	39.2	11.2	11.2	7.5%
	Average deviation in %	4.6	5.7	5.8	11.1	3.4	4.1	14.2			

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. The representativeness for the year or occupational group is labelled as green, yellow or red when the average deviation is 0-10, 10-15 and 15+, respectively. Deviations for individual occupation-year groups are marked in light blue if larger than 20% and darker blue if larger than 25%. "y. w/o b." gives the average for the years considered excluding breaks.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and mid-year Singapore Labour Force Survey (2020) data.

5.5.3. Weights

We construct time-varying weights by SSOC 2015 occupational group based on the share of observations per occupation out of total observations for both BGT data and employment data. Table 49 shows the share of observations per occupational group out of total BGT data. Table 50 displays the share of employed people per occupational group out of total employment. Comparing the two tables suggests professionals to be the most relatively represented group. In addition, only small shares of job opening for occupations 7-9 are featured in BGT data relative to LFS employment data.

Table 49. Share, occupational group out of total BGT data, 2012-19 (Singapore)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Legislators, senior officials and managers	17.7%	18.5%	18.1%	18.1%	18.6%	17.8%	17.8%	16.3%
2	Professionals	29.2%	28.9%	28.4%	30.3%	32.2%	34.8%	35.5%	35.2%
3	Associate professionals and technicians	19.5%	18.5%	17.7%	18.3%	17.5%	17.1%	16.7%	14.9%
4	Clerical support workers	17.6%	17.4%	17.1%	16.4%	15.3%	14.0%	13.9%	15.4%
5	Service and sales workers	8.9%	9.3%	10.7%	9.9%	9.6%	9.2%	8.8%	9.4%
7	Craftsmen and related trades workers	1.6%	1.5%	1.5%	1.4%	1.5%	1.5%	1.4%	1.3%
8	Plant and machine operators and assemblers	2.2%	2.3%	2.4%	2.1%	1.9%	2.1%	2.0%	2.4%
9	Cleaners, labourers and related workers	3.4%	3.6%	4.2%	3.6%	3.4%	3.5%	3.8%	5.0%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 50. Share, occupational group out of total employment data, 2012-19 (Singapore)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Legislators, Senior Officials & Managers	17.6%	17.6%	16.8%	16.6%	15.5%	15.8%	15.1%	15.9%
2	Professionals	18.6%	18.5%	18.4%	18.9%	19.7%	20.7%	21.1%	21.6%
3	Associate Professionals & Technicians	17.9%	18.8%	20.1%	20.6%	21.7%	21.4%	22.6%	22.6%
4	Clerical Support Workers	13.3%	13.5%	13.1%	12.7%	11.5%	11.6%	11.1%	10.8%
5	Service & Sales Workers	13.1%	12.5%	12.2%	12.3%	12.8%	12.0%	12.5%	12.1%
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	Craftsmen & Related Trade Workers	4.6%	4.1%	4.0%	4.0%	3.8%	3.6%	3.3%	3.1%
8	Plant & Machine Operators & Assemblers	7.6%	7.4%	7.2%	7.0%	7.3%	7.3%	7.0%	7.1%
9	Cleaners, Labourers & Related Workers	7.4%	7.6%	8.2%	7.7%	7.7%	7.6%	7.3%	6.9%
	Total of all occupations	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on mid-year Singapore Labour Force Survey (2020) data.

Table 51. Occupational group and time-specific representativeness weights (Singapore)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Legislators, Senior Officials & Managers	0.99	0.95	0.93	0.92	0.83	0.89	0.85	0.97
2	Professionals	0.64	0.64	0.65	0.62	0.61	0.59	0.59	0.61
3	Associate Professionals & Technicians	0.92	1.01	1.13	1.13	1.25	1.25	1.35	1.51
4	Clerical Support Workers	0.76	0.78	0.77	0.78	0.75	0.83	0.80	0.70
5	Service & Sales Workers	1.47	1.35	1.15	1.24	1.33	1.30	1.42	1.29
7	Craftsmen & Related Trade Workers	2.83	2.74	2.72	2.96	2.55	2.44	2.37	2.33
8	Plant & Machine Operators & Assemblers	3.39	3.26	3.01	3.40	3.84	3.44	3.44	2.91
9	Cleaners, Labourers & Related Workers	2.18	2.11	1.96	2.17	2.25	2.16	1.91	1.38

Source: Authors' own calculations based on Burning Glass Technologies (2020) and mid-year Singapore Labour Force Survey (2020) data.

Table 51 displays the weights that are calculated by dividing the occupational share in LFS employment data by occupational shares in BGT data. It would be advisable to apply the weights if the research question of interest concerns the full population of workers. Weights appear relatively stable over time. This means that observed trends over time are likely to

reflect real changes and not a change in representativeness of certain occupations relative to others, over time.

5.6. New Zealand

5.6.1. Assessing the representativeness of BGT data

Table 52 displays a heat map of the number of job openings in BGT, by 1 digit level of the ANZSCO occupational group and years 2012-19. During the period 2012-19, the total number of job openings in BGT data seem to vary importantly, i.e. between 22 thousand and 317 thousands.

Table 53 shows the number of BGT job openings by occupation divided by employment by occupation figures, based on New Zealand Census data, with both BGT and Census data classified following ANZSCO.[14] One sees immediately that the share of BGT job openings relative to employment is likely to be generally small for all occupations. A maximum value of 6% is observed in the case of professionals.

Unfortunately, employment by occupation for New Zealand is only available for 2013. However, we note that employment by occupation shares are very similar in the case of Australia and New Zealand. Hence, in order to have a broad sense of the possible representativeness of BGT data for New Zealand, we compare NZ BGT-base statistics with statistics based on AU LFS in the rest of this section.

Table 52. BGT data - Frequency by occupational group and year (New Zealand)

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	2,805	9,266	13,971	24,461	29,005	37,155	24,336	27,066
2	Professionals	9,361	24,150	35,377	62,703	67,421	79,043	54,325	67,822
3	Technicians and Trades Workers	2,141	6,852	11,491	27,994	38,731	51,154	32,149	36,159
4	Community and Personal Service Workers	1,228	4,772	10,253	14,914	18,559	22,191	16,306	18,965
5	Clerical and Administrative Workers	3,116	10,013	14,854	26,346	31,543	38,791	26,570	32,421
6	Sales Workers	1,842	6,046	10,043	18,365	23,196	29,556	18,812	24,295
7	Machinery Operators and Drivers	592	2,189	3,493	9,468	14,327	22,864	15,349	17,418
8	Labourers	1,122	4,815	8,286	15,934	24,244	36,807	27,842	32,059
	Total	22,207	68,103	107,768	200,185	247,026	317,561	215,689	256,205

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 53. Share, BGT data in relation to employment by occupation figures, 2013 (New Zealand)

		2013
1	Managers	2.6%
2	Professionals	5.6%
3	Technicians and Trades Workers	3.0%
4	Community and Personal Service Workers	2.8%
5	Clerical and Administrative Workers	4.4%
6	Sales Workers	3.4%
7	Machinery Operators and Drivers	2.1%
8	Labourers	2.3%

Note: BGT shares are calculated dividing BGT data frequencies by employment by occupation figures at 1 digit ANZSCO occupational levels.
Source: Authors' own calculations based on New Zealand Census (2019) data.

Table 54 displays the heat map of the growth rates of BGT job openings data by occupational group for New Zealand. As data availability does not allow calculating LFS-based employment by occupation growth rates for New Zealand, and employment by occupation shares are very similar in the case of Australia and New Zealand, we again compare NZ BGT-based growth rates with AU LFS growth rates. This helps getting a sense of the extent to which BGT employment by occupation growth rate may be in line with LFS-type figures. Table 55 shows again the growth rates in employment by occupation for Australia, to compare them against NZ BGT data.

Table 54. Growth rates in BGT data (New Zealand)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	230.3%	50.8%	75.1%	18.6%	28.1%	-34.5%	11.2%
2	Professionals	158.0%	46.5%	77.2%	7.5%	17.2%	-31.3%	24.8%
3	Technicians and Trades Workers	220.0%	67.7%	143.6%	38.4%	32.1%	-37.2%	12.5%
4	Community and Personal Service Workers	288.6%	114.9%	45.5%	24.4%	19.6%	-26.5%	16.3%
5	Clerical and Administrative Workers	221.3%	48.3%	77.4%	19.7%	23.0%	-31.5%	22.0%
6	Sales Workers	228.2%	66.1%	82.9%	26.3%	27.4%	-36.4%	29.1%
7	Machinery Operators and Drivers	269.8%	59.6%	171.1%	51.3%	59.6%	-32.9%	13.5%
8	Labourers	329.1%	72.1%	92.3%	52.2%	51.8%	-24.4%	15.1%
	Total of all occupations (weighted)	206.7%	58.2%	85.8%	23.4%	28.6%	-32.1%	18.8%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 55. Growth rates in employment by occupation, Australia (as proxy for New Zealand)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	0.9%	3.4%	1.8%	0.5%	0.1%	1.8%	-2.5%
2	Professionals	0.4%	2.5%	4.4%	2.6%	5.1%	3.1%	5.0%
3	Technicians and Trades Workers	-0.1%	1.3%	1.9%	-2.0%	3.1%	3.7%	0.3%
4	Community and Personal Service Workers	5.3%	1.1%	5.5%	4.6%	3.4%	1.1%	6.4%
5	Clerical and Administrative Workers	0.0%	-2.0%	0.6%	2.5%	-2.5%	4.0%	3.4%
6	Sales Workers	2.3%	2.0%	0.8%	0.3%	0.9%	0.2%	-1.6%
7	Machinery Operators and Drivers	3.9%	-3.4%	-0.6%	1.5%	3.0%	6.6%	5.1%
8	Labourers	-1.5%	0.3%	-0.8%	3.8%	4.4%	1.4%	0.8%
	Total of all occupations (weighted)	1.0%	1.0%	2.1%	1.7%	2.3%	2.7%	2.3%

Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

5.6.2. Identifying changes in representativeness by occupation and possible drivers

Table 56 shows the growth rates in the BGT data minus employment growth rates taken from Australia, This barely changes the BGT data-based statistics displayed in Table 54.

Table 56. Growth rates in BGT data corrected for employment growth (New Zealand)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	227.5%	45.8%	72.1%	18.0%	28.0%	-35.7%	14.0%
2	Professionals	157.0%	42.9%	69.7%	4.8%	11.5%	-33.3%	18.9%
3	Technicians and Trades Workers	220.5%	65.6%	139.0%	41.1%	28.1%	-39.4%	12.1%
4	Community and Personal Service Workers	269.1%	112.5%	37.9%	19.0%	15.7%	-27.3%	9.3%
5	Clerical and Administrative Workers	221.4%	51.4%	76.3%	16.8%	26.1%	-34.1%	18.0%
6	Sales Workers	220.8%	62.9%	81.5%	25.9%	26.3%	-36.5%	31.2%
7	Machinery Operators and Drivers	255.8%	65.1%	172.8%	49.1%	54.9%	-37.1%	8.0%
8	Labourers	335.7%	71.6%	93.8%	46.5%	45.4%	-25.4%	14.3%
	Total of all occupations (weighted)	203.6%	56.7%	81.9%	21.4%	25.6%	-33.9%	16.1%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and the Australian Labour Force Survey (2020).

Table 57 finally displays the BGT growth rates by occupation relative to the growth rate for the total BGT data per year, where both growth rates are corrected for employment growth already. Table 58 takes the absolute values of Table 57. Doing so highlights that data related to the years 2013, 2014 and 2015 may need to be flagged red, as well as many occupational groups. The only exceptions to the possibly limited representativeness of BGT data are represented by "Managers", "Clerical and administrative workers" and "Sales workers", which seem to be sufficiently well represented. Somewhat better properties of the data are observed when considering only the years 2015-19.

It has to be remembered, though that this assessment is only speculative, as we rely on Australian data, in the absence of the relevant data for New Zealand.

Table 57. Deviation, BGT growth rates (New Zealand)

		2013	2014	2015	2016	2017	2018	2019
1	Managers	23.9%	-10.9%	-9.9%	-3.3%	2.4%	-1.8%	-2.0%
2	Professionals	-46.6%	-13.8%	-12.2%	-16.5%	-14.1%	0.6%	2.8%
3	Technicians and Trades Workers	16.9%	8.9%	57.0%	19.7%	2.4%	-5.6%	-4.0%
4	Community and Personal Service Workers	65.5%	55.8%	-44.0%	-2.4%	-9.9%	6.6%	-6.7%
5	Clerical and Administrative Workers	17.7%	-5.3%	-5.6%	-4.6%	0.5%	-0.2%	1.9%
6	Sales Workers	17.2%	6.2%	-0.5%	4.5%	0.7%	-2.6%	15.2%
7	Machinery Operators and Drivers	52.1%	8.4%	90.9%	27.8%	29.3%	-3.2%	-8.1%
8	Labourers	132.0%	14.9%	11.9%	25.2%	19.8%	8.5%	-1.8%

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. Figures in Table 57 are calculated by taking growth rates corrected for employment growth (in Table 56) and subtract the corrected growth rates in the total BGT data (lowest row in Table 56).
Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

Table 58. Deviation, BGT data, absolute numbers (New Zealand)

M. isco	Anzc.	ANZSCO occupation titles	2013	2014	2015	2016	2017	2018	2019		Avg.	Avg. y. w/o b.	Pop. share
1	1	Managers	23.9	10.9	9.9	3.3	2.4	1.8	2.0		7.8	2.4	18.7%
2	2	Professionals	46.6	13.8	12.2	16.5	14.1	0.6	2.8		15.2	8.5	22.5%
3	3	Technicians and Trades Workers	16.9	8.9	57.0	19.7	2.4	5.6	4.0		16.4	7.9	12.0%
4	5	Clerical and Administrative Workers	17.7	5.3	5.6	4.6	0.5	0.2	1.9		5.1	1.8	12.0%
5	6	Sales Workers	17.2	6.2	0.5	4.5	0.7	2.6	15.2		6.7	5.7	9.3%
8	7	Machinery Operators and Drivers	52.1	8.4	90.9	27.8	29.3	3.2	8.1		31.4	17.1	5.4%
9	8	Labourers	132.0	14.9	11.9	25.2	19.8	8.5	1.8		30.6	13.8	11.1%
	4	Community and Personal Serv.Workers	65.5	55.8	44.0	2.4	9.9	6.6	6.7		27.3	6.4	9.0%
		Average deviation in %	46.5	15.5	29.0	13.0	9.9	3.6	5.3				

Note: BG growth rates minus LFS-based employment growth rates, corrected for average increase in coverage of overall BGT data. For New Zealand we use ANZSCO rather than ISCO-08 occupational classification. However, in order to allow for cross-country comparison we also add the manually matched ISCO-08 code to the right of the table. The order of the rows (occupations) is displayed in line with ISCO-08 and SOC, but the occupational 1 digit code is kept consistent with ANZSCO. The representativeness for the year or occupational group is labelled as green, yellow or red when the average deviation is 0-10, 10-15 and 15+, respectively. Deviations for individual occupation-year groups are marked in light blue if larger than 20% and darker blue if larger than 25%. "y. w/o b." gives the average for the years considered excluding breaks, i.e. excluding 2013-2015 data.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and Australian Labour Force Survey (2020) data.

5.6.3. *Weights*

Table 59 shows the share of the occupational groups out of the total data for both BGT and employment data in 2013. It also shows the weights that are constructed by dividing the occupational share calculated over LFS-based employment data by the occupation share in BGT data. "Professionals" are again the group that is represented to the highest extent in BGT data for New Zealand, followed by "Clerical and administrative workers". "Community and personal service workers", "Machinery operators and drivers" as well as "Labourers" again emerge as possibly being less well represented in BGT data in comparison to real labour market data.

Table 59. Share occupational group out of total employment data, and occupational group and time-specific representativeness weights, 2013 (New Zealand)

		BG	Emp. D.	Weight
		2013	2013	2013
1	Managers	13.6%	18.7%	1.38
2	Professionals	35.5%	22.5%	0.63
3	Technicians and Trades Workers	10.1%	12.0%	1.19
4	Community and Personal Service Workers	7.0%	9.0%	1.28
5	Clerical and Administrative Workers	14.7%	12.0%	0.82
6	Sales Workers	8.9%	9.3%	1.05
7	Machinery Operators and Drivers	3.2%	5.4%	1.70
8	Labourers	7.1%	11.1%	1.57

Source: Authors' own calculations based on Burning Glass Technologies (2020) and New Zealand Census (2020) data.

Section 6. Cross country comparison

In what follows, we compare the results of the characterisation performed thus far on the six economies considered in the analysis, namely the United States, United Kingdom, Canada, Australia, Singapore and New Zealand (listed in the order they appear in the analysis). This is done with the aim to uncover possible patterns that apply to all countries and to assess the overall representativeness of BGT data, and to identify the subset of data that are most suitable for cross-country comparative analysis and to be used in support of evidence-based policy advice.

Table 60 displays the average deviation for different occupational groups when all countries and years are considered.[15] It combines data from, Table 18, Table 28, Table 38, Table 48 and Table 58 to get an overall feeling of the representativeness for the different occupational groups. Column 1 considers the average deviation for all countries and years, which leads to ISCO-08 occupations 1-5 that are tagged green, occupations 7-9 that are flagged yellow and occupation groups 6 and 10 that are marked red. On average, 65.1% of the employed population gets tagged green in BGT data; 33.8% of the employed population is tagged yellow, whereas concerns exist only for about 1% of the employed population. Column 2 shows that all occupational groups are tagged green when only the years without breaks are considered, except for occupations 6, 8 and 9, which are tagged yellow.

Table 60. Cross country comparison of representativeness for different occupations

ISCO Code		Average All countries All years	Average All countries Years w/o breaks	Average US/UK All years	Pop. Share US/UK/CA All years
1	Managers	5.3	4.2	4.5	12.2%
2	Professionals	6.9	4.9	5.9	20.6%
3	Technicians and associate professionals	8.8	5.5	1.9	13.7%
4	Clerical support workers	5.9	4.7	5.2	12.2%
5	Service and sales workers	8.6	7.0	8.2	16.2%
6	Skilled agricultural, forestry and fishery workers	28.7	12.2	12.2	1.2%
7	Craft and related trades workers	10.5	7.4	8.4	8.6%
8	Plant and machine operators, and assemblers	16.6	12.3	17.7	5.9%
9	Elementary occupations	15.3	11.0	11.0	9.5%
10	Community and Personal Service Workers	20.8	7.8		

Representation good: 1-5	75	% of population	
Representation sufficient: 7-9	24	% of population	
Representation flagged: 6, 10	1	% of population	

Note: We consider ISCO-08 for all occupation groups except for occupation group 10, which is only available for AU and NZ in ANZSCO. We manually matched the ISCO-08 occupation categories with SSOC and ANZSCO for Singapore, Australia and New Zealand, therefore this table only presents a general picture of the representativeness of the different occupational groups.
Source: Authors' own calculations based on Burning Glass Technologies (2020), United States Occupational Employment Statistics (OES) Survey (2020), United Kingdom's Labour Force Survey (2020), Canadian Labour Force Survey (2020), mid-year Singapore Labour Force Survey and Australian Labour Force Survey (2020) data.

Table 61 compounds the analysis shedding light on the countries and years displaying good representativeness. With the exception of Canada and New Zealand, for which some

representativeness concerns exist, all countries display good overall representativeness when one considers only those years for which no breaks are observed. This analysis suggests that the time span that can be safely considered in the analysis vary between 4 years in the case of New Zealand and 8 years in the case of the Unites States for analysis aimed at generalising results for policymaking purposes.

Table 61. Cross country comparison of representativeness, 6 economies, with and without time breaks

Country	All years	Avg. deviation, all years	D. Quality	y. w/o breaks	Avg. deviation, y. w/o breaks
UK	2012-2019	7.3	Good	2012-2019	7.3
US	2010-2019	10.3	Good	2010-2012 & 2013-2018	8.1
CA	2012-2019	17.5	Flagged	2014-2019	7.4
SG	2012-2019	7.0	Good	2012-2019	7.0
AU	2012-2019	8.4	Good	2012-2013 & 2014-2019	6.7
NZ	2012-2019	17.6	Flagged	2015-2019	8.0

Note: "Avg. deviation, y. w/o b." gives the average deviation for the years considered excluding breaks.

Section 7. Testing weights

In this section, we propose a variable-specific discussion and test our weights by considering trends in weighted and unweighted averages of minimum degree level requirements in the United Kingdom. We do so for the United Kingdom to show that using weights is still important for economies for which good representativeness exist in BGT data. In addition, high quality official data are available for the United Kingdom, which allows for statistical testing.

When data are missing at a specific variable level, the need may arise to estimate weights for the relevant subsample. As an example, in Table 62 - Table 64, we calculate the weights that may need to be applied for the subsample related to the minimum degree level of education required in the job opening. This information exists in a proportion varying between 15% and 20% of the BGT job openings data by occupational group and year for the United Kingdom.

Table 62. Share, occupational group (out of total BGT data), minimum education degree-related information in job openings

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	12.6%	11.8%	12.1%	12.4%	11.5%	11.8%	10.3%	10.5%
2	Professionals	48.7%	43.7%	44.8%	46.3%	45.4%	46.7%	49.0%	48.7%
3	Technicians and associate professionals	14.9%	14.9%	15.4%	14.9%	14.9%	14.9%	14.1%	14.7%
4	Clerical support workers	6.2%	7.9%	8.1%	6.8%	7.6%	6.9%	6.6%	6.7%
5	Service and sales workers	12.8%	14.0%	12.9%	12.9%	13.4%	12.9%	12.9%	11.9%
6	Skilled agricultural, forestry and fishery workers	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
7	Craft and related trades workers	3.0%	4.4%	4.1%	4.2%	4.8%	4.7%	5.0%	5.2%
8	Plant and machine operators, and assemblers	0.5%	1.0%	0.7%	0.7%	0.7%	0.6%	0.7%	0.8%
9	Elementary occupations	1.2%	2.2%	1.7%	1.6%	1.6%	1.3%	1.3%	1.4%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table 63. Share occupational group out of total employment data

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	10.7%	10.9%	10.9%	11.1%	11.3%	11.6%	11.6%	12.2%
2	Professionals	23.8%	24.0%	24.2%	24.1%	24.8%	24.5%	25.1%	25.9%
3	Technicians and associate professionals	12.6%	12.4%	12.2%	12.3%	12.2%	12.3%	12.4%	12.1%
4	Clerical support workers	10.1%	10.0%	9.9%	10.2%	9.8%	10.0%	9.9%	9.4%
5	Service and sales workers	19.3%	19.2%	19.1%	18.9%	18.6%	18.4%	18.1%	17.9%
6	Skilled agricultural, forestry and fishery workers	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
7	Craft and related trades workers	8.4%	8.5%	8.6%	8.4%	8.1%	8.2%	8.0%	7.9%
8	Plant and machine operators, and assemblers	5.0%	5.0%	5.0%	5.0%	5.2%	5.1%	5.0%	4.9%
9	Elementary occupations	8.9%	8.8%	8.9%	8.9%	8.8%	8.7%	8.7%	8.4%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: United Kingdom's Labour Force Survey (2020) data.

Table 64. Occupational group and time-specific representativeness weights

		2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	0.85	0.93	0.90	0.89	0.98	0.98	1.12	1.16
2	Professionals	0.49	0.55	0.54	0.52	0.55	0.53	0.51	0.53
3	Technicians and associate professionals	0.84	0.83	0.79	0.82	0.81	0.82	0.87	0.83
4	Clerical support workers	1.63	1.27	1.22	1.49	1.28	1.46	1.51	1.41
5	Service and sales workers	1.51	1.37	1.48	1.46	1.39	1.43	1.40	1.51
6	Skilled agricultural, forestry and fishery workers	15.97	11.17	11.30	13.67	12.17	14.21	12.08	9.76
7	Craft and related trades workers	2.74	1.94	2.07	2.00	1.71	1.73	1.61	1.52
8	Plant and machine operators, and assemblers	10.91	5.10	7.06	7.01	7.71	8.04	7.34	6.43
9	Elementary occupations	7.46	4.02	5.11	5.53	5.42	6.55	6.50	5.89

Note: Weights are based on a sample of BGT data for which minimum degree level data are available. The weights are calculated following Formula 3, as presented in the US-related analysis.
Source: Authors' own calculations based on Burning Glass Technologies (2020) and United Kingdom's Labour Force Survey (2020) data.

Using the weights in Table 64, the trends in weighted and unweighted average minimum degree level required are presented in Figure 6. As can be seen, the weighted minimum degree level average is substantially lower than the unweighted one, because occupations with on average relatively higher levels of education, such as "Managers", "Professionals", "Technicians and associate professionals", are relatively more represented in BGT data. Assigning a lower weight to these occupations, to correct for the relative overrepresentation of these groups in BGT data, lowers the average minimum degree level substantially, as can be seen in Figure 6.

Figure 6. Weighted and unweighted average minimum degree level required, UK, 2012-19
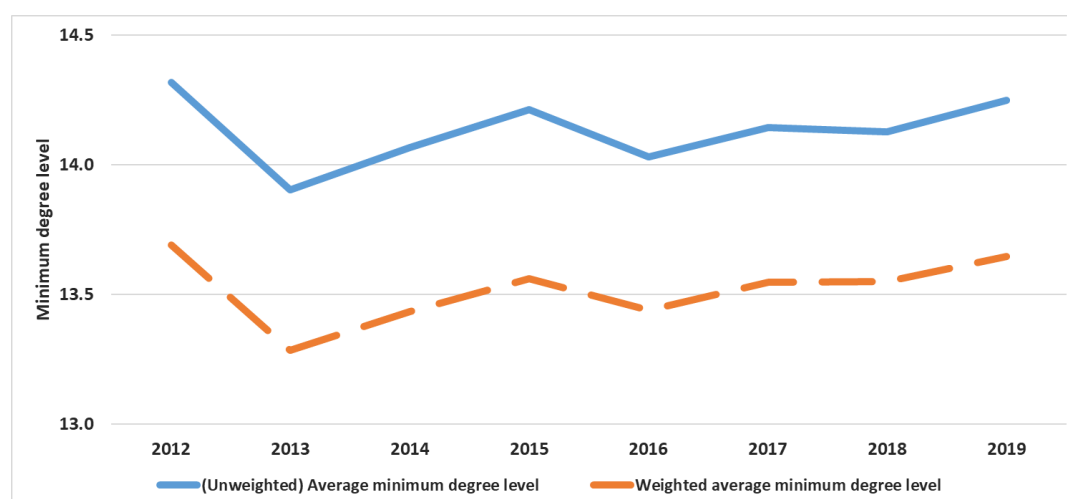
Source: Authors' own calculations based on Burning Glass Technologies' data (2020)

A second observation from Figure 6 is that the weighted average line moves parallel to the unweighted average line. This can be explained by changes in weights over time to be small due to the good representativeness of the BGT data for the United Kingdom. The bigger changes in weights over time for the other countries may lead by definition to different patterns over time for the weighted relative to the unweighted average, making it more important to use time-varying weights. After using weights, we still observe a decrease in minimum degree levels in 2013 and an increase afterwards, reflecting real changes in

average minimum degree levels. Figure 7 shows that this finding is also robust for most occupations considered separately. This finding is in line with, e.g. Modestino, Shoag and Ballance (2016[16]), who find that in the aftermath of the Great Recession decreasing minimum degree levels for the United States can be traced back to business cycle fluctuations.

Figure 7. Average Minimum Degree Level Requirements
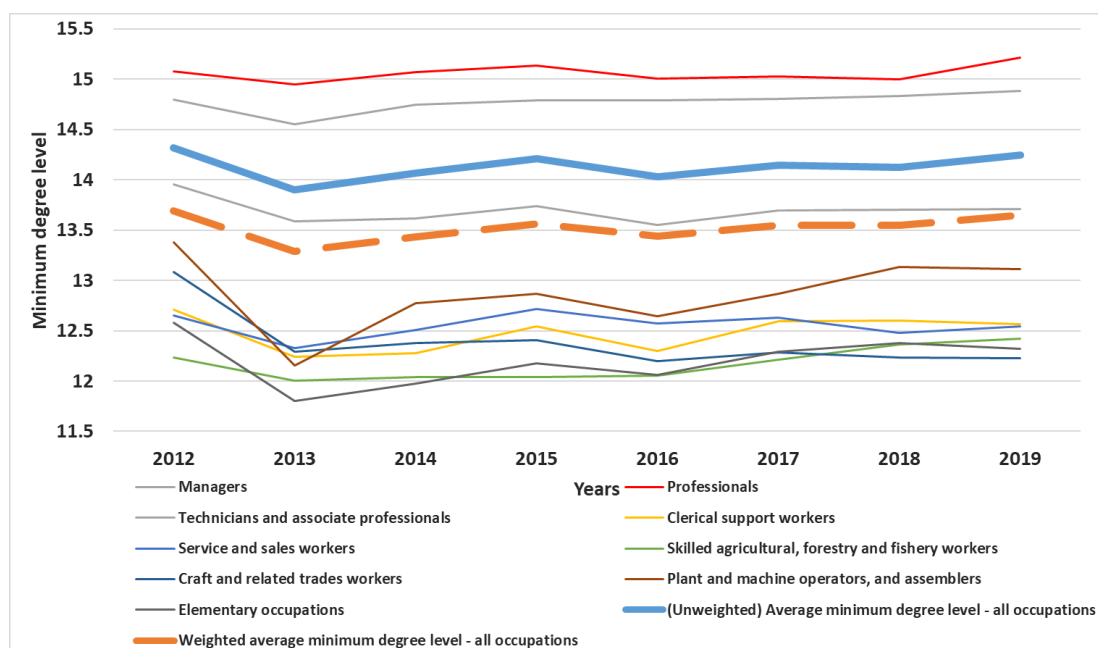
Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Section 8. Conclusions

The analysis contained in the present paper proposes an assessment of the statistical properties and distributional characteristics of Burning Glass Technologies (BGT) data, at the occupational group level.

The analysis encompasses all economies for which BGT data are currently available for at least five years. These are Australia, Canada, New Zealand, Singapore, the United Kingdom and the United States and data are available for the period 2010-19.

Assessing the representativeness of BGT data against official data we observe that, while BGT exhibit good statistical properties for most years and countries considered, there are some cases requiring attention, especially when compiling indicators and when analyses are to be generalised for policy-relevant purposes. Among the issues observed, some breaks in the series emerge, and relative over- and underrepresentation of some occupational groups. These call for the need to check the years and economy-specific data that can be used, depending on the purpose of the analysis.

In addition, we propose weighting schemes aimed at making BGT-based analysis representative at the occupation and country levels. It would be advisable to use such weights in analysis to be generalised to inform policy. Failing to do so, may lead to drawing incorrect policy conclusions, as statistics may be excessively informed by a subset of the population and/or influenced by the way in which representativeness changes over time.

These drawbacks notwithstanding - some of which are more general and relate to the very nature of online job posting data - BGT appears as a good source of information and allows an up-to-date snapshot of jobs and skills demand patterns and trends.

Endnotes

[1] Data related to about ten additional (European) countries have been also obtained by the OECD, but they relate to a reduced subset of the years considered in the present analysis.

[2] As long as the changes in the job postings captured over time are orthogonal to changes in the variables studied, this should not affect the soundness of the analysis and its results.

[3] In what follows, data are aggregated on a yearly basis to deal with the relatively high volatility of BGT data as well as to avoid seasonality. More details can be found in the statistical analysis part of the paper.

[4] The high percentage observed in the case of managers triggers questions about a number of issues, including possible labour supply issues or data duplications, which would need to be further investigated.

[5] BGT data for the United States are also available for 2007, but not for the years 2008 and 2009. Hence, the analysis here is limited to the period 2010-19.

[6] BGT data contain information on occupation using SOC occupational classification, whereas official employment statistics are available following the ISCO-08 occupational classification. For the purpose of comparison, the occupational information in SOC is converted to ISCO-08 using a crosswalk. Most SOC codes are linked to only one 1-digit ISCO-08 code, but the few SOC codes that are linked to more than one 1-digit ISCO-08 code are assigned to ISCO-08 codes using proportions calculated based on the 1:1 matched codes in the same 2-digit SOC sub-sample.

[7] The median number of years of tenure with the current employer for employed wage and salary workers was 4.2 years in 2018, suggesting a turnover rate of $\frac{1}{4.2}$ =23.8% (U.S. Bureau of Labour Statistics, 2020). The turnover rate is somewhat smaller for "Managers and Professionals", suggesting that the larger number of BGT job openings for these occupations is unlikely to reflect a higher turnover rate.

[8] The fact that a job opening is posted online does not impinge upon the possibility that the same job may appear e.g. on newspapers, may be shared with head-hunters, or even more simply displayed in physical spaces like cafés, bars, or outside the very premises of a company.

[9] Growth rates based on two base years: $Growth_{it} = (\frac{Q_{it}}{0.5(Q_{it-1}+Q_{it})}$ - 1) * 100;

Three-year moving average growth rates: $Growth_{it} = \frac{(Growth_{it} + Growth_{it-1} + Growth_{it-2})}{3}$

[10] The growth in total BGT data was presented in Table 4 and was, for instance, 21% in 2011, 28% in 2013 and 29% in 2018, whereas negative growth rates are observed for 2012 and 2017.

[11] This benchmark is based on the average difference for all countries/years/occupations, which is estimated to be about 14%.

[12] There are many reasons possibly explaining such differences, including the very way in which companies may or may not decide to post jobs online. Independently of the reasons behind these differences, it is important to design weights able to make online job openings data representative of the labour force.

[13] Average job tenure in Canada in 2019 was 101.5 months for all occupations and 148.2 months for Management occupations. Source: Statistics Canada. Table 14-10-0305-01 Job tenure by occupation, annual).

[14] In the case of Australia and New Zealand, the analysis relies on ANZSCO, as both BGT data and LFS employment data are available in ANZSCO and there are issues in converting available data into ISCO-08 classes, as discussed when proposing the statistics related to Australia.

[15] SSOC (for Singapore) and ANZSCO (for Australia and New Zealand) are manually matched to ISCO-08 as is done in Table 38, Table 48 and Table 58. Statistics are based on all years for which data exist. This leads to the United States shaping more importantly the overall analysis, as we have two more years of data about for the United States than for the other economies.

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Annex A. Complementary Tables and Figures

Table A 1. Share, BGT data in relation to employment by occupation figures, United States, 2010-19

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
11	Chief Executives, Senior Officials and Legislators	33%	7%	1%	8%	59%	8%	9%	9%	115%	7%
12	Administrative and Commercial Managers	32%	58%	38%	40%	39%	67%	66%	59%	50%	67%
13	Production and Specialized Services Managers	14%	28%	34%	23%	18%	22%	42%	21%	22%	42%
14	Hospitality, Retail and Other Services Managers	213%	282%	295%	311%	293%	320%	32%	273%	370%	430%
21	Science and Engineering Professionals	19%	25%	25%	26%	25%	26%	25%	24%	31%	38%
22	Health Professionals	96%	104%	28%	31%	34%	61%	59%	59%	54%	49%
23	Teaching Professionals	4%	5%	6%	8%	7%	8%	7%	7%	12%	12%
24	Business and Administration Professionals	23%	27%	21%	26%	26%	29%	30%	28%	34%	29%
25	Information and Communications Technology Professionals	.	.	.	.	.	.	.	.	.	96%
26	Legal, Social and Cultural Professionals	12%	14%	14%	18%	17%	16%	16%	13%	17%	20%
31	Science and Engineering Associate Professionals	7%	11%	11%	13%	13%	14%	14%	13%	18%	21%
32	Health Associate Professionals	20%	21%	17%	19%	21%	28%	27%	24%	27%	31%
33	Business and Administration Associate Professionals	14%	17%	16%	20%	20%	24%	24%	20%	27%	31%
34	Legal, Social, Cultural and Related Associate Professionals	12%	13%	15%	22%	23%	21%	21%	18%	25%	31%
35	Information and Communications Technicians	155%	85%	194%	214%	200%	215%	195%	194%	263%	41%
41	General and Keyboard Clerks	5%	6%	5%	7%	7%	8%	8%	8%	11%	14%
42	Customer Services Clerks	8%	10%	10%	14%	14%	16%	16%	15%	20%	24%
43	Numerical and Material Recording Clerks	6%	8%	8%	12%	12%	16%	16%	16%	20%	16%
44	Other Clerical Support Workers	3%	4%	3%	5%	6%	7%	7%	7%	8%	12%
51	Personal Services Workers	4%	4%	5%	8%	8%	8%	8%	7%	12%	15%
52	Sales Workers	8%	8%	7%	13%	15%	17%	17%	15%	19%	18%
53	Personal Care Workers	21%	27%	28%	49%	67%	48%	48%	46%	84%	11%
54	Protective Services Workers	3%	4%	4%	6%	6%	9%	9%	8%	10%	12%
61	Market-oriented Skilled Agricultural Workers	2%	2%	2%	4%	3%	7%	6%	7%	9%	15%
62	Market-oriented Skilled Forestry, Fishery and Hunting	4%	4%	6%	8%	12%	8%	8%	8%	11%	20%
63	Subsistence Farmers, Fishers, Hunters and Gatherers	1%	2%	2%	2%	2%	2%	2%	2%	3%	4%
71	Building and Related Trades Workers (excluding Electricians)	3%	4%	4%	6%	6%	6%	6%	5%	7%	9%
72	Metal, Machinery and Related Trades Workers	6%	8%	6%	9%	9%	10%	9%	9%	12%	12%
73	Handicraft and Printing Workers	3%	2%	4%	5%	6%	6%	6%	3%	4%	11%
74	Electrical and Electronic Trades Workers	7%	9%	9%	9%	9%	9%	9%	10%	14%	19%
75	Food Processing, Woodworking, Garment and Other Craft and Related Trades Workers	4%	5%	5%	6%	7%	9%	9%	7%	10%	12%
81	Stationary Plant and Machine Operators	1%	2%	2%	3%	3%	3%	3%	3%	5%	6%
82	Assemblers	31%	40%	37%	48%	60%	60%	61%	18%	24%	6%
83	Drivers and Mobile Plant Operators	8%	10%	9%	15%	19%	45%	44%	34%	35%	21%
91	Cleaners and Helpers	3%	3%	4%	5%	6%	6%	6%	6%	12%	16%
92	Agricultural, Forestry and Fishery Labourers	2%	2%	2%	3%	3%	3%	3%	3%	5%	7%
93	Labourers in Mining, Construction, Manufact. and Transport	2%	2%	4%	3%	3%	7%	3%	3%	5%	6%
94	Food Preparation Assistants	1%	1%	1%	3%	3%	4%	4%	4%	7%	8%
95	Street and Related Sales and Services Workers	.	.	.	.	.	.	.	.	.	2%
96	Refuse Workers and Other Elementary Workers	9%	11%	6%	16%	19%	11%	22%	21%	32%	40%

Note: BGT shares are calculated dividing BGT data frequencies by employment by occupation figures at two digit ISCO-08 occupational levels. Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

Figure A 1. Growth rates, BGT versus OES data, "Managers" and "Professionals", US, 2011-2019
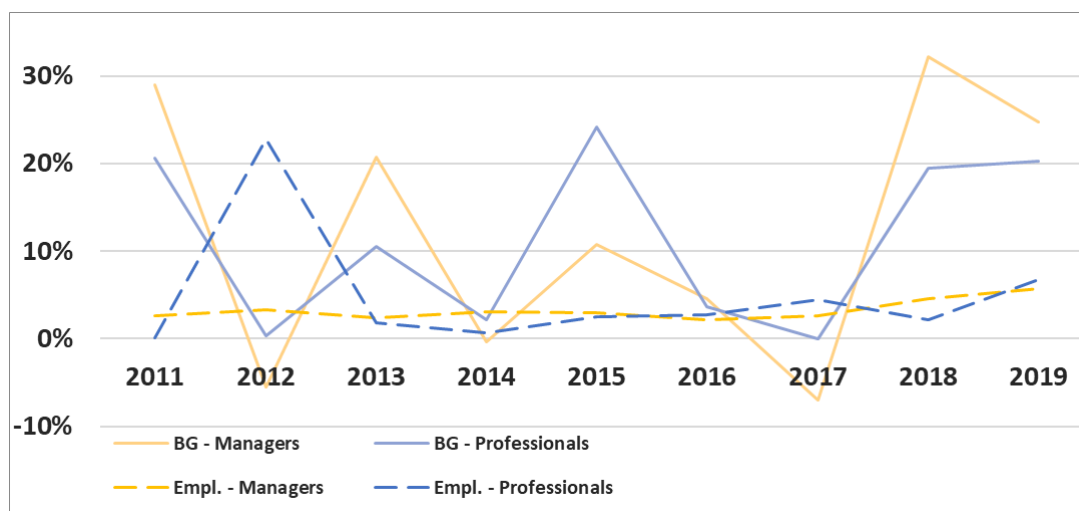
Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and United States Occupational Employment Statistics (OES) Survey (2020).

Table A 2. Growth rates in BGT data, United States, calculated using two base years

		2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers	12.7%	-2.9%	9.4%	-0.2%	5.1%	2.2%	-3.6%	13.9%	11.0%
2	Professionals	9.3%	0.2%	5.0%	1.0%	10.8%	1.8%	0.0%	8.9%	9.2%
3	Technicians and associate professionals	9.2%	-0.5%	10.0%	0.6%	4.5%	5.1%	-3.2%	13.1%	12.4%
4	Clerical support workers	9.6%	0.5%	17.7%	1.8%	3.1%	5.5%	-1.5%	13.1%	10.7%
5	Service and sales workers	6.7%	-0.6%	26.9%	6.6%	-4.7%	6.2%	-3.6%	17.4%	11.7%
6	Skilled agricultural, forestry and fishery workers	8.4%	4.7%	24.3%	-3.9%	2.8%	10.2%	-3.9%	20.6%	26.0%
7	Craft and related trades workers	8.5%	-0.3%	14.6%	2.7%	-4.0%	8.8%	-6.0%	17.9%	11.0%
8	Plant and machine operators, and assemblers	13.9%	-2.5%	22.8%	13.6%	7.9%	30.2%	-10.5%	4.6%	-12.0%
9	Elementary occupations	11.8%	2.5%	18.7%	7.4%	-3.0%	10.1%	-0.6%	24.4%	13.2%
	Total of all occupations (weighted)	9.7%	-0.4%	12.2%	2.7%	4.6%	6.0%	-2.7%	12.6%	9.8%

Note: Growth rates are calculated by the following formula: $\llbracket Growth \rrbracket\_{it} = \left(\frac{Q_{it}}{\llbracket 0.5(Q) \rrbracket_{it-1} + Q_{it}} \right) - 1) * 100$,
where I is the ISCO-08 occupational group considered, with $i \in \{1, 2, \ldots, 9\}$ and t the focal year, with $t \in \{2011, 2012, \ldots, 2018\}$.
Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table A 3. Growth rates in BGT data, United States, calculated using 3 years averages

		2013	2014	2015	2016	2017	2018	2019
1	Managers	14.7%	4.9%	10.4%	5.0%	2.7%	9.9%	16.7%
2	Professionals	10.5%	4.3%	12.3%	10.0%	9.3%	7.7%	13.3%
3	Technicians and associate professionals	13.9%	7.5%	10.9%	7.1%	4.6%	11.6%	17.4%
4	Clerical support workers	21.7%	15.9%	17.6%	7.2%	5.0%	12.9%	17.1%
5	Service and sales workers	28.9%	28.9%	26.2%	6.2%	-0.9%	16.2%	20.5%
6	Skilled agricultural, forestry and fishery workers	30.8%	22.3%	20.9%	7.0%	7.0%	22.4%	38.2%
7	Craft and related trades workers	17.5%	13.1%	10.7%	5.7%	0.1%	17.2%	19.0%
8	Plant and machine operators, and assemblers	28.8%	28.6%	35.9%	45.1%	28.3%	25.8%	-10.2%
9	Elementary occupations	25.9%	22.4%	18.7%	10.8%	5.1%	28.6%	31.3%
0	Total of all occupations (weighted)	16.1%	10.8%	14.3%	9.3%	5.7%	12.1%	15.1%

Note: Growth rates are calculated by the following formula: $Growth3yma_{it} = \frac{(Growth_{it} + Growth_{it-1} + Growth_{it-2})}{3}$, where i is the ISCO-08 occupational group considered, with $i \in \{1, 2, \dots, 9\}$ and t the focal year, with $t \in \{2013, 2014, \dots, 2018\}$.
Source: Authors' own calculations based on Burning Glass Technologies' data (2020).

Table A 4. Occupational group and time-specific representativeness weights for the United States, using the Standard Occupational Classification (SOC) code

	SOC	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
11	Management Occupations	0.36	0.34	0.37	0.39	0.42	0.42	0.45	0.47	0.47	0.47
13	Business and Financial Operations Occupations	0.69	0.65	0.65	0.71	0.77	0.72	0.79	0.79	0.81	0.81
15	Computer and Mathematical Occupations	0.18	0.18	0.19	0.24	0.26	0.24	0.30	0.29	0.27	0.27
17	Architecture and Engineering Occupations	0.54	0.46	0.44	0.53	0.56	0.57	0.65	0.61	0.60	0.58
19	Life, Physical, and Social Science Occupations	0.78	0.79	0.71	0.86	0.77	0.80	0.81	0.83	0.85	0.90
21	Community and Social Service Occupations	1.33	1.41	1.29	1.20	1.17	1.18	1.30	1.43	1.35	1.18
23	Legal Occupations	0.73	0.68	0.55	0.61	0.78	1.15	1.36	1.50	1.27	1.17
25	Education, Training, and Library Occupations	3.07	2.94	2.27	2.17	2.14	2.34	2.56	2.54	2.00	2.13
27	Arts, Design, Entertainment, Sports, and Media Occupations	0.51	0.56	0.53	0.47	0.49	0.55	0.62	0.61	0.59	0.57
29	Healthcare Practitioners and Technical Occupations	0.45	0.51	0.53	0.59	0.56	0.43	0.41	0.38	0.51	0.53
31	Healthcare Support Occupations	1.30	1.49	1.52	1.46	1.39	1.34	1.35	1.37	1.39	1.94
33	Protective Service Occupations	2.81	2.83	2.64	2.49	2.50	2.08	2.13	2.15	2.04	1.90
35	Food Preparation and Serving Related Occupations	3.52	4.04	3.46	2.37	2.21	2.65	2.31	2.28	2.05	1.87
37	Building and Grounds Cleaning and Maintenance Occupations	3.04	3.19	2.95	2.66	2.42	2.98	2.88	2.67	1.87	1.64
39	Personal Care and Service Occupations	1.64	1.69	1.55	1.17	1.07	1.99	2.51	2.78	1.49	1.00
41	Sales and Related Occupations	0.83	0.84	0.94	0.82	0.81	0.86	0.85	0.89	0.90	0.84
43	Office and Administrative Support Occupations	1.71	1.69	1.64	1.47	1.50	1.52	1.54	1.46	1.41	1.21
45	Farming, Fishing, and Forestry Occupations	6.18	5.94	5.51	4.16	4.56	5.03	5.09	5.02	4.73	3.59
47	Construction and Extraction Occupations	3.98	3.97	3.88	3.41	3.46	4.33	4.07	4.22	3.51	3.40
49	Installation, Maintenance, and Repair Occupations	1.20	1.26	1.27	1.20	1.21	1.31	1.30	1.38	1.21	1.13
51	Production Occupations	2.94	2.60	2.54	2.46	2.24	2.95	2.62	2.47	2.25	2.23
53	Transportation and Material Moving Occupations	1.99	1.80	1.86	1.53	1.25	1.19	0.74	0.87	0.97	1.69

Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and the United States Occupational Employment Statistics (OES) Survey (2020).

Table A 5. Occupational group and time-specific representativeness weights for the United Kingdom, using the United Kingdom's Standard Occupational Classification (UKSOC) 2010 code

	UKSOC	2012	2013	2014	2015	2016	2017	2018	2019
1	Managers, directors and senior officials	0.89	0.94	0.91	0.93	0.96	0.97	1.03	1.10
2	Professional occupations	0.58	0.60	0.56	0.56	0.59	0.58	0.63	0.68
3	Associate professional and technical occupations	0.82	0.81	0.81	0.80	0.82	0.83	0.84	0.82
4	Administrative and secretarial occupations	1.30	1.38	1.34	1.38	1.21	1.20	1.11	1.04
5	Skilled trades occupations	1.77	1.70	1.87	1.76	1.65	1.74	1.59	1.57
6	Caring, leisure and other service occupations	1.93	1.74	1.66	1.82	1.71	1.66	1.48	1.34
7	Sales and customer service occupations	0.72	0.72	0.80	0.81	0.79	0.82	0.87	0.85
8	Process, plant and machine operatives	2.09	1.87	2.25	2.14	2.19	2.08	1.70	1.63
9	Elementary occupations	2.50	2.23	2.74	2.60	2.61	2.55	2.06	1.81

Source: Authors' own calculations based on Burning Glass Technologies' data (2020) and the Annual Population Survey (2020).