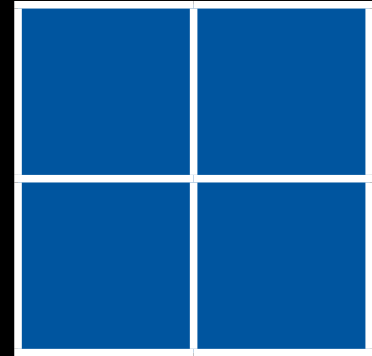# Singapore's Graduate Labour Market, 2013/2017: A Task-based Analysis

Golo Henseke and Francis Green

LLAKES Research Paper 68

Centre for Learning and Life Chances in Knowledge Economies and Societies

LLAKES is an ESRC-funded Research Centre - grant reference ES/J019135/1.

To request printed copies of this paper or other LLAKES Research Papers,
please contact the LLAKES Centre - ioe.llakescentre@ucl.ac.uk.

To view this and other LLAKES Research Papers online, please visit www.llakes.ac.uk.

LLAKES Research Paper 68

Singapore's Graduate Labour Market, 2013/2017: A Task-based Analysis

Golo Henseke and Francis Green.

To view this and other LLAKES Research Papers online, please visit www.llakes.ac.uk.

Golo Henseke and Francis Green '' Singapore's Graduate Labour Market, 2013/2017, published by the Centre for Learning and Life Chances in Knowledge Economies and Societies at: http://www.llakes.ac.uk

List of Contents

Abstract

1. Introduction

2. The Context of Singapore's Graduate Labour Market

3. Definitions, Data, and Methods

4. Empirical Findings

5. Conclusions and Implications

References

Abstract

The importance of higher education among the resident Singapore workforce has been increasing. Yet there are few studies that have considered the coevolution of higher education attainment in the workforce and the utilisation of graduate skills. To do so, we have drawn on the conceptual distinction between graduate jobs and non-graduate jobs. However, we have also explicitly recognised that there is considerable variation among graduate jobs. We distinguish further between 'task-warranted' and 'task-unwarranted' graduate jobs. In both types a degree is required to obtain these jobs, but in the former, task-warranted graduate jobs the job involves carrying out typical graduate-level tasks; while the latter require only low levels of graduate-level tasks. In task-unwarranted graduate jobs, employers still require a degree because it helps sort applicants for their hard-to-observe skills – the logic that lies behind signalling and credentialism. To operationalise the distinction, and to analyse the Singapore graduate labour market, we use data on task use in two surveys, one in 2013 the other in 2017.

We find that the continued expansion of higher attainment in the resident workforce between 2013 and 2017 is met by a similarly-strong growth in graduate jobs over the period. This growth of graduate jobs can be fully explained by upskilling: an increasing use of graduate-level tasks within jobs. The share of task-warranted graduate jobs expanded sharply from 21% to 32% of jobs, while the share of task-unwarranted graduate jobs fell slightly. Despite these positive signs, it remains the case that about 1 in 3 employed graduates were in jobs that were on average not making full use of graduate skills.

Complementing these trends in supply and demand, the pay premium associated with higher education remained stable and high: graduates' pay was more than double that of secondary school leavers. Yet there is dispersion among graduates' pay, and in particular a wage penalty of 35% for underemployed graduates in 2017. There was a much smaller wage penalty (16%) for being in an task-unwarranted graduate job as opposed to a task-warranted graduate job. Neither of these had significantly changed from 2013. In both years attainment and utilisation of a degree is stratified by parents' highest level of education. Given the very substantial pay premium, and the considerable pay penalty for underemployment, this stratification is likely to have adverse consequences for social mobility in Singapore.

1 Introduction[1]

Around the developed world, graduate labour markets have been evolving in response to two major trends: the massification of higher education that began in the late 20th century led by the United States, and the ongoing rise in the demand for high-skilled jobs that has accompanied the technological transformation of work for several decades. While the supply of tertiary-educated people to the labour market subsequently grew universally, especially as younger workers educated to higher levels replaced those from earlier generations, the share of high-skilled jobs also increased in most countries (Marginson, 2016; Goldin and Katz, 2008; Machin and Van Reenen, 1998; Autor et al., 2003).

Nevertheless, a concern in many western countries is that the expansion of graduate jobs has not been fast enough to match the rising numbers of young graduates, each with their elevated aspirations for high-skilled employment (Verhaest and Van der Velden, 2012; Kiersztyn, 2013; Green and Henseke, 2016a; Holmes and Mayhew, 2016). One recent paper suggests that the demand for higher level skills in the United States, often a leading economy presaging trends elsewhere, has entered a 'reversal' with skills stagnating or declining, with the consequence that an increasing share of graduates takes up formerly middle-skilled jobs (Beaudry et al., 2016). At the same time, a growing percentage jobs set a Batchelor's degree as their minimum educational requirement (Blair and Deming, 2020; Hershbein and Kahn, 2018; Modestino et al., 2019). This trend contrasts with little overall upskilling and even a reversal in some skill domains in the US labour market (Freeman et al., 2020). In the US context, it thus seems conceivable that educational upgrading has led to a rising number of supposedly graduate jobs for which a degree has become essential for employment in them, even if the skills acquired in university seem unnecessary for doing the job (Fuller and Raman, 2017).

In Europe, the supply of tertiary labour has generally risen modestly faster than the growth of high-skilled jobs over the decade from 2005 to 2015, and in several the excess growth of supply over demand has been substantial, leading to rising under-employment (Green and

---

Henseke, 2019). This growth of excess supply has arisen, either because the supply of tertiary-level labour has grown especially fast, or because there has been only slow growth of, or even a decline in the demand for high-skilled labour. Some countries (e.g. Greece, Hungary and Poland) have also seen falls in the conventional wage premium for those that are educated to tertiary level. In contrast, a few other countries (e.g. Germany, Estonia) have seen high-skilled jobs expanding as fast as the supplies of tertiary graduates and a stable or rising graduate wage premium. Rising underemployment is a concern because it indicates a market imbalance which could take very many years for uninhibited market processes to bring back towards an equilibrium. Underemployed graduates are widely found to experience a long-term 'scarring' in the labour market, including reduced pay, lower job satisfaction, and lower well-being than graduates who are matched to graduate jobs (Green and Henseke, 2016a). Notwithstanding education's external benefits, rising underemployment may also indicate a misallocation of private and government education spending.

Similar concerns have been expressed about East Asian countries, where it is found that the massification of higher education has not delivered widely hoped-for benefits in terms of rising social mobility, and where the working conditions of graduates are widely reported to have fallen short of expectations (Mok, 2016a; Mok and Neubauer, 2016; Mok, 2016b). There is, however, little published formal evidence on the evolution of graduate jobs, alongside that of the supply of graduates and the growth or decline of graduate pay levels.

In this paper, we focus on Singapore. We ask whether the graduate labour market in Singapore is similar to the majority European pattern of rising underemployment of graduate labour (Green and Henseke, 2020), or whether, like a minority of European countries, it has been able to increase the utilisation of labour in high-skilled jobs alongside changes in its supplies of tertiary-educated labour. Specifically, we will analyse how degree requirements have changed and the extent to which upskilling can explain the trend towards degree qualification in the labour market. For the analysis we distinguish 'task-warranted' from 'task-unwarranted' graduate jobs. The former requires graduate-level tasks to be carried out effectively, whereas the latter uses the degree qualification as a signal for unobserved ability to carry out unobserved tasks more effectively.

2

Singapore is of interest because, while small in terms of population, it is a well-developed knowledge economy. Its citizens have a high propensity to invest in education which is delivered in a distinctive school system that is very successful as judged by performance in PISA rankings. Its workforce has multiple segments, including a large non-citizen workforce comprised of both high-skilled and low-skilled migrant labour. According to Habibi (2019), Singapore is an exception among East Asian countries, in that its government's policies have controlled the growth of higher education. In addition, it has had a measured evolution of training and sub-degree tertiary education. Here, we contribute by examining the recent state of the Singaporean graduate labour market through the lens of 'graduate jobs'.

We use data from Skills Utilisation 2 Survey 2013 (SU2), the Singapore Skills and Learning Study 2017, and, for international comparison, the Survey of Adult Skills (PIAAC). The contributions of this paper are to track both the supply of graduates and the prevalence of graduate jobs in Singapore over recent years; at the same time, we also report the key wage trends among graduates. We find clear evidence of labour market upskilling: The employment share of graduate jobs expanded substantially alongside greater graduate skill requirements. The proportion of graduates in task-warranted graduate jobs rose, while the pay premium associated with higher education and the wage penalty associated with underemployment and underutilisation remained stable. The patterns are largely consistent across gender and age. Nonetheless, about 1 in 3 employed graduates were in jobs that were on average not making full use of graduate skills in 2017. Moreover, access to higher education and graduate outcomes are stratified by parents' highest level of education.

The next section briefly reviews the context of Singapore's graduate labour market: the Singapore higher education system and the growth of the number of graduates, the place of HE in the government's overall skills policy, and existing literature from previous studies. It then describes how the concept of the graduate job can be used to help characterise graduate job markets, and develops this concept further by distinguishing between 'task-warranted' and 'task-unwarranted' graduate jobs based on the tasks undertaken. The rest of the paper then applies these concepts to the understanding of the Singapore graduate labour market in 2013 and 2017. Section 3 provides details on our data sources, samples, and important variables and then presents descriptive statistics. Our findings are given in section 4.

3

2 The Context of Singapore's Graduate Labour Market

Singapore's education system has the characteristics of a Confucian model in the context of a small country, with strong and competent state control, a sense of family duty to concentrate on education, and increasing private funding (Marginson, 2011; Dimmock and Tan, 2016d). Its core institutions are comprised of hybrid school-led post-secondary and tertiary education systems, with a strong emphasis on workplace skills, and on aiming to anticipate and match skills supply and demand. The system compares to other hybrid post-secondary education systems in the Netherlands and Denmark which also combine school-led training with workplace skills formation in polytechnic education.

The supply of high-skilled labour

As an advanced knowledge economy, it could be expected that there would be a high and growing demand for high-skilled labour in Singapore. To meet this demand the country is distinctive in that it has a well-developed short-cycle tertiary education sector led by its five polytechnics, which has delivered a considerable proportion of employers' high-skill needs. Yet those educated to degree level have become an important segment of Singapore's tertiary labour force, not least because university graduates are expected to be an essential component of the skills deepening effort (discussed below). To meet future demands for graduate labour, there are now six autonomous universities in this small city state: the National University of Singapore, Nanyang Technological University, Singapore Management University, Singapore University of Technology and Design, Singapore Institute of Technology and Singapore University of Social Sciences with a collective enrolment of more than 100,000. In addition, there are many private campuses offering qualifications from foreign higher education institutions.

In 2019, the size of the workforce was 3.7 million, of whom 2.3 million were Singapore citizens or permanent residents (Ministry of Manpower, 2020b). Some 31 percent of these had professional qualifications, diplomas or post-secondary but non-tertiary education qualifications, while 38 percent were university graduates, up from 26.7% in 2009.

The remaining 1.4 million non-residents – 38 percent of the workforce – are highly segmented (Ministry of Manpower, 2020a). A 'talent gap' at the high end of the economy has been partly filled by an influx of ex-patriate graduates: professionals, managers and executives with Employment Passes make up about one in ten non-resident workers. A similar proportion hold S Passes for degree or diploma holders concentrated in healthcare and social services; the rest of the non-resident workforce, roughly eight in ten, (or about 30 percent of the whole workforce) are Work Permit holders or Foreign Domestic Workers. The analysis below perforce applies solely to the resident workforce, since the skills data do not cover the other components of the workforce.

Table 1: Residential labour force and Educational attainment in Singapore, 2009-2019

Mid-Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Resident Labour Force ('000)	1,985.7	2,047.3	2,080.1	2,119.6	2,138.8	2,185.2	2,232.3	2,257.6	2,269.7	2,292.7	2,328.5
Post-Secondary (Non-Tertiary)	7.8	12.0	11.8	12.0	11.6	11.5	12.0	11.5	11.3	11.5	11.2
Diploma & Professional Qualification	16.9	18.1	18.2	18.7	18.4	19.5	19.3	19.4	18.9	19.5	20.1
Degree	26.7	27.6	28.3	29.4	31.5	32.0	32.2	33.7	35.7	36.7	37.5

Source: https://stats.mom.gov.sg/Pages/Labour-Force-Summary-Table.aspx

Previous Literature on Singapore's Graduate Labour Market

Previous literature on Singapore's higher education has mainly focused on the issues of how far its universities are succeeding in becoming a global education hub and in managing the massification of HE without lowering standards, and on related issues of governance, including the potential contradiction between strong state control and the academic demand for autonomy exhibited by the most successful universities (Ng, 2013; Lee, 2016; Mok and Neubauer, 2016).

Studies of Singapore's graduate labour market, however, are scarce. Appold (2005) analyses changing occupation structures in the 1990s alongside the growing university participation and subsequent supply of graduates. He concluded that Singapore at that time was already

experiencing rising overeducation and credentialism, and falling relative graduate wages, similar to the experiences of several other countries in both East Asia and Europe. This was, however, arguably a surprising finding, given the historical orientation of the Singapore government towards manpower planning (Ashton et al., 1999). Moreover, Appold's analysis also notes the simultaneous trend towards increasing import of high-skilled labour, a contradiction not fully resolved in the analysis. Habibi (2019), by contrast, singles out Singapore and Hong Kong, in contrast with Middle Eastern states, for having political leaders with sufficient strength to push back against middle-class pressure to over-expand access to universities. The consequence, Habibi argues, is that Singapore achieves a balance between the skill composition of jobs and that of the workforce. One incomplete aspect of Habibi's argument arises from the fact that the share of high-skilled jobs is especially high in Singapore: it is thus not clear whether the balance achieved is due to the control over graduate supply, or its higher level of demand. Moreover, neither Habibi (2019) nor the earlier analysis by Appold (2005) present any direct evidence on graduate jobs or on graduate underemployment to support their different conclusions.

Increasing focus on higher education.

The need for a new analysis of Singapore's graduate labour market at this juncture arises from the expected ongoing rise in supply of graduates in the labour force, but also from Singapore's evolving skills policy.

Till recently, the focus of skills supply policy has been on non-tertiary education. Before 2015, the policy was mainly for working adults entering the labour market, and for enhancing the labour market flexibility and employability of those already in the labour market. As such, the continuing education and training (CET) system was closely supported by the competency-based Workforce Skills Qualification (WSQ) system and the continuing controlled expansion of the higher education sector in order to cater for the ever-increasing larger numbers of professional, managerial and executive (PME) jobs. This past approach relied on workplaces to act as the main recruitment points for CET programmes, which meant that employer engagement had to be strong. To create an extensive employer engagement and up-take, CET provision relied on three principles: (a) content relevance (to

6

actual operation and industry needs); (b) promoting an image of training as an 'investment' and not a 'cost', supported by strong state subsidies; and (c) making training modular ('bite size') to avoid disruption for both individuals and employers.

In 2015 and 2016, the government radically changed this supply driven skills development model to one that pays twin emphases on skills utilisation and the quality of skills supply. SkillsFuture was inaugurated, a 'national movement' with programmes designed for students, individuals, employers and providers. Its aim is to transform skills development from a piece-meal, on-demand and segmented approach – that is, focusing on target groups and the distinction between pre-employment training (PET) and continuing education and training – to one that embraces the full-notion of lifelong learning. Under SkillsFuture, learning, education and training are encouraged and provided for all citizens, irrespective of employment status or age, and emphasis is placed upon "skills deepening", with "skills mastery" the ultimate objective. This new approach to lifelong learning is summarised in a recent economic strategic document:

> "With the rapid pace of technological development, our workers will need to develop deep skills to stay relevant. Two key shifts are needed. First, since technologies and jobs are likely to change throughout our lifetimes, we need to go beyond the pursuit of the highest possible academic qualifications early in life to focus on acquiring and using knowledge and skills throughout our lives. Second, as technology replaces routine tasks, our people need to acquire deeper skills to create value, and more importantly ensure that they can utilise their skills effectively on the job." (*Report of the Committee on the Future Economy*, 2017: 6).

This shift of policy emphasis has naturally led to an increased emphasis on the sort of high-skills flexibility for which university education is most suited. Indeed, as early as 2012, the government announced its intention to raise the Cohort Participation Rate in university education from the then 27% to 40%, a goal that has been achieved in 2020 (Davie, 2020). Higher education has become the fastest growing branch of post-secondary education in Singapore. Combined intake at Singapore's six autonomous universities grew by four per cent per year since 2008, while the total intake at polytechnical institutions and the Institute

of Technical Education remained largely unchanged (Ministry of Education, 2019). At a constant growth rate of four per cent, university intake doubles approximately every 17 years. The government's motivation to expand higher education is with a keen eye on labour market trends, according to the Singapore Ministry of Education.

Even without the rising enrolments in higher education, a growth in the supply of graduate labour is expected due to the gap between the old and young workforce. According to data collected by PIAAC in 2014, 46% of 25-34-year-old Singaporean citizens and permanent residents held a Bachelor's degree or higher, compared with less than 10% in the age-group 55 and above.

Given the expected rises in supply there emerges a pressing need for information on trends in the use of Singapore graduates' skills – that is, in the parallel expansion of graduate jobs – both to understand the relative successes of the historical, controlled expansion of higher education, and to provide a baseline of information with which to assess future changes under the SkillsFuture strategy. Currently, universities run annual surveys of graduate employment 6 months after graduation (Ministry of Education, 2020). These reveal relatively high levels of employment at this point, which nevertheless vary substantively according to the subjects studied, similar to the variation found in other countries. These need to be supplemented, however, by analyses of graduate skills utilisation throughout the labour force and in comparison with other countries.

The Concept of a 'Graduate Job"

An important component of this analysis is the concept of a graduate job. Following Green and Henseke (2016), a graduate job is defined as one where ".. a substantial portion of the skills used are normally acquired in the course of higher education, including many of the activities surrounding it, and of its aftermath—the years after higher education when skills are acquired in work through graduates' acquired faculty for learning them" (Green and Henseke, 2016b: p.3). With this concept it is also important that an indicator of a graduate jobs should be based on skills utilisation. Alternative approaches to measurement relying on skills utilisation follow either a statistical approach based on task-based survey analysis of jobs (Henseke and Green, 2017) or expert-based assessments of required qualifications (Elias and Purcell, 2013) including those used for official occupation classifications globally.

Having defined a graduate job, a graduate is said to be 'matched' if they are doing a graduate job, and to be 'under-employed' (or 'overeducated') if they are doing a non-graduate job.

Our recent studies have revealed that the prevalence of graduate jobs varies considerably across countries; among the findings, the relative quality of graduates in a nation, compared with those who acquire high skill levels through alternative vocational routes, is shown to be positively correlated with the prevalence of task-warranted graduate jobs. It is also found that high-skilled jobs have been increasing in prevalence, but in a number of countries the rate of increase has been slower than the increase of graduates in the labour force; indeed, in a few countries (Greece, Italy, Slovakia and the Czech Republic) the prevalence of high-skilled jobs has declined, even in the face of ongoing increases in graduate supply. There is also evidence that underemployment is highest in countries with higher excesses of graduate supply over graduate demand, and that underemployment increases most where the gap between the rate of expansion of the graduate labour supply and the rate of expansion of graduate jobs is the greatest (Green and Henseke, 2017).

Cross-country comparison based on the Survey of Adult Skills

To see how Singapore compares with other countries, Table 2 presents data that we have extracted through analysis the OECD's Survey of Adult Skills (SAS), which is part of its Programme for International Assessment of Adult Competences (PIAAC). In this survey, individuals can be straightforwardly classified as in a graduate job if they report being in a job where a degree or higher would be required by a current applicant to get the job. The table benchmarks the graduates and graduate jobs of Singapore residents against other high-income countries in the wider region (Korea, Japan), geographic neighbours (Jakarta (ID)), Anglophone countries (England, USA, New Zealand), and finally the Netherlands and Denmark which (as noted earlier) have somewhat similar education systems to Singapore's.

Columns (1) and (2) show the relative importance of higher and professional education in the combined role of post-secondary and tertiary training systems to prepare youth for the labour market. Singapore stands out. Close to 85% of 25-34-year-old citizens and permanent residents held some form of post-secondary qualification or above; about half achieved a university degree or equivalent. These figures are well above attainment levels in the other

9

countries in the comparison. In New Zealand, around 75 % in the same age-bracket held post-secondary qualification followed by Japan and Korea. Higher educational attainment was about 40% in New Zealand and the Netherlands.

However, the significance of Singapore's high level of post-secondary and higher education attainment among its resident population in international comparison needs to be interpreted with care, especially when the focus is on the whole labour force. The figures for other countries refer to all people (in the age group), those for Singapore refer solely to the resident population. If as a rough approximation one were to assume that between 10% and 20% of the non-resident workforce were educated to degree level (all of the Employment Pass workers and a proportion of the S Pass workers[2]), then the higher education attainment percentage of the whole workforce would be in the range 35% to 39% -- comparable to other developed nations.

A comparison of columns (3) and (1) can give insights into the mass expansion of higher education in more recent decades. In almost all countries apart from the US and Jakarta, higher educational attainment in the young generation substantially exceeds the levels in the working-age population overall. The difference in attainment was particularly large in Singapore's resident workforce (17.5 points) followed by Korea, Denmark, and England. Even without further expansion of higher education, university attainment in the workforce will rise from momentum alone.

Singapore might be expected to have a relatively low share of graduate jobs for an affluent economy, given the quality of its post-secondary training system, including the polytechnics, which are able to supply some of the required high-skilled workers through an alternative below-degree level route. Column (4) of Table 2 reports the percentage of jobs for which a degree is necessary to carry out the work satisfactorily according to workers' self-reports. The PIAAC sample suggests that about 35% of the employed residential labour force worked in self-reported graduate jobs in jobs held by Singapore residents, a seemingly relatively high share by the international comparisons.

---

[2] https://www.mom.gov.sg/passes-and-permits/s-pass/eligibility

However, the international comparison is again complicated by the restriction of the target job population: those low-skilled jobs occupied by non-residents are not included in the PIAAC sample data. If we make a similar approximate adjustment, in which it is assumed that between 10% and 20% of jobs held by non-residents – mainly those with Employment Passes or S passes – are graduate jobs, then overall the proportion of graduate jobs in the whole workforce is between 26% and 29%, which is similar to England, lower than in the US, Netherlands or New Zealand, but higher than in Denmark, Japan and Indonesia.

A comparison of columns (4) and (3) shows that there are relatively more graduate jobs than graduates among the Singapore residents, although the difference was small. In the Netherlands and Jakarta, although at lower levels, there was a substantial excess of graduate jobs over graduates. By contrast, Japanese figures reveal a greater share of graduates in the workforce than jobs that require degree qualification.

Cross-country differences in the excess supply of graduates are likely to influence the risk of underemployment. Column (5) of Table 2 reports the percentage of graduates in jobs that do not require degree qualifications according to the job holders. The percentage of underemployed graduates varies widely across countries from about one in five in the Netherlands and Singapore to above three in ten in England, Korea and Japan. It seems that the hybrid education systems for Singapore's residents and for the Netherlands are more effective at matching graduate skills supply with skills demand than either the Anglophone systems or the East Asian higher education systems of Japan and Korea. However, we remain cautious of such comparisons when the figures for the proportions underemployed in Singapore refer to only the 62% of the workforce who are residents.

How much should governments worry about graduate underemployment? A comparison of the underemployment wage penalty might at least partly reflect the average productivity gap between matched and mismatched graduates across countries. We will therefore compare the mean hourly wages of matched and mismatched graduates across countries to examine how the underemployment pay penalty in Singapore compares internationally. Table 3 reports the estimated wage differentials.

11

Table2: Graduate labour markets in international comparison, 2011-2016

Country	(1) Higher Education (25-34, %)	(2) Post-secondary and tertiary professional (25-34, %)	(3) Higher Education (25-65, %)	(4) Self-reported Graduate jobs (%)	(5) Underemployed Graduates (%)
Singapore	49.9 (1.54)	34.9 (1.46)	32.4 (0.73)	34.9 (0.90)	20.5 (1.24)
Denmark	30.8 (1.53)	21.6 (1.41)	19.3 (0.54)	20.5 (0.67)	26.3 (1.55)
Jakarta (ID)	13.3 (1.05)	7.2 (0.75)	11.3 (0.54)	17.6 (1.03)	22.7 (3.07)
Japan	34.7 (1.62)	23.4 (1.40)	26.6 (0.68)	20.9 (0.75)	41.6 (1.63)
Korea	35.9 (1.48)	26.2 (1.30)	23.9 (0.61)	22.6 (0.83)	34.9 (1.75)
Netherlands	39.7 (1.81)	1.8 (0.44)	31.1 (0.75)	37.8 (0.94)	18.6 (1.36)
New Zealand	40.1 (1.70)	23.6 (1.44)	33.5 (0.78)	33.6 (0.98)	27.0 (1.52)
United States	33.4 (1.26)	21.7 (1.16)	31.8 (0.73)	32.6 (0.93)	23.5 (1.34)
England (UK)	36.4 (1.75)	12.7 (1.21)	26.4 (0.74)	27.9 (0.97)	34.7 (1.87)

Secondary analysis of PIAAC. Column (1): higher educational attainment (ISCED5A/6) in the age-group 25-34 years. Column (2): post-secondary and professional tertiary education educational attainment (ISCED3,4/5B). Column (3): higher educational attainment (ISCED5A/6) in the age-group3-65 years. Column (4): percentage of jobs that require a degree to get according to jobholders in the employed workforce 25-65 years. Column (5): percentage of higher education graduate who work in jobs which require less than degree qualification to get in the employed workforce 25-65 years. Standard errors in parentheses.

In general, the estimates are relatively similar across the countries. The estimated pay gap varies from 0.3 log-points in relatively less unequal Denmark to 0.49 log-points in the Netherlands. The Singaporean value falls into the upper end of this range, but it is not unusually high. As in many other countries, a Singapore graduate who fails to attain a graduate job pays a considerable price. The similarity of the penalty can arise if typical non-graduate destinations for underemployment graduates are comparable and, at the same time, the inter-occupation inequalities do not vary too much across countries.

Table3: The graduate underemployment pay penalty in international comparison

Country	Mean pay penalty	N
Singapore	-0.427[***] (0.048)	1061
Denmark	-0.301[***] (0.027)	1077
Jakarta (ID)	-0.430[*] (0.199)	241
Japan	-0.361[***] (0.041)	914
Korea	-0.315[***] (0.047)	848
Netherlands	-0.485[***] (0.069)	889
New Zealand	-0.435[***] (0.036)	986
United States	-0.482[***] (0.045)	1141
England (UK)	-0.441[***] (0.046)	879

Secondary analysis of PIAAC. Weighted OLS regression of log real gross hourly pay and a tobit regression of log real gross hourly earning bands for the US on a non-graduate job indicator and control variables for employed graduates aged 25–65 years. Control variables comprise 10-year age-groups, indicator for children, and living as single interacted with gender. Robust standard errors in parentheses.

Heterogeneity of Graduate Jobs.

Earlier studies have challenged the simplicity of the category of 'underemployment', on the grounds that graduates' skills are heterogeneous. Using partial but nevertheless informative data on graduates' skills, it was found that that some graduates in non-graduate jobs possessed lower skills than those in graduate jobs. They were found to be not under-utilising skills or at least not so much. Their status was termed 'apparent' or 'formal' overqualification (Chevalier, 2003; Green and Zhu, 2010). Various studies have showed that measures of skills underutilisation, even within homogenous qualification groups, is associated with lower pay and job satisfaction (e.g. Allen and van der Velden, 2001). These studies partially undermined the force of underemployment as a useful explanatory concept on its own. Nevertheless, since skills underutilisation studies have also suffered from a lack

13

of consensus as to how skills utilisation is properly measured, and since measures of skills heterogeneity inevitably capture only a narrow range of skills, 'underemployment' has largely retained its place as a useful concept with explanatory value in labour markets in many countries.

Within graduate jobs, however, there is also some considerable heterogeneity in the intensity and range of tasks requiring prior graduate education. The variation is not easily arranged into discrete jumps, which is why the borderline between graduate and non-graduate jobs is potentially fuzzy (see below). But in addition, not all graduate tasks can in practice be observed in any general survey of workers. The achievement of a degree qualification is typically taken as an indication that job-applicants can do or easily acquire the skills employers demand. It is therefore possible that a degree qualification is required in a job even though the observed graduate tasks are not at a high level. Credentialism arises in these cases, where employers also utilise qualification achievements as an indicator of those unobserved skills. It is also possible that qualifications only serve as an indicator in rank terms, i.e. possession of a higher qualification than other applicants is taken as the indicator of the ability to do those unobserved tasks; thus credentialism can be a source of rising qualification requirements, as the population's qualification level rises, even in the absence of changes in job skill requirements.

To capture this variation in graduate jobs, in this paper we distinguish between *task-warranted* graduate jobs --- which require degree qualifications to get and utilise a high level of observable graduate skills as measured by tasks performed; and *task-unwarranted* graduate jobs, where a degree is required even though a degree is not predicted to be warranted by the observed constellation of tasks in the job. Both these categories are distinguished from *non-graduate* jobs, that do not require higher education to access the job.

To our knowledge, Kracke et al., 2018 and Kracke and Rodrigues (2020) are the only previous studies to bring task-based analysis to bear on the study of labour market mismatch. Using data from the German labour market where occupational tasks and skills are relatively well-defined, Kracke and Rodrigues (2020) finds that both cognitive skills mismatch – where workers are in manual jobs performing tasks that do not utilise the skills

14

of the occupations where they were apprenticed – and overqualification are separately associated with a wage penalty compared with matched workers.

Research Issues

In light of the above, to characterise the state of the graduate labour market for Singapore residents, we pose two sets of questions:

RQ1: What proportion of the jobs held by Singapore resident graduates are self-reported to be graduate jobs, and among those graduate jobs, what proportion are task-warranted, involving the performance of identifiable graduate tasks, and what proportion are task-unwarranted. And how are these proportions changing over time?

RQ2: Second, complementary to the changes in these proportions and the growing share of graduates, what is the wage premium in Singapore for graduates as compared with non-graduates, and the wage penalties for graduates who are either in non-graduate jobs or task-unwarranted graduate jobs, compared with those in task-warranted graduate jobs? And how are this premium and these penalties changing over time?

3. Definitions, Data, and Methods

Defining and Measuring Graduate Jobs

The approach we deploy here to define and measure the different types of graduate jobs in Singapore uses data on the self-reported education requirements and on work tasks carried out by those working in each job. It matches those tasks to the skills typically acquired in the course of a graduate education and associated work experience.

In general, national institutional configurations and labour market circumstances will shape the mapping of graduate skills to work tasks. Organisations decide on the deployment of new technologies, how to structure work processes or what task to outsource, and thus how to design jobs. Dominant management practices, institutional characteristics of labour and product markets, and the availability and relative quality of other sources of high skilled labour will affect organisations' decisions on which qualification group to allocate to which task (Acemoglu and Autor, 2011). Though high-skill jobs will typically require graduate

labour to be carried out competently, other post-secondary qualifications may provide the required skills depending on the selectivity and quality of each country's education system.

However good an empirical differentiation of graduate jobs, there will remain an ambiguity in any simple categorisation of jobs as task-warranted graduate, task-unwarranted graduate or otherwise. There is variation in the level and types of skills deployed across jobs. Furthermore, job skill requirements are neither absolute nor precise, so that substitution among variously skilled co-workers is usually possible. Any classification of graduate jobs must assume, therefore, that ambiguity at the threshold, and the variation among jobs, are not so extensive as to generate measurement error that outweighs the benefit from a simple indicator of graduate labour markets. Moreover, a classification of graduate jobs based on skills use at work does not limit higher education's contribution for individuals and society to paid work (McMahon, 2009); nor does it imply that graduates can necessarily make use of all their skills acquired during higher education nor that graduates are the exclusive suppliers of the skills required in complex jobs.

To distinguish between job types, we draw on the task-based approach to labour market analysis (Autor, Levy, and Murnane, 2003). The approach distinguishes between routine and non-routine job task. The former are automatable tasks which can be feasibly carried out by machines or algorithms, whereas the latter are bottlenecks for automation. In general, jobs with fewer repetitions, where there is the need to learn new things to deal with unfamiliar situations, or greater levels of task discretion are thought to be less automatable. University graduates are assumed to have a competitive advantage in carrying out non-routine cognitive and interpersonal tasks that draw on creative and social intelligence (Acemoglu and Autor, 2011; Frey and Osborne, 2017). Job task profiles therefore shape graduate skills requirements (Green, 2012; Green and Henseke, 2016a,b).

Data

The primary sources of data for this paper are the Skills Utilisation 2 Survey 2013 (SU2) and the Singapore Skills and Learning Study 2017 (SLS). SLS and SU2 are the second and third iterations of the Skill Utilisation series which aims to track skills utilisation in Singapore, respectively. Both surveys drew part of their design and question wording from the British Skills and Employment surveys. They collected rich, comparable data on job tasks and

16

qualification requirements alongside job-related learning from a sample of workers aged 20-65 years (SLS: 70 years).

SU2 is a quota sample of 3,422 Singapore citizens and permanent residents who had been in paid work in the last seven days before the time of the interview. Quotas were based on ethnicity, gender, age, and dwelling type. SLS used the more satisfactory method of random probability sampling of adult citizens and permanent residents; the achieved sample was 6,298, of whom 77% were in paid work. In both cases, interviews were conducted face-to-face with self-completion modules for the job tasks requirements and wellbeing sections. SU2 achieved an overall response rate of 39%. SLS' response rate was 68% for. For this paper, we combine the surveys into a pooled file to test how the job task mix and educational requirements have changed over the three years between the survey sweeps. Besides differences in sampling methods, measurement of some importance variables differs between surveys. These differences need to be born in mind when discussing the findings.

The approximately 38% of temporary foreign workers in the employed workforce are not included in the target population in either survey. The share is larger in sectors that are usually not associated with graduate employment such as manufacturing, construction, accommodation and food services and close to zero in financial and insurance services. The focus on the residential workforce is therefore likely to bias upward the estimates of graduate employment and, possibly, graduate attainment compared with a full account of the de facto economically active population in Singapore.

The international comparison draws on the Survey of Adult Skills (PIAAC). PIAAC is a cross-nationally comparative survey of the adult population. It collects rich information on key skills in addition to educational attainment, labour force experience, lifelong learning and skills utilisation. It also offers insights into people's work including job tasks, education requirements and job autonomy as well as information on individual circumstances and socio-demographic characteristics. So far, there are PIAAC data for in total 39 countries/ economies from three rounds. Singapore fielded the survey in 2014. Most OECD countries participated in the first round in 2011/2012. As in SU2 and SLS, Singapore modified the target population to exclude temporary foreign workers and instead limit it to all Singapore

citizens and permanent residents between the ages of 16 and 65 in private households in Singapore at the time of data collection (OECD, 2019). This importation limitation should borne in mind in the discussion of the international estimates.

Educational Requirements

To measure jobs' educational requirements, SU2 and SLS asked workers "If they were applying today, what qualifications, if any, would someone need to get the type of job you have now?". Workers can select all applicable qualifications from a list of nationally recognised qualifications. The question wording was the same across both surveys, but the list of qualifications changed. Table 1 maps qualifications by survey wave into five qualification levels and their breakdown in the labour force aged 20-65 years in 2013 and 2017.

According to the survey data, there has been a surge of jobs that require a bachelor's degree or above from 29% to 38% that to get over just four years between surveys. The 9-point jump comes after a prolonged period of slow GDP growth in the aftermath of the 2008-09 financial crisis. There is a parallel here with interesting evidence from the United States, which suggests that periods of economic downturn might spur educational upgrading (Blair and Deming, 2020).

For comparison, it is worth noting that figures from a Government Job Vacancy Survey of private and public organisation with 25 employees or more, show that only 30% of all vacancies required degree qualifications in 2017 (MoM, 2018). The discrepancy between the vacancy and worker surveys is likely due to the latter surveys' focus on the resident rather than the economically active workforce.

Although some measurement error is conceivable, workers are generally well placed to assess the qualification requirements to get their jobs (Verhaest and Omey, 2006, 2012). Nonetheless, survey participants may benchmark their responses around typical qualification of workers in similar jobs or their individual educational attainment. It also possible that social desirability introduces an upward bias into individuals' self-reported assessments. Moreover, job satisfaction or wages could have a reverse effect on workers' assessment of education requirements. In addition, not every job that require degree qualifications to get them will actually utilise graduate skills. Our approach is, therefore, to

18

use job task data to condition out the variation in people's self-assessed qualification requirements that is unrelated to their job skill. Jobs task are thought to determine skills use at work and thus in combination define the level of graduate skills requirements.

Table 4: Qualifications map and the breakdown of educational requirements in 2013 and 2017.

Level	SU2 (2013)		SLS (2017)	
	%	Detailed Qualifications	%	Detailed Qualifications
no qual	7.8	None/No qualifications	10.5	No formal qualification/ Pre-primary/ Lower primary
secondary	31.7	PSLE or below Lower secondary Workplace literacy and numeracy statement of attainment (WPLN SOA) Secondary / 'O' level or equivalent	19.9	PSLE or equivalent Lower secondary Secondary ('O'/ 'N' Level or equivalent)
post-secondary	10.6	Workforce skills qualifications (WSQ) certificate 'A' level or equivalent ITE certificate	5.0	Post-secondary (non-tertiary): General ('A' level or equivalent) Post-secondary (non-tertiary): Vocational (ITE)
short tertiary	21.0	Polytechnic Diploma Workforce skills qualifications (WSQ) diploma Professional Qualifications & Other Diploma	26.2	Polytechnic diploma Professional qualification and other diploma
higher education	29.0	Bachelor's degree Workforce skills qualifications (WSQ) graduate diploma Master's degree PhD	38.4	Bachelor's or equivalent Postgraduate diploma/ Certificate Master's or equivalent Doctorate or equivalent

Job tasks

The definition and selection of job task items follows previous articles by the authors (Green and Henseke, 2016a,b; Henseke and Green, 2017) and related task-based research (Autor, 2013; Autor and Handel, 2013; Green, 2012; Spitz-Oener, 2006). SLS and SU2 ask survey participants about the importance of more than 45 job tasks including manual, literacy (reading and writing short/long documents), numeracy (calculations using addition/ fractions/ statistics), problem-solving (spotting problems, working out solutions), orchestrating others (planning others, persuading, negotiating) or computer use (importance and complexity). Each item measures the importance of the job task in the respondent's job in five steps from "essential" to "not all important/ does not apply". To study the demand for graduate skills, we concentrate on job tasks around high-level information processing, orchestration, interpersonal tasks and computer use. Each task variable is dichotomized with a value of one if a job task is deemed essential and zero otherwise.

Unlike the other task domains, the complexity of computer use was queried through a whole item battery, which changed between survey years. In SU2, the question prompt referred to computer or computerised equipment and asked respondents to select descriptors that best describe their computer use. The descriptors distinguished between straightforward, basic, moderate, complex and advanced computer use; each anchored with examples such as sending or receiving emails for basic usage or word-processing as indicator of moderate use. SLS changed that. First, the prompt specifically includes mobile devices. Second, instead of selecting appropriate descriptors, respondents reported the frequency with which they carried out specific computer tasks including using email, the internet, office applications, teleconference applications or a programming language. To derive complexity scores, we first estimate item response models for each wave separately before we predict the latent computer complexity score from the estimated parameters for computer users. From the values, we define a complex computer use indicator in each survey wave if the predicted score is a standard deviation above the sample mean of the variable. For workers who never use computers, the indicators are set to zero. It should be noted that despite our effort to create harmonised scores, the variables are not strictly

comparable across survey waves. Estimation results for the item response models can be obtained from the authors.

Table 5: Changes in degree requirements and job task profiles, 2013-2017

	(1) 2013	(2) 2017	(3) Δ.(2013-2017)	(4) Δ.(Within)
Self-reported graduate job	0.288 (0.008)	0.383 (0.007)	0.095*** (8.85)	0.092
Literacy	0.104 (0.005)	0.156 (0.005)	0.052*** (6.82)	0.049
Numeracy	0.120 (0.006)	0.171 (0.006)	0.052*** (6.47)	0.048
Dealing with people	0.823 (0.007)	0.813 (0.006)	-0.009 (-1.06)	-0.021
Giving speeches	0.288 (0.008)	0.341 (0.007)	0.052*** (4.94)	0.049
Persuading	0.455 (0.009)	0.537 (0.007)	0.081*** (7.12)	0.076
Analyzing	0.196 (0.007)	0.303 (0.007)	0.108*** (11.02)	0.104
Learning new things	0.371 (0.006)	0.526 (0.005)	0.154*** (20.64)	0.146
Continuous learning requirements	0.342 (0.008)	0.434 (0.007)	0.093*** (8.34)	0.080
Non-repetitive	0.204 (0.007)	0.085 (0.004)	-0.119*** (-14.56)	-0.116
Planning own work	0.237 (0.007)	0.292 (0.007)	0.055*** (5.41)	0.053
Concentrating on details	0.396 (0.009)	0.445 (0.007)	0.049*** (4.29)	0.038
Managing/ supervising	0.198 (0.007)	0.276 (0.007)	0.078*** (8.04)	0.087
High-level task discretion	0.274 (0.008)	0.215 (0.006)	-0.058*** (-5.87)	-0.061
Computer use	0.436 (0.009)	0.523 (0.007)	0.087*** (7.60)	0.074
Computer use complexity	0.069 (0.004)	0.189 (0.006)	0.120*** (16.36)	0.117
N	3,402	4,569	7,971	

Secondary analysis of SU2 and SLS for the resident workforce 20-65 years. Columns (1) and (2) report mean of self-reported graduate jobs in 2013 and 2017, respectively. Column (3) gives the mean differences and p-values from t-test. Column (4) calculates the changes within occupation as opposed to between occupations from a shift-share analysis.

Table 5 reports relevant descriptive statistics. It summarises the percentage of self-reported graduate jobs in the resident workforce 20-65 years, and average task intensities as well as their change from 2013 to 2017. Firstly, the sharp increase of degree requirements seems to be matched by rising job task intensities across most domains, with the exceptions of non-

21

repetitive taks content and task discretion, which fell. The latter change is consistent with international trends and provides a challenge to the hypothesis of routine-biased technological change (Freeman et al., 2020). Secondly, almost all of the changes happened *within* 2-digit occupations rather than *between* those 2-digit occupations. This has important implications for our understanding of how technological and organisational changes are manifested in the labour market. Rather than replacement or growth of whole occupations, we see changes in the job task mix and education requirements within occupations. In all, the descriptive statistics suggest that job upskilling could explain the surge in degree requirements.

Additional variables

To study graduate outcomes, we draw on survey information on educational attainment, gross monthly pay and worker-reported levels of skills utilisation. Graduates are people with a Bachelor's or higher degree.

SLS2 collects gross monthly pay as numeric value. The survey distinguishes between regular pay and other payment bonuses; self-employed report their total annual earnings before tax and deductions. By contrast, SU2 collects information on regular pay and self-employed earnings in income bands. In both surveys, we convert the values into gross hourly pay (bands) by dividing the monthly wages by 4.33 times the usual weekly working hours. Hourly pay is deflated to 2019 using the Consumer Price Index.

SU2 and SLS assess skills utilisation through a single-item Likert-type scale, but the questions changed between surveys. SU2 asked respondents to assess "How much of your past experience, skill and abilities can you make use of in your present job?" (very little, a little, quite a lot, almost all). In SLS respondents reported how much they agree or disagree with the statement "In my current job I have enough opportunity to use the knowledge and skills that I have" (Strongly agree, agree, disagree, strongly disagree). We recode the variable so that higher values indicate better skills use and normalise the responses to the [0,1] range.

In addition, we use occupation codes (SU2: SSOC 2010, SLS: SSOC 2015) to distinguish professionals, managers, executives and technicians (PMET: occupation major groups 1-3) from Clerical, Sales & Service Workers (CSS: occupation major groups 4 and 5) and

Production & Transport Operators, Cleaners & Labourers (PROD: occupation major groups 7-9).

Sociodemographic information such as age, gender, marital status or whether there are dependent children in the household serve as control variables to understand labour market segmentation. SLS includes in addition parents' educational attainment and information on the place of birth.

Table 6 summarises the descriptive statistics.

Table 6: Descriptive Statistics of important dependent and independently variables, 2013/2017

	(1)	(2)
	SU2	SLS
Graduates	0.32	0.39
Hourly pay (S$)		
Total	17.71	23.43
Graduates	27.68	36.61
Non-graduates	13.22	15.96
Skill use 2012	0.58	
Skill use 2017		0.73
PMET	0.57	0.59
CSS	0.24	0.25
PROD	0.18	0.16
Age	42.14	41.76
Female	0.51	0.48
Foreign-born		0.25
Graduate parents		0.11

Descriptive Statistics from SU2 and SLS for the employed resident workforce 20-65 years (SU2: N=3364, SLS: N=4391).

4 Empirical Findings

The job task content of graduate jobs

We saw that the employment share of get-graduate jobs rose by more than 9 percentage points between surveys. To test if upskilling can explain the surge in degree requirement, we first estimate a probit model of self-reported degree requirements on the earlier defined job tasks. Table 7 summarises the resulting average marginal effects of a unit change in job task intensity on the likelihood of degree requirements for the years 2013 and 2017. Giving speeches, the need to learn new things, low task repetition, managing others, and the importance as well as the complexity of computer use are persistently associated with degree requirements across both survey waves. By contrast, dealing with people, analyzing and learning new things have become less important predictors with time, while numeracy, persuading, non-repetitive work, and the importance of computer use have gained in importance. Conditional on the job tasks, task discretion has become a significant negative predicator for self-reported degree requirements; similar to our findings for Britain.

Table 7: Job task correlates of graduate skill requirements (Marginal effects)

	(1) 2013	(2) 2017
Literacy	0.036	0.013
	(0.024)	(0.019)
Numeracy	0.022	0.044**
	(0.023)	(0.017)
Dealing with people	0.054***	0.028
	(0.021)	(0.018)
Giving speeches	0.092***	0.102***
	(0.017)	(0.015)
Persuading	0.011	0.035**
	(0.017)	(0.015)
Analyzing	0.082***	0.041***
	(0.020)	(0.016)
Learning new things	0.118***	0.056**
	(0.023)	(0.022)
Continuous learning requirements	0.098***	0.083***
	(0.014)	(0.013)
Non-repetitive	0.054***	0.180***
	(0.017)	(0.022)
Planning own work	-0.034*	-0.030*
	(0.019)	(0.016)
Concentrating on details	0.021	0.003
	(0.016)	(0.014)
Managing/ supervising	0.145***	0.125***

	(0.017)	(0.014)
High-level task discretion	-0.020	-0.066***
	(0.016)	(0.016)
Importance of computer use	0.121***	0.222***
	(0.016)	(0.013)
Complexity of computer use	0.149***	0.133***
	(0.028)	(0.016)
N	3,402	4,569

Marginal effects after logit regression of the reported graduate job indicator on job tasks. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Given the substantial changes in the job task mix and the strong association of job tasks with degree requirements, there appears to be a clear case for a task-warranted growth of the demand for graduate skills in Singapore. A non-linear decomposition of the growth in graduate jobs confirms this (Fairlie, 2005). The decomposition splits the change into a component that is explained by changes in the job task mix and an unexplained, residual component. Table 8 summarises the results. The overall change in the share of jobs with degree requirements is entirely accounted for by the greater job task intensities. The unexplained component, which measures changes in degree requirements that are unrelated to job skills, is indistinguishable from zero.

Table 8: A decomposition of the rising self-reported graduate jobs in Singapore.

	Overall Change	Job task change	Unexplained
Coefficient	0.096***	0.096***	0.000
se	(0.010)	(0.008)	(0.011)

Results from a non-linear Oaxaca-Blinder style decomposition using SLS and SU2 job task data and self-reported degree requirements for employed residential workers 20-65 years. Bootstrapped standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In all, we find that graduate jobs are, as hypothesized, closely linked to job skills requirements defined by work tasks. The growth of jobs that demand degree qualification is fully explained by job upskilling.

However, this does not rule out that at any point some graduates might be underemployment or underutilized. In other words, some graduate might find themselves in non-graduate jobs (underemployment) or in jobs that match their qualifications but do not utilize graduate skill (matched but underutilised). Using the insights from the job task model, in the following section, we will distinguish between task-warranted and task-unwarranted graduate jobs to differentiate between matched, matched but underutilised and underemployed graduates.

Distinguishing types of graduate jobs

To distinguish between task-warranted and task-unwarranted graduate jobs, we, first, re-estimate the job task model with *self-reported degree requirements* as the dependent variable in the pooled sample. Second, from the estimates, we predict a *graduate skills requirement score* as the probability of degree requirements conditional on job task content. Next, we dichotomise the graduate skills requirement score into a low and high value range. For this, we determine an optimal cut-point which maximizes the sum of sensitivity and specificity (Youden, 1950). In this application, sensitivity is the proportion of correctly identified self-reported graduate jobs out of all jobs that require a degree to get, whereas specificity measures the proportion of actually identified non-graduate jobs out of all jobs that do not require a degree according to the job holder. The assumption is that typically qualification requirements match the skill needs to carry out the job duties. The so derived threshold is 0.297. At the threshold, sensitivity is 0.78 and specificity is 0.69. In other words, about one in five jobs (=1-0.78) that required degree qualifications to get, had task profiles similar to typical non-graduate jobs, while three out of ten (=1-0.69) jobs that did not ask for degree qualifications had task profiles similar to that of graduate jobs.

From the graduate skills requirement score together with self-reported qualification requirements, we define three types of jobs:

- Non-graduate jobs: jobs that do not require degree qualification to get, according to the job holder
- Task-unwarranted graduate jobs: jobs that require a degree to get according to the job holder, but which score below the derived threshold.
- Task-warranted graduate jobs: jobs that require a degree to get according to the job and which score above the cut-point on the graduate skills requirement score.

This threefold definition of jobs leads to an analogous definition of graduate underemployment and underutilization:

- Underemployed Graduates (UG): Graduates in non-graduate jobs
- Matched but Underutilized Graduates (MUGs): Graduates in task-unwarranted graduate jobs

- Matched Graduates (MGs): Graduates in task-warranted graduate jobs

In the following, we apply these distinctions to analyse the Singapore graduate labour market between 2013 and 2017. The aim is to examine how graduate supply and demand have changed.

Graduate attainment, graduate jobs, and graduate utilisation in Singapore

As in the vast majority of high-income countries across the world, higher educational attainment among Singapore's residential population has risen substantially over the last decade. In Singapore this has occurred despite student number caps at universities. The trends towards greater higher education attainment continued (Table 9). Higher educational attainment rose by 6 points from 33% to 39 % between both survey years. These survey figures are tolerably close to those shown by the official national figures shown in Table 1.

The earlier observed expansion of graduate skills requirements (shown in Table 5) is evident in the percentage of task-unwarranted and task-warranted graduate jobs. Whereas the former shrinks significantly from 9% to 6%, employment in the latter surges from 21% to 32%. In short, according to these estimates more Singapore citizens and permanent residents were being employed in task-warranted graduate jobs.

Interestingly, this did not significantly reduce the proportion of graduates who were underemployed, which stood at 23% in 2013 and 21% in 2017. Rather, the trend towards greater skill use is evident in a sharp reduction of matched but underutilised graduates (MUGs) from 21% to 11%.

Nonetheless, about one in three employed graduates were still not able to fully utilise their skills in 2017. In all, skills demand has continued to increase, but there remains substantial potential to improve graduate skills utilisation.

Table 9: Graduate Labour Market Trends in %, 2013-2017

	(1)	(2)	(3)	(4)	(5)
	Higher education attainment	Task-unwarranted graduate job share	Task-warranted graduate job share	Underemployed graduates (UG)	Matched but underutilised graduates (MUG)
2013	32.8 (0.85)	8.9 (0.52)	20.7 (0.73)	23.2 (1.33)	21.5 (1.29)
2017	39.0 (0.76)	6.4 (0.38)	32.3 (0.73)	21.2 (1.03)	11.5 (0.80)
Difference	6.2*** (1.14)	-2.5*** (0.64)	11.6*** (1.03)	-2.1 (1.68)	-10.1*** (1.52)

Secondary analysis of SU2 and SLS data for the employed workforce aged 25-65 in Singapore. Higher education attainment rate, employment rate of task-unwarranted and task-warranted graduate jobs, the percentage of graduates in non-graduate destinations and the percentage of graduates in task-unwarranted graduate jobs. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Graduate jobs by occupations

It is next of interest to ask where the growth in demand for graduate skills between 2013 and 2017 is located. We compare the trends in task-unwarranted and graduate jobs by occupation major group (Table 10).

Task-warranted graduate jobs are concentrated but not limited to Professionals, Managers, Executives and Technicians (PMETs); specifically in the first two major groups. By 2017, more than half of PMET jobs were task-warranted graduate jobs; up by 16 points from the 2013 value. Over the same period, the share of task-unwarranted graduate jobs dropped for PMETs. Among other occupations, the share of task-warranted graduate jobs is small but nevertheless non-negligible and expanding, especially among Clerical, Sales and Service Workers (CSS). Nonetheless, unlike among PMETs, the expansion of task-warranted graduate jobs was not accompanied by a reduction of task-unwarranted graduate job share. The estimates provide strong direct evidence for an expansion of graduate skills demands

for PMETs and a trend towards professionalisation that continues to cascade down the occupation hierarchy.

Table 10: Graduate jobs by occupation major groups, 2013 and 2017

Occupation Major Group	Task-unwarranted graduate job share (%)			Task-warranted graduate job share (%)		
	2013	2017	Δ	2013	2017	Δ
Professionals, managers, executives and Technicians (PMET)	14.1 (0.8)	8.5 (0.6)	-5.6*** (1.0)	35.1 (1.1)	51.3 (1.0)	16.2*** (1.5)
Legislators, Senior Officials and Managers	12.7 (1.3)	3.8 (0.7)	-8.9*** (1.5)	46.3 (2.0)	57.8 (1.9)	11.5*** (2.7)
Professionals	21.0 (1.9)	9.9 (1.0)	-11.1*** (2.1)	49.4 (2.3)	69.6 (1.6)	20.2*** (2.8)
Associate Professionals and Technicians	10.5 (1.2)	11.3 (1.1)	0.8 (1.6)	15.5 (1.4)	27.1 (1.5)	11.5*** (2.1)
Clerical, Sales & Service Workers (CSS)	3.0 (0.7)	4.7 (0.7)	1.7 (0.9)	1.8 (0.5)	7.0 (0.8)	5.2*** (0.9)
Production & Transport Operators, Cleaners & Labourers (PROD)	0.6 (0.3)	1.4 (0.4)	0.8 (0.5)	0.3 (0.2)	1.9 (0.5)	1.6** (0.6)

Percentage share of graduate jobs within occupation groups defined by SSOC 2010 in 2013 and SSOC 2015 in 2017 in the resident workforce 20-65 years. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Differences in graduate attainment and underemployment across gender, age and migration status

Neither higher educational attainment nor access to graduate employment is usually equally distributed across socio-demographic groups. For example, although young women have overtaken men in higher educational attainment, graduate outcome gaps persist (OECD, 2019). Depending on nations' institutional configuration of the school-to-work transition and education system, young graduates at the beginning of their career are often found to be at greater risk of underemployment and underutilisation than prime-aged graduates (e.g. Caroleo and Pastore, 2015). Migration status or the parent's educational attainment is also often found to influence attainment and continue to matter for graduate outcomes (e.g., Crawford et al, 2016; Macmillan et al., 2015; Meroni and Vera-Toscano, 2017). In short, there are good reasons to expect inequalities in access to and in the outcomes from higher education across socio-demographic groups in Singapore.

Table 11 breaks down higher educational attainment, underemployment, and underutilisation by gender, age, migration status, and parents' level of education. The latter two indicators are only available for 2017.

As elsewhere, university attainment has expanded faster in the female than in the male workforce. For 2017 we cannot rule out that attainment has converged in both groups. Nonetheless, female graduates remain more likely than males to be underemployed or underutilised in their job. About 36% of employed female graduates were not matched compared, 9 points more than in the male graduate workforce.

There remain clear age differences in attainment, although the share of university-educated workers rose faster in the age-bracket 35-65, than among under 35-year-olds. As in the pooled sample of the workforce, underutilisation dropped by gender and age while the share of underemployed graduates remained about constant. Negligible age differences in graduate destinations are indicative of well-structured school-to-work transition pathways. Nonetheless, gender differences in outcomes persist despite a general improvement in skills utilisation.

While 57 % of the resident workforce who migrated to Singapore after their 20th birthday was university-educated in 2017, this compares with just 35% for the rest of the resident workforce. In all about a quarter of the university-educated resident workforce migrated to Singapore after their 20th birthday. These high-skill migrants were slightly more likely to be matched than Singapore-born graduates with regards to qualification requirements and skills use.

Finally, there are large differences by socio-economic class in university attainment and, to a lesser extent, in graduate outcomes. Resident workers with at least one parent who graduated from university were 2.5-times more likely to have attained higher education than workers with non-graduate parents – sometimes referred to as the 'first in family' to go to university. Among those that graduated, there remained a 10-percentage point advantage to be matched to a task-warranted graduate job for workers with graduate parents. It appears that a degree qualification is not enough to equivalise graduate employment opportunities.

Table 11: Graduate attainment, underemployment and underutilisation in 2013 and 2017 by gender, age, whether born in Singapore, and whether first-in-family.

	Attainment			Under-employed Graduates (UGs)			Matched but Under-utilised Graduates (MUGs)		
	2013	2017	Δ	2013	2017	Δ	2013	2017	Δ
Men	34.5 (1.17)	39.2 (1.06)	4.7** (1.58)	22.4 (1.75)	18.8 (1.36)	-3.6 (2.22)	19.1 (1.63)	8.2 (0.95)	-11.0*** (1.89)
Women	31.2 (1.23)	38.8 (1.10)	7.6*** (1.65)	24.1 (2.02)	23.9 (1.56)	-0.2 (2.56)	23.5 (2.02)	13.3 (1.24)	-10.2*** (2.37)
25-34	54.1 (1.76)	54.7 (1.47)	0.6 (2.29)	25.1 (2.10)	21.9 (1.67)	-3.2 (2.68)	22.5 (2.03)	11.2 (1.28)	-11.3*** (2.40)
35-65	25.3 (0.91)	33.3 (0.87)	8.1*** (1.26)	21.8 (1.71)	20.8 (1.31)	-1.1 (2.15)	20.3 (1.66)	10.2 (0.97)	-10.1*** (1.93)
Singapore born		35.0 (0.83)			22.9 (1.24)			10.0 (0.88)	
Foreign-born		57.2 (1.80)			16.4 (1.78)			12.1 (1.59)	
Graduate parents		86.7 (1.70)			15.9 (1.99)			10.2 (1.67)	
Non-graduate parents		34.9 (0.80)			22.3 (1.19)			10.7 (0.88)	

Secondary analysis of SU2 and SLS data for the employed workforce aged 25-65 in Singapore broken down by gender, age-group and migration status (born in Singapore or migrated before 20th birthday versus foreign-born and migrated to Singapore after 20th birthday). Change in graduate attainment, underemployment, and underutilization of graduates. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Graduate wages and skills utilisation

Higher education wage premium

Changes in graduate demand and supply are expected to not only influence the proportions of underemployed graduates but also inform the wage premium associated with higher

education. Our earlier analyses suggest a growing demand for graduate skills in excess of supply. From the canonical model of labour markets, we would therefore expect a rising pay premium associated with higher education. To obtain estimates for the wage premium, we run a series of Mincer-type wage models of log hourly earnings on highest educational attainment and a set of common demographic control variables (age, cohabitation status, dependent children in the household and gender). We measure the higher education wage premium as the differential in log hourly wages between university educated workers and workers with at most secondary-level qualifications. Table 12 summarises the estimates for the whole workforce, by gender and age.

Table 12: Higher Education Wage Differential by sex and age, 2013 and 2017

	2013	2017	Δ.(2017-2013)	N
Total	1.108*** (0.031)	1.104*** (0.033)	-0.003 (0.045)	6,233
Men	1.135*** (0.043)	1.091*** (0.049)	-0.044 (0.065)	3,253
Women	1.051*** (0.044)	1.108*** (0.046)	0.057 (0.064)	2,980
25-34	0.681*** (0.055)	0.755*** (0.058)	0.073 (0.080)	1,775
35+	1.227*** (0.038)	1.190*** (0.040)	-0.037 (0.055)	4,458

Weighted OLS regression of log real gross hourly pay in 2017 and interval regression of log real gross hourly earning bands in 2013. Displayed coefficients are the estimated wage differential associated with degree qualifications over secondary education for workers in the age bracket 25–65. The estimates are adjusted by 5-year age-groups, indicator for the presence of dependent children under 16 in the household, and cohabitation status. Robust standard errors in parentheses. [#] $p < 0.1$, [*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

First, higher education is associated with a very substantial wage premium in Singapore. Across the whole resident workforce in 2017, graduate hourly pay was more than twice (=exp(1.104)) the mean pay for secondary school leaver. The wage differential was similarly wide in the male and female workforce. Secondly, the graduate wage premium rises with age. It is larger in the age-bracket 35-65 years than for younger workers; consistent with international evidence that higher education leads to faster wage growth over the course of careers (Hanushek et al 2016). Thirdly, the graduate wage premium held its ground; which is

consistent with a balanced expansion of graduate supply with the demand for graduate skills.

Pay penalty of underemployment and underutilisation

Changes in the graduate wage premium are unlikely to provide a full account of pay dynamics over time within the graduate labour force. As discussed earlier, with rising higher educational attainment, graduate labour markets tend to diversify. One dimension of differentiation along which outcomes diversify is the type of jobs graduates pursue (Henseke and Green, 2020); specifically, the extent to which graduate destinations require degree qualification and use graduate skills. Both underemployment and skills underutilisation are associated with a significant pay penalty (Allen and Belfi, 2020; Chevalier and Lindley, 2009; Figueiredo et al. 2017; Green and Zhu, 2010; Wu and Wang, 2018). The incidence and the wage 'costs' associated with underemployment and underutilisation should depend on the co-evolution of graduate supply and demand. If the growth of graduate labour supply exceeds the additional demand for high skilled labour, graduates compete down the job skill hierarchy and move into non-graduate positions that are increasingly distant from the typical skill level of graduate employment. Consistent with the earlier findings of a growing excess demand for graduate skills, we expect to find drops in the wage penalties associated with underemployment and underutilisation. Across types of mismatch, we expect there to be little to no wage gap between matched and underutilised graduates, since employers would still need to pay graduate wages tied to the qualification requirements independently of skills use, and a substantial wage gap between matched and underemployment graduates.

Table 13 presents the estimates of the mean pay penalty associated with underemployment and underutilisation for graduates in Singapore. The estimates do not adjust for the potential influence of skills differences between graduates on the likelihood of mismatch. The estimates are thus best interpreted as conditional wage differentials.

Two key findings stand out. First, underemployment carries a heaver wage penalty than underutilisation on its own. In 2017, average hourly pay for task-unwarranted graduates was about 16 per cent lower than for their well-matched peers. The existence of this penalty is consistent with the similar findings from Germany (Kracke and Rodrigues, 2020), but its

magnitude is notably less than the penalty experience by underemployed graduates, who earned on average 35 per cent (=1-exp(-0.418)) less than graduates in task-warranted graduate jobs.

Second, we find no significant change in the wage penalties associated with underemployment and underutilisation between 2013 and 2017. Nonetheless, the point estimates for men and in the age-group 25-34 years suggest a widening of the pay differentials in the sample. The finding of a stable but potentially declining underemployment wage penalty in Singapore is consistent with trends in most other European graduate labour markets (Green and Henseke, 2020).

Table 23: The graduate underemployment wage penalty by sex and age. 2013 and 2017

		2013	2017	Δ.(2017-2013)	N
Total					2,234
	UG	-0.418*** (0.045)	-0.418*** (0.051)	0.000 (0.069)	
	MUG	-0.123** (0.038)	-0.179*** (0.048)	-0.056 (0.061)	
Men					1,200
	UG	-0.403*** (0.066)	-0.471*** (0.086)	-0.067 (0.108)	
	MUG	-0.171** (0.059)	-0.261*** (0.064)	-0.090 (0.087)	
Women					1,034
	UG	-0.416*** (0.062)	-0.356*** (0.059)	0.060 (0.086)	
	MUG	-0.068 (0.048)	-0.104 (0.069)	-0.036 (0.084)	
25-34					941
	UG	-0.235*** (0.054)	-0.345*** (0.054)	-0.110 (0.076)	
	MUG	-0.082* (0.041)	-0.121* (0.048)	-0.039 (0.063)	
35-65					1,292

UG	-0.606*** (0.072)	-0.467*** (0.077)	0.139 (0.106)	
MUG	-0.166* (0.066)	-0.217** (0.080)	-0.051 (0.104)	

Weighted OLS regression of log real gross hourly pay in 2017 and interval regression of log real gross hourly earning bands in 2013 on indicators for underemployment (non-graduate job) and underutilization (task-unwarranted graduate job) and control variables for employed graduates aged 25–65 years. Control variables comprise 5-year age-groups, sex, indicator for the presence of dependent children under 16 in the household, and cohabitation status. Robust standard errors in parentheses. [#] $p < 0.1$, [*] $p < 0.05$, [**] $p < 0.01$, [***] $p < 0.001$

Skills utilisation

Finally, we investigate differences in reported skills use across graduates conditional on job match. In the previous subsection, we found relatively small wage differences between MUGs and matched graduates. However, from our definition of graduate employment, graduates in task-unwarranted graduate jobs will have as little opportunity to apply their skills as underemployed graduates. In other words, we expect there to be a skill-use gap between, on one hand, matched graduates and, on the other, underemployed and matched but underutilised graduates. As earlier we do not adjust the potential bias from endogenous job assignment. Because the skills use questions changes between survey waves, we concentrate on the cross-sectional comparison.

Table 14 reveals indeed a significant skills utilisation gap between matched graduates and the other graduates in the workforce with notable variation by age. Graduates outside task-warranted graduate jobs can apply less of their skills set in their current job. The estimates also confirm that in terms of skill use, MUGs and UGs struggle similarly. The directions of the effects and patterns are consistent across labour market segment. However, young graduates reported smaller skills use gaps by job type. Although the item changed between surveys, the uncovered patterns are robust over the years.

Table 34: Skills underutilisation by sex and age. 2013 and 2017

	Underemployed Graduates	Matched but Underutilised Graduates	Matched graduates	p-value (underemp = underuse)	N
Total					
2013	-0.082*** (0.022)	-0.097*** (0.023)	(ref.)	0.595	1024
2017	-0.048*** (0.013)	-0.056*** (0.014)	(ref.)	0.667	1582
Men					
2013	-0.061* (0.030)	-0.121*** (0.029)	(ref.)	0.089	591
2017	-0.052** (0.019)	-0.061** (0.020)	(ref.)	0.751	822
Women					
2013	-0.105** (0.034)	-0.073* (0.035)	(ref.)	0.459	451
2017	-0.043* (0.019)	-0.055** (0.019)	(ref.)	0.604	760
25-34					
2013	-0.030 (0.033)	-0.065# (0.035)	(ref.)	0.393	443
2017	-0.022 (0.019)	-0.033# (0.018)	(ref.)	0.633	617
35-65					
2013	-0.124*** (0.030)	-0.119*** (0.030)	(ref.)	0.903	599
2017	-0.064*** (0.018)	-0.072*** (0.020)	(ref.)	0.761	965

Weighted OLS regression of self-assessed skills utilization in 2013 and 2017 on indicators for underemployment (non-graduate job) and underutilization (task-unwarranted graduate job) and control variables for employed graduates aged 25–65 years. Control variables comprise 5-year age-groups, sex, indicator for the presence of dependent children under 16 in the household, and cohabitation status. Robust standard errors in parentheses. # $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Taken together the findings suggest that underemployed as well as matched but

underutilised graduates cannot fully utilise their skills. Although matched but underutilised

graduates have only a modest pay disadvantage their level of skills underutilisation is similar to graduates in non-graduate jobs. The gaps in skills utilisation between matched and non-matched graduates were especially large in the age-bracket 35-65 years.

5 Conclusions and Implications

We have argued in this paper that higher education for the resident population is becoming more important in the supply of skills to Singapore's economy. While a proportion of high-skilled talent has been obtained from foreign workers, the importance of higher education among the resident workforce has been increasing, especially in view of the policy priorities implied by SkillsFutures. Yet there are few studies that have considered the coevolution of higher education attainment in the workforce and the utilisation of Singapore resident graduates' skills. To do so, we have drawn on the conceptual distinction between graduate jobs and non-graduate jobs, a distinction that has been applied successfully in a range of other countries and settings.

We have also explicitly recognised that there is considerable variation among graduate jobs. While adding to the literature by applying the concept to the graduate labour market in the circumstances of Singapore, we contribute also by making a new conceptual distinction between 'task-warranted' and 'task-unwarranted' graduate jobs. In both types of job a degree is required to obtain these jobs, but in the task-warranted graduate jobs the job involves carrying out typical graduate-level tasks; while task-unwarranted graduate jobs require no or low levels of observed graduate-level tasks. The reason for this requirement is that it helps sort applicants for their hard-to-observe skills – the logic that lies behind signalling and credentialism. To operationalise the distinction we use data on task use in two surveys, one in 2013 the other in 2017, and apply conventional methods to estimate a threshold probability of being in a task-warranted or task-unwarranted graduate job.

We have found that the continued expansion of higher attainment in the resident workforce between 2013 and 2017 is met by a similarly-strong growth in graduate jobs over the period. This growth of graduate jobs can be fully explained by upskilling: an increasing use of graduate-level tasks within jobs. Thus it was, in particular, the share of task-warranted graduate jobs which expanded sharply from 21% to 32% of jobs, while the share of task-unwarranted graduate jobs fell slightly. Despite these positive signs, it remains the case that

37

about 1 in 3 employed graduates were in jobs that were on average not making full use of graduate skills.

Complementing these trends in supply and demand, we find that the pay premium associated with higher education remained very high: graduates' pay was more than double that of secondary school leavers. This premium was unchanged between 2013 and 2017.

As elsewhere, however, there is dispersion among graduates' pay, and in particular a wage penalty of 35% for underemployed Singapore graduates in 2017. There was a much smaller wage penalty (16%) for being in an task-unwarranted graduate job as opposed to a task-warranted graduate job. Neither of these penalties had significantly changed from 2013.

These patterns of change and continuity are largely consistent across gender and age. Yet in both years attainment of a degree is highly stratified by parents' highest level of education; this is compounded by the fact that first-in-family graduates are more likely to be underemployed. Given the very substantial pay premium, and the considerable pay penalty for underemployment, these stratifications are likely to have adverse consequences for social mobility in Singapore.

Two limitations to our analysis deserve repeating here. First, both the supply and the demand data refer only to the resident population. The substantial proportion (38%) of the labour force which are made up of non-residents – themselves divided into segments with varying skills – are not able to be included in the analysis. While concentration on the Singapore residents can be justified when the analysis concerns the relationship between the education system and the supplies of residents' skills, the value of analyses of skills supply and utilisation for Singapore's economy would be enhanced if it becomes possible in future to survey the jobs and job-holders in the remaining segments of the economy. Comparisons with other countries, where analyses are applied to all the workforce, would also thereby become more illuminating.

Second, analyses like the ones presented here rely on the good quality of survey data, since it is impractical to collect such data through administrative means. We would recommend that future surveys continue to be based on clustered random survey methods used in 2017, since it is hard to guarantee the quality of quota sampling (or other, non-random sampling methods). Considerable efforts need to be made, also, to ensure the maximum response

38

rate in any future surveys: in the 2017 survey we consider that the response rate is acceptable (when compared to others used in the literature) but that improvement is desirable and any deterioration in a future survey would lower confidence in its findings. Moreover, although there can be benefits in adapting surveys to current needs and policy programmes, to illuminate long-term changes a careful balance must be struck between updating the questionnaire and a consistent questionnaire and study design. The latter is essential for robust longitudinal evidence.

With these qualifications, our findings provide the first in-depth analysis of Singapore's graduate labour market of which we are aware. Over the short period between 2013 and 2017 they paint a picture of a dynamic labour market. The findings show the potential for task-based analysis of graduate labour markets, and suggest that there is ongoing value in monitoring the utilisation of graduate skills in Singapore's economy every four or five years, as an aide to future planning both for policy-makers and for individuals' careers.

References.

Acemoglu, D., & Autor, D. (2011) Skills, Tasks and Technologies: Implications for Employment and Earnings, *Handbook of Labor Economics*. https://doi.org/10.1016/S0169-7218(11)02410-5

Allen, J., & Belfi, B. (2020). Educational expansion in the Netherlands: better chances for all?. *Oxford Review of Education*, 46(1), 44-62.

Allen, J. and R. van der Velden (2001). "Educational mismatches versus skill mismatches: effects on wages, job satisfaction, and on-the-job search." *Oxford Economic Papers* 53(3): 434-452.

Appold, S. J. (2005). The Weakening Position of University Graduates in Singapore's Labor Market: Causes and Consequences. *Population and Development Review*, 31(1), 85-+.

Ashton, David; Francis Green; Donna James and Johnny Sung. (1999). *Education and Training for Development in East Asia the Political Economy of Skill Formation in East Asian Newly Industrialised Economies*. London and New York: Routledge.

Autor, D. H. (2013). The "task approach" to labor markets: an overview. *Journal for Labour Market Research*, *46*(3), 185–199. https://doi.org/10.1007/s12651-013-0128-z

Autor, D. H., & Handel, M. J. (2013). Putting Tasks to the Test: Human Capital, Job Tasks, and Wages. *Journal of Labor Economics*, *31*(2), S59–S95. https://doi.org/10.1086/669332

Autor, D. H., F. Levy and R. J. Murnane (2003). "The skill content of recent technological change: An empirical exploration." *Quarterly Journal of Economics*, 118(4): 1279-1333.

Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *Quarterly Journal of Economics*, *118*(4), 1279–1333. https://doi.org/10.1162/003355303322552801

Beaudry, Paul; David A. Green and Benjamin M. Sand. 2016. "The Great Reversal in the Demand for Skill and Cognitive Tasks." *Journal of Labor Economics*, 34(1 , pt 2), S199-S247.

Blair, P. Q., & Deming, D. J. (2020). Structural Increases in Demand for Skill after the Great Recession. *AEA Papers and Proceedings*, *110*, 362–365. https://doi.org/10.1257/pandp.20201064

Caroleo, F. E., & Pastore, F. (2015). Overeducation: A disease of the school-to-work transition system. In *Youth and the Crisis* (pp. 50-70). Routledge.

Chevalier, A., & Lindley, J. (2009). Overeducation and the skills of UK graduates. *Journal of the Royal Statistical Society*: Series A (Statistics in Society), 172(2), 307-337.

Crawford, C., Gregg, P., Macmillan, L., Vignoles, A., & Wyness, G. (2016). Higher education, career opportunities, and intergenerational inequality. *Oxford Review of Economic Policy*, 32(4), 553-575.

Davie, S. (2020, January 28). Planning for university places needs rethink, Education News & Top

Stories - The Straits Times. *The Straits Times*. Retrieved from

  https://www.straitstimes.com/singapore/education/planning-for-uni-places-needs-rethink

Dimmock, Clive, Tan, Cheng Yong (2016) Explaining the Success of the World's Leading Education

  Systems: The Case of Singapore, *British Journal of Educational Studies*, 64:2, 161-184.

Elias, P. and K. Purcell (2013). Classifying graduate occupations for the knowledge society,

  Futuretrack. Working Paper(5): 1-37.

Fairlie, R. W. (2005). An extension of the Blinder-Oaxaca decomposition technique to logit and probit

  models, *Journal of Economic and Social Measurement*, 30(4), 305–316.

Figueiredo, H., Biscaia, R., Rocha, V., & Teixeira, P. (2017). Should we start worrying? Mass higher

  education, skill demand and the increasingly complex landscape of young graduates'

  employment. *Studies in Higher Education*, 42(8), 1401-1420.

Freeman, R. B., Ganguli, I., & Handel, M. J. (2020). Within-Occupation Changes Dominate Changes in

  What Workers Do: A Shift-Share Decomposition, 2005–2015. *AEA Papers and Proceedings*, *110*,

  394–399. https://doi.org/10.1257/pandp.20201005

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to

  computerisation? *Technological Forecasting and Social Change*, *114*, 254–280.

  https://doi.org/10.1016/j.techfore.2016.08.019

Fuller, J. B., & Raman, M. (2017). *Dismissed by Degrees*.

Goldin, C. and L. F. Katz (2008). *The Race Between Education and Technology*. US: Cambridge,

  Harvard University Press.

Green, F. (2012a). Employee Involvement, Technology, and evolution in job skills: A Task- Based

  analysis. *Industrial and Labor Relations Review*, *65*(1), 36–67.

  https://doi.org/10.1177/001979391206500103

Green, F., & Henseke, G. (2016a). Should governments of OECD countries worry about graduate

  underemployment?, *Oxford Review of Economic Policy* 32(4): 514-537.

Green, F., & Henseke, G. (2016b). The changing graduate labour market: analysis using a new

  indicator of graduate jobs. *IZA Journal of Labor Policy*, *5*(1), 1–25.

  https://doi.org/10.1186/s40173-016-0070-0

Green, F., & Henseke, G. (2017). Graduates and "graduate jobs" in Europe: a picture of growth and

  diversification Graduates and "graduate jobs" in Europe: a picture of growth and

  diversification. *Centre for Global Higher Education Working Paper Series*, (25). Retrieved from

  www.researchcghe.org

Green, F. & G. Henseke (2020). Graduate employment and under-employment: Trends and

  prospects in high participation systems of higher education. *The Future of Higher Education*. C.

41

Callender, W. Locke and S. Marginson. London, Bloomsbury.

Green, F., & Zhu, Y. (2010). Overqualification, job dissatisfaction, and increasing dispersion in the returns to graduate education. *Oxford economic papers*, 62(4), 740-763.

Habibi, N. 2019. "Preventing Overeducation and Graduate Surplus What Can West Asia Learn from Singapore and Hong Kong." *Asian Education and Development Studies*, 8(4), 523-35.

Hanushek, E. A., Schwerdt, G., Woessmann, L., & Zhang, L. (2017). General education, vocational education, and labor-market outcomes over the lifecycle. *Journal of human resources*, 52(1), 48-87.

Henseke, G., & Green, F. (2017). Cross-national deployment of "graduate Jobs": Analysis using a new indicator based on high skills use. *Research in Labor Economics*, *45*, 41–79. https://doi.org/10.1108/S0147-912120170000045002

Hershbein, B., & Kahn, L. B. (2018). Do recessions accelerate routine-biased technological change? evidence from vacancy postings. *American Economic Review*, *108*(7), 1737–1772. https://doi.org/10.1257/aer.20161570

Holmes, C., & Mayhew, K. (2016). The economics of higher education. *Oxford Review of Economic Policy*, 32(4), 475-496.

Ka Ho Mok & Deane Neubauer (2016) Higher education governance in crisis: a critical reflection on the massification of higher education, graduate employment and social mobility, *Journal of Education and Work*, 29:1, 1-12.

Ka Ho Mok (2011) The quest for regional hub of education: growing heterarchies, organizational hybridization, and new governance in Singapore and Malaysia, *Journal of Education Policy*, 26:1, 61-81.

Ka Ho Mok (2016b) Massifying and internationalising higher education, changing labour markets and social mobility: challenges for education and urban governance*, Journal of Higher Education Policy and Management*, 38:3, 233-241,

Kiersztyn, A. (2013). Stuck in a mismatch? The persistence of overeducation during twenty years of the post-communist transition in Poland. *Economics of Education Review*, 32, 78-91.

Kracke, N., M. Reichelt and B. Vicari (2018). "Wage Losses Due to Overqualification: The Role of Formal Degrees and Occupational Skills." *Social Indicators Research* 139(3): 1085-1108.

Kracke, N. and M. Rodrigues (2020). "A Task-Based Indicator for Labour Market Mismatch." *Social Indicators Research* 149(2): 399-421.

Machin, S. and J. Van Reenen (1998). Technology and Changes in Skill Structure: Evidence From Seven OECD Countries. *Quarterly Journal of Economics*, 113(4): 1215-1244.

Macmillan, L., Tyler, C., & Vignoles, A. (2015). Who gets the top jobs? The role of family background

and networks in recent graduates' access to high-status professions. *Journal of Social Policy*, 44(3), 487-515.

Marginson, S. (2016). "High participation systems of higher education." Journal of Higher Education 87(2): 243-271.

McMahon, W. W. (2009). *Higher Learning, Greater Good: The Private and Social Benefits of Higher Education*. US: Baltimore: Johns Hopkins University Press. https://doi.org/10.1353/book.3416

Meroni, E. C., & Vera-Toscano, E. (2017). The persistence of overeducation among recent graduates. *Labour Economics*, 48, 120-143.

Michael H. Lee (2016) Researching Higher Education in "Asia's Global Education Hub": Trends and Issues in Singapore, *Education and Society*, 34 (2), 5-25.

Ministry of Education. (2019). Intake, Enrolment and Graduates by Institutions. Retrieved June 23, 2020, from https://data.gov.sg/dataset/intake-enrolment-and-graduates-by-institutions

Ministry of Education. (2020). *Graduate employment survey.* Singapore. Retrieved from https://www.moe.gov.sg/docs/default-source/document/education/post-secondary/files/joint-web-publication-ges-2019.pdf

Ministry of Manpower. (2020a). Foreign workforce numbers. Retrieved June 23, 2020, from https://www.mom.gov.sg/documents-and-publications/foreign-workforce-numbers

Ministry of Manpower. (2020b). Summary Table: Labour Force. Retrieved June 23, 2020, from https://stats.mom.gov.sg/Pages/Labour-Force-Summary-Table.aspx

Modestino, A. S., Shoag, D., & Ballance, J. (2019). Upskilling: Do Employers Demand Greater Skill When Workers are Plentiful? *Review of Economics and Statistics*, 1–46. https://doi.org/10.1162/rest_a_00835

Mok, K. H. 2016a. "Massification of Higher Education, Graduate Employment and Social Mobility in the Greater China Region." *British Journal of Sociology of Education*, 37(1), 51-71.

OECD (2019), Education at a Glance 2019: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/f8d7880d-en.

OECD. (2019). Technical Report of the Survey of Adult Skills (PIAAC). FR: Paris. Retrieved from https://www.oecd.org/skills/piaac/publications/PIAAC_Technical_Report_2019.pdf

Pak Tee Ng (2013) The global war for talent: responses and challenges in the Singapore higher education system, *Journal of Higher Education Policy and Management*, 35:3,280-292.

Singapore Department of Statistics (2015). Singapore Standard Occupational Classification 2015. https://tinyurl.com/y5xxcntc .

Spitz-Oener, A. (2006). Technical Change, Job Tasks, and Rising Educational Demands: Looking outside the Wage Structure. *Journal of Labor Economics*, *24*(2), 235–270.

https://doi.org/10.1086/499972

Verhaest, D., & Omey, E. (2006). The Impact of Overeducation and its Measurement. *Social Indicators Research*, *77*, 419–448. https://doi.org/10.1007/s11205-005-4276-6

Verhaest, D., & Omey, E. (2012). Overeducation, Undereducation and Earnings: Further Evidence on the Importance of Ability and Measurement Error Bias. *Journal of Labor Research*, *33*(1), 76–90. https://doi.org/10.1007/s12122-011-9125-6

Verhaest, D., & Van der Velden, R. (2012). Cross-country differences in graduate overeducation. *European Sociological Review*, 29(3), 642-653.

Wu, N., & Wang, Q. (2018). Wage penalty of overeducation: New micro-evidence from China. *China Economic Review*, 50, 206-217.

Youden, W. J. (1950). Index for rating diagnostic tests. *Cancer*, 3(1), 32-3.