

Skills for the Future: Analyses of Singapore's Graduate Labour Market and its Upper Secondary Education and Training System in Comparative Perspective

Final Report¹

Francis Green, Andy Green, Golo Henseke, Neil Kaye and Hao Phan

LLAKES Centre, UCL Institute of Education.

¹ Responsibility for this report's findings lies solely with its authors, but we would like to acknowledge that the project has been a fruitful collaboration between the UCL Institute of Education and Singapore's Institute of Adult Learning. A great deal of assistance has been provided by Professor Johnny Sung from the Institute of Adult Learning, through the provision of data, advice on access to informants, and informed first-hand knowledge of Singapore's skill system. We would also like to acknowledge with thanks the helpful and generous comments of discussants at this [report's presentation](#) on May 27th, 2021: Dr Gog Soon Joo (Chief Skills Officer, SkillsFuture Singapore), Dr N. Varaprasad (Partner and Principal Consultant, Singapore Education Consulting Group), and Professor Zongyi Deng (UCL Institute of Education).

Executive Summary

Singapore has been of long-standing interest worldwide for those interested in skills issues. This small city state has broadly succeeded over decades in maintaining a balance between the skills demanded in the economy at successive stages in its development and the skills being supplied through schools, polytechnics and workplace training, supplemented by a substantial segmented migrant workforce. Singapore also stands out for the successes of its school system, with the pupils in its schools being ranked among the highest globally in the PISA tests. This report examines two important aspects of the supply and utilisation of skills in Singapore in recent years: the graduate labour market and the system of upper secondary education and training.

First, using two surveys conducted in 2013 and 2017 and other official data it finds that:

- Between 2013 and 2017, the share of graduates rose from 32 percent to 38 percent, but this rise was more than matched by a rise in the share of jobs that are graduate jobs – those that require a university degree upon entry – from 29 percent to 38 percent. These joint expansions maintained a broad dynamic balance between the total supply and demand.
- The report distinguishes between graduate jobs which are ‘warranted’ by the tasks involved, and those ‘unwarranted’ graduate jobs where a degree is required but the generic tasks involved do not appear to require a university degree.
- Most of the increase in graduate jobs between 2013 and 2017 was ‘warranted’ by changes in the task-content of graduate jobs that entailed a greater requirement to perform typical generic graduate tasks.
- The hourly pay premium for university graduates, relative to those with at most secondary qualifications, is just over 200 percent, and remained stable at this high level between 2013 and 2017.
- As in many other countries, ‘underemployed’ graduates -- those who do not work in a graduate job -- earn less than those who work in graduate jobs. This underemployment wage penalty in Singapore was 31 percent in both 2013 and 2017.
- Graduates working in ‘task-warranted’ graduate jobs earned 18 percent greater hourly pay than graduates working in ‘task-unwarranted’ jobs.
- Among Singapore graduates, women and those whose parents are not university educated are more likely to be underemployed. However, the place where graduates were born (whether inside or outside Singapore) makes no difference to their probability of being underemployed.
- Consistent, precise comparisons with other developed countries are difficult because the relevant data elsewhere cover all workers rather than, as in Singapore, just the resident workforce. Approximate comparisons suggest, however, that neither higher education attainment, nor the proportion of graduate jobs, nor the graduate underemployment wage penalty is exceptional in Singapore.

Second, using data from the PISA tests and the OECD's Survey of Adult Skills (SAS), the report compares the progression of core skills between age 15 and early adulthood, through the stage of upper-secondary education and training. It examines Singapore and 32 other OECD countries/regions, comparing the outcomes for average skill levels and their inequalities in relation to the type of education system. It finds that:

- Singapore performs highly in mean scores for Reading/literacy and Maths/numeracy both at age 15 (PISA) and at ages 18-20 (SAS).
- At age 18-20 in SAS, among the countries with values in our sample, Singapore ranked first in numeracy and sixth in literacy.
- According to our analysis of relative changes in skills between age 15 and age 18-20, Singapore maintains its high position relative to other countries in both literacy and numeracy skills, although it does not significantly improve on it during the upper secondary phase.
- Given the tracked nature of its lower and upper secondary systems - often associated across countries with greater inequality in skills - Singapore also has rather less unequal skills outcomes that might be expected.
- In PISA 2009 Singapore's country rank position on the skills Gini measure of inequality was low to average – 20th out of 28 countries for Reading and 15th out of 30 countries for Maths. Notably, Singapore had a very low proportion scoring at below level 2 in Reading (12 percent against the OECD average of 19 percent), with only five countries scoring better on this measure.
- Skills inequality at age 18-20 in SAS was again quite low in both skills domains, with Singapore ranked 23rd out 32 countries on the skills Gini measure of inequality for literacy and 26th out of 32 countries on that measure for numeracy.
- In almost all countries, literacy skills inequality falls during the upper secondary phase, although by different amounts. In numeracy six countries see increases in inequality with the remainder seeing a reduction.
- Singapore was less successful than many countries in reducing inequality in literacy, with 17 countries doing better and 11 worse. However, in numeracy it was among the most successful in inequality mitigation, with only five of 32 countries doing better.
- In common with most other countries which perform relatively well in raising skills levels and reducing inequalities, Singapore has high rates of participation and completion in long-cycle upper secondary and training, with a high proportion of students in vocational programmes. However, the proportion of vocational students undertaking work-based learning - through work-experience placements, internships or school-based apprenticeships - remains comparatively low.

Introduction: *Research Questions and Objectives*

At the heart of this report lies a fundamental issue for successful modern economies: how to ensure that all those joining and those continuing in the workforce have adequate, growing skills, while also minimising the risks that some workers' skills become underutilised. It is widely held that growing skills -- including knowledge, technical and social skills, and abilities -- are essential for a competitive 'knowledge economy' in which innovation is the driving force (Powell and Snellman, 2004). The problem, however, for many modern economies is that the ideal of the knowledge economy is rarely achieved. Education systems vary greatly in how effective they are at generating the skills needed. Regular PISA tests show that, across OECD countries, the average reading, mathematics and science skill score of 15-year-olds rose slowly between 2006 and 2012, but by 2018 had fallen to near its 2006 level (OECD, 2019, p. 130). Many systems result in undesirably high skills inequalities among 15-year-old school children and later among adults (Green et al., 2015). The excessive emphasis on growth, as opposed to environmental sustainability has also been questioned (Lin, 2006). Moreover, among those young people who succeed in education and achieve good qualifications, many fail to gain employment in what are termed 'graduate jobs', spending years in low-level jobs that do not make use of the skills they have learned in their education systems. According to some writers, the problem of "graduate under-employment", in particular, has been rising, both in Europe and in many East Asian systems where forceful drivers towards expanded participation in higher education have not been checked either by market forces or by government controls (Green and Henseke, 2020, 2021; Mok and Jiang, 2018; Habibi, 2019).

Singapore has been of long-standing interest worldwide for those interested in these skills issues. This small city state has broadly succeeded over decades in maintaining a balance between the skills demanded in the economy at successive stages in its development and the levels and types of skills being supplied by schools, polytechnics and through workplace training, supplemented by a substantial segmented migrant workforce (Ashton et al., 1999). Singapore also stands out for the successes of its school system, with the pupils in its schools being ranked among the highest globally in the PISA tests (OECD, 2019, p.15). In the adult workforce, the skills of its young adults also rank highly, in contrast to older adults especially 55–65-year-olds) who record some of the lowest literacy and numeracy scores.²

For the decade leading up to 2018 Singapore continued to grow rapidly for a fully developed economy. One significant feature of the growth of skills in this period is the substantive ongoing rise in the enrolment of students in Singapore's universities and consequent growth in the flows of graduates into the Singapore workforce. By 2020 four out of every ten young Singaporeans transiting from education into employment were going through higher education. Of course, this level of enrolment in itself is not exceptional, given that the "massification" of higher education has become a ubiquitous phenomenon in the modern era (Marginson, 2016). But while previously the demand to enrol in universities has been held in check by government controls over available places (Habibi, 2019), the expansion in recent years prompts the question as to whether there are, and will be, sufficient "graduate jobs" to occupy the many new graduates, especially if the participation rate continues to rise as expected.

Another feature of this latest decade is a substantive alteration in the focus of the government's approach to skills policy. Starting in 2015 with the introduction of its SkillsFuture programme,

² [Skills-Matter-Singapore.pdf \(oecd.org\)](https://www.oecd.org/skills-matter-singapore.pdf)

Singapore radically changed its mainly supply driven, industry-specific skills development model to one that pays twin emphases on skills utilisation and the quality of skills supply. Before then, the skills supply policy was mainly for working adults providing skills for entering the labour market as well as enhancing labour market flexibility and employability, once the worker is in the labour market. As such, the continuing education and training (CET) system was closely supported by the competency-based Workforce Skills Qualification system. This past approach relied on workplaces to act as the main 'recruitment' points for CET programmes, both for new entrants and 'upgrading'³. In comparison, SkillsFuture transforms skills development from a previously targeted piece-meal, on-demand and segmented approach to one that embraces the full notion of lifelong learning. Learning, education and training are encouraged and provided for all citizens, irrespective of employment status or age. Individuals, and not necessarily workplaces, become the target for learning and training. Policymakers now aim to "deepen" skills, so that individuals can achieve 'skills mastery'. Combining earning and learning, to enhance the application and use of skills learnt in the education system, are now encouraged through the 'work-study' programmes offered to graduates from the Institute of Technical Education (ITE) and the Polytechnics. SkillsFuture and its lifelong learning approach were neatly summarised as follows (*Report of the Committee on the Future Economy, 2017: 6*):

"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."

In this scenario, university graduates are expected to be an essential component of the national 'skills deepening' effort. Yet the rest of the population who achieve post-lower-secondary education and training qualifications are also going to be important. The problem encountered in many countries is not only the low skill levels sometimes achieved, but also the inequalities of core skills gained by fifteen-year-olds. It is generally the case that skills inequalities decrease somewhat by the stage, a few years later, when each cohort is entering the workforce; however, there are very considerable differences between countries at the 15-year-old stage and in the extent to which inequalities change over the ensuing years through the post-secondary system. Certain features of Singapore's educational system -its tracking within lower and upper secondary education, and its high rate of participation in vocational programmes in upper secondary institutions and in work-place training – would lead one to expect relatively successful skills outcomes as indicated by the mean levels of skills, but potentially high levels of skills inequality. However, research on the role of post-lower-secondary systems worldwide, and in particular on Singapore's position in the spectrum of post-lower-secondary education and training systems, is relatively scarce. Given the strong evidence that skills inequalities are one of the more important factors underpinning socio-economic inequalities, an understanding of how those inequalities are altered in the post-secondary phase is needed.

While the SkillsFuture re-orientation of skills policy could be expected to have its effects over the long term, a baseline study of the skills system in the late 2010s will provide valuable findings to be compared with future evidence after some years of change. This report aims to make two specific

³ For the job seekers and working individuals, they could (still do) join the training system as an individual, but the numbers of these groups were (are) relatively small, compared with the vast numbers of trainees coming from workplaces.

contributions towards a better understanding of Singapore's overall skills system. The first part seeks to understand the utilisation of rapidly rising graduate skills in Singapore. To do this it uses new survey data collected by Singapore's Institute of Adult Learning, and develops new conceptual tools based on task-based analysis. It draws on previous work to define what is meant by 'graduate jobs', but then extends this work to identify jobs that make full use of graduates' skills to do what are normally regarded as graduate tasks. This new approach permits a fuller understanding of the graduate labour market in Singapore and suggests a way forward for future monitoring of graduate skills utilisation. The overarching question addressed by this part of the report is: is the economy generating new graduate jobs at a similar rate to the rise in the numbers of graduates, and what are the outcomes for the graduate labour market?

In the second part, the report seeks to contribute new understanding surrounding the least researched part of Singapore's skills system, namely post-lower-secondary education, which we refer to as 'upper secondary education and training' for the sake of international comparability in the second part of our report (Hodgen et al, 2017, p.30). This is a crucial stage of education during which the primarily academic skills of 15-year-olds are added to in uneven ways and start to be transformed into useful work skills and life skills, potentially increasing or decreasing the inequalities that have developed during schooling. The questions to be addressed here are: How should Singapore's post-secondary skill system be characterised relative to equivalent systems around the world? Is there anything distinctive about Singapore in comparative terms, and if so, what might be the policy implications? Before it can get to answer these questions, however, the report builds on earlier analyses of post-lower-secondary education and training systems, adding new data and many more countries that enrich the comparative perspective.

1. Singapore's Graduate Labour Market

Contributed by Francis Green and Golo Henseke

The aim of this part of the report is to examine the utilisation of graduates' skills in the labour market. To set the context, we consider the supplies of graduates that emerge from Singapore's education system and note what earlier analyses have concluded about Singapore. We elucidate and draw on the concept of a graduate job, then develop the classification further using task-based analysis before applying it to recent representative survey data about the use of graduate skills.

1.1 The Context of Singapore's Graduate Labour Market

The supply of high-skilled labour

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. 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 traditionally 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 now 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.

To meet future demands for graduate labour, there are now six autonomous universities: 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. These institutions have a collective enrolment of more than 100,000 students. In addition, there are many private transnational 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 27% in 2009 (see Table 1).

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 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 its educational attainment in Singapore, 2009-2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Resident Labour Force ('000)	1986	2048	2080	2120	2139	2185	2232	2258	2270	2293	2329
<i>Educational attainment (%)</i>											
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 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. However, as Table 1 makes clear, Singapore has nevertheless experienced a rapid growth of the share of graduates in the labour force. 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 both from the recent rapid rise in supply of graduates in the labour force, but also from its expected continued rise in the context of Singapore's evolving skills policy – the inauguration of SkillsFuture, with programmes designed for students, individuals, employers and providers. The 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 was achieved in 2020 (Davie, 2020). The 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 would double every 17 years; and even without these rising enrolments, a growth in the proportion of graduates in the labour force would be expected during the 2020s decade, as older less qualified workers retire.

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. 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.

1.2 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: 3).

With this concept it is important that an indicator of graduate jobs should be based on skills utilisation. For two reasons, it is unsatisfactory to define graduate jobs as the jobs that graduates do. First, this approach neglects the fact that some graduates may not attain graduate jobs and may cluster in less-skilled occupations. Second, the definition is used in tautological ways, adding nothing to explanatory power.

Alternative approaches to measurement of graduate jobs relying on skills utilisation follow either a statistical approach based on task-based survey analysis of jobs (or expert-based assessments of required qualifications (Elias and Purcell, 2013) including those used for official occupation classifications globally, or on individuals' self-reports of graduate qualification requirements in their jobs (Henseke and Green, 2017; Elias and Purcell, 2013; Green and Zhu or REFLEX). Each of these has its advantages and disadvantages, depending on the data available. This report follows the self-report method, primarily because of data availability.

Having defined a graduate job, a graduate is said to be 'under-employed' (or 'overeducated') if doing a non-graduate job. For any individual graduate, not to attain a graduate job is associated typically with substantively lower pay (for example, Wu and Wang, 2018) and, according to some studies, lower job satisfaction, compared with similar graduates who are in graduate jobs (Allen and van der Velden, 2001). In evidence from other countries, immigrant graduates are more likely to be underemployed than indigent graduates (Green et al., 2007); typically, graduates' risk of being underemployed varies across socio-demographic groups, field of study, and achieved skill level. It is of interest, therefore, to investigate who among Singapore graduates are most likely to experience underemployment.

Recent studies have revealed that the prevalence of graduate jobs varies considerably across countries. 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. Under-employment also varies considerably between countries. It is found to be highest in countries with higher excesses of graduate supply over graduate demand. Also, 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).

Graduate jobs can be further distinguished between those jobs that involve doing tasks that are normally associated with degree-holders, and jobs which do not involve such tasks to a significant extent. We term the former ‘task-warranted’ graduate jobs. In the latter, which are termed ‘task-unwarranted’ graduate jobs, applicants are required to have degrees, but this is because there are unobserved tasks requiring high skill levels, and the relevant unobserved abilities are signalled by the achievement of a university degree. University qualifications may serve as an indicator of either absolute ability or rank in the ability spectrum. As the prevalence of degree-holders in the population rises, more employers may require a degree qualification as a signal of their applicants’ unobserved skills. It could be predicted, however, that task-warranted graduate jobs are likely to pay higher wages than task-unwarranted jobs – which, in turn would still pay more than non-graduate jobs. The use of task-based data to decompose graduate jobs is rare (Kracke and Rodrigues, 2020), though likely to become more common as relevant data becomes available for many countries.

1.3 Research Objectives

In light of the above, to characterise the state of the graduate labour market for Singapore residents, the report sets out to examine the following questions:

- 1: What proportion of the jobs held by Singapore resident graduates are self-reported to be graduate jobs? 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?
- 2: 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? What are 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 the premium and penalties changing over time?
- 3: What are the socio-economic background determinants of obtaining a graduate job in Singapore?
- 4: How does Singapore’s graduate labour market compare with that of other countries?

1.4 Data

The primary sources of data 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 built on the design of the British Skills and Employment surveys. They collected rich, comparable data on job tasks and qualification and learning requirements.

SU2 is a quota sample of 3,422 Singapore citizens and permanent residents aged 20 to 65 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, aged 20 to 70, with a response rate of 68%; 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. The surveys were combined into a pooled sample of workers aged 20 to 65, in order to test how the job task mix and educational requirements have changed over the three years between the surveys. Although both surveys achieved a broadly representative sample of the targeted population, the differences in sampling methods need to be born in mind when discussing the findings.

Temporary foreign workers in the employed workforce were not included in the target population in either survey. Temporary foreign workers are predominantly employed in sectors that are usually not associated with graduate employment, such as manufacturing, construction, accommodation, and food services. The focus on the residential workforce is therefore likely to bias upward the estimates of graduate employment and graduate attainment compared with a full account of the economically active population working in Singapore.

The international comparison draws on the Survey of Adult Skills (SAS, the survey for the Programme for the International Assessment of Adult Competences, PIAAC). SAS 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. Most OECD countries participated in the first round in 2011/2012. Singapore fielded the survey in 2014. As in SU2 and SLS, Singapore modified the target population to exclude temporary foreign workers. It focuses on 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 limitation should be borne in mind in the interpretation of the international comparisons that are drawn below, Section 1.7.

1.5 Variable Measurement

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. Both the attained and the required qualifications were mapped into five qualification levels: no qualifications, secondary, post-secondary, short tertiary, and higher education; for the detailed definitions, see Henseke and Green (2020, Table 4). Although some measurement error is possible, experience elsewhere suggests that workers can generally accurately report both their highest attained qualification and the qualification requirements to get their jobs (Green and James, 2003). A similar approach is taken in the OECD's SAS.

A graduate job is defined as one where the respondent would need a higher education qualification.

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.

To distinguish between task-warranted and task-unwarranted graduate jobs, the following three-stage procedure was followed. First, we estimated a probit model of respondents' self-reported degree requirements on job tasks using the pooled sample from SU2 and SLS. Second, from these estimates, for all graduate jobs we predicted a *graduate skills requirement score*, defined as the estimated probability of the job requiring a degree, conditional on its task content. Third, we dichotomised the graduate skills requirement score into a low and high value range. We therefore distinguished task-unwarranted graduate jobs with a low task-based probability of requiring a degree (threshold at probability of 0.3) from task-warranted jobs. Further details of this procedure, along with sensitivity tests that vary the threshold and conclude that the pattern of results is robust to such variations, are described in Henseke and Green (2020).

Additional variables: pay, perceived skills utilisation, demographics, and socio-economic background

SLS2 collects gross monthly pay as numeric value. The survey distinguishes between regular pay and other payment bonuses. The 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.

We use occupation codes (SU2: SSOC 2010, SLS: SSOC 2015) to distinguish professionals, managers, executives, and technicians (occupation major groups 1-3) from Clerical, Sales & Service Workers (occupation major groups 4 and 5) and Production & Transport Operators, Cleaners & Labourers (occupation major groups 7-9).

In addition to standard demographics, SLS includes data on parents' educational attainment and information on respondents' place of birth.

Table 2 summarises the descriptive statistics.

Table 2: Descriptive Statistics:

	(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
Age	42.14	41.76
Female	0.51	0.48
Foreign-born		0.25
Graduate parents		0.11
<i>Occupation shares:</i>		
Professionals, Managers, Executives and Technicians	0.57	0.59
Clerical, Sales and Service Workers	0.24	0.25
Production & Transport Operators, Cleaners & Labourers.	0.18	0.16

Descriptive Statistics from SU2 and SLS for the employed resident workforce 20-65 years (SU2: N=3353, SLS: N=4391).

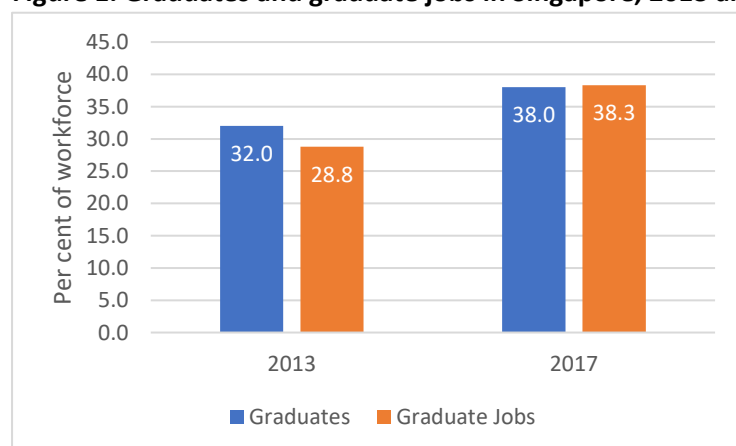
1.6 Key Findings

1.6.1 Singapore's dynamic graduate labour market, 2013-2017.

Figure 1 begins to address our first key research question. The share of graduates in the employed workforce rose from 32 per cent to 38 per cent in the four years between the surveys. Reassuringly, these estimates are quite similar to the annual estimates of graduate labour supply shown in Figure 1 which come from a different source (official statistics).

The impressive growth of the graduate workforce was more than matched by a 9.6-point increase in the per cent of jobs that required a university degree upon entry. At least over this short but not untypical period of high growth, then, it seems that there is a dynamic balance between the supply of graduates and graduate jobs.

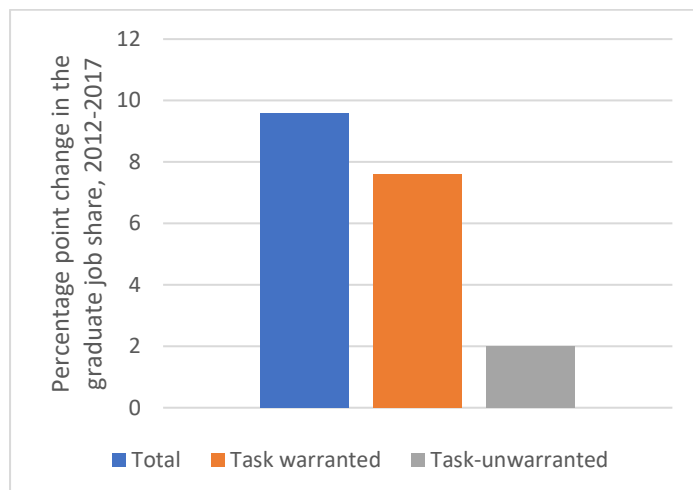
Figure 1. Graduates and graduate jobs in Singapore, 2013 and 2017.



The substantial change in the demand for degree qualification begs the question, however, as to whether the change towards higher qualifications is reflected in a shift of the job task mix towards activities in which graduates have a comparative advantage. Using the job task data in SU2 and SLS, we decomposed the change in degree requirements into a ‘task-warranted’ and ‘task-unwarranted’ component using statistical methods, as described above. Figure 2 plots the findings.

According to this analysis, 7.6 points out of total 9.6-point rise of degree requirement is ‘task-warranted’, that is, it can be attributed to shifts in the job task mix. Thus, almost all of the surge in degree requirements over this period in the Singaporean labour market was grounded in job upskilling. The proportion of jobs which appear to have been re-designated as jobs requiring degrees without any change in graduate job content is small, and insignificantly different from zero. The net result was that the proportion of graduates who were in task-warranted graduate jobs rose from 56.5% to 66.3%. We thus conclude that, assuming these two surveys have captured representative samples of the employed residential population, the 2013 to 2017 period was one of substantive upskilling in Singapore’s jobs.

Figure 2 The majority of the growth in graduate jobs is task-warranted

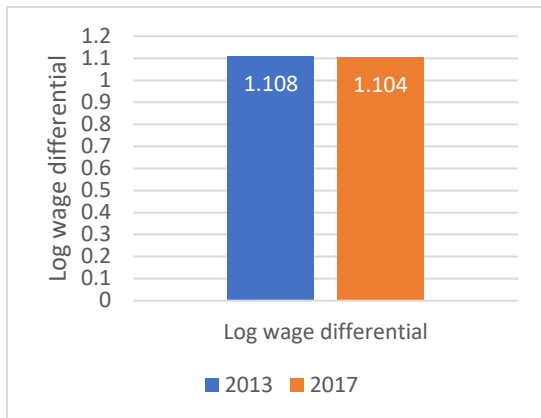


1.6.2 Graduate wage premiums and penalties

We now address our second question, surrounding the overall premiums and the penalties for graduates, according to the type of job they attain. Changes in graduate demand and supply are thought to influence the wage premium associated with higher education; but since both rose to a broadly similar extent, one might expect to see some stability. Stability is also predicted because the institutions and processes underpinning wage determination for graduate jobs are not expected to change rapidly. Wages are to an extent regulated across Singapore, with a strong influence coming from the ‘going rate’ in each industry.

To calculate the wage premium, we estimate a linear regression model with log hourly wages as the dependent variable on 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. Figure 3 shows the estimates of the wage premium for 2013 and 2017.

Figure 3: The hourly pay premium for graduates relative to those who had attained at most secondary-level qualifications



Note: The estimated log wage differential is conditioned on the following additional variables: gender, 5-year age-groups, indicator for the presence of dependent children under 16 in the household, and cohabitation status.

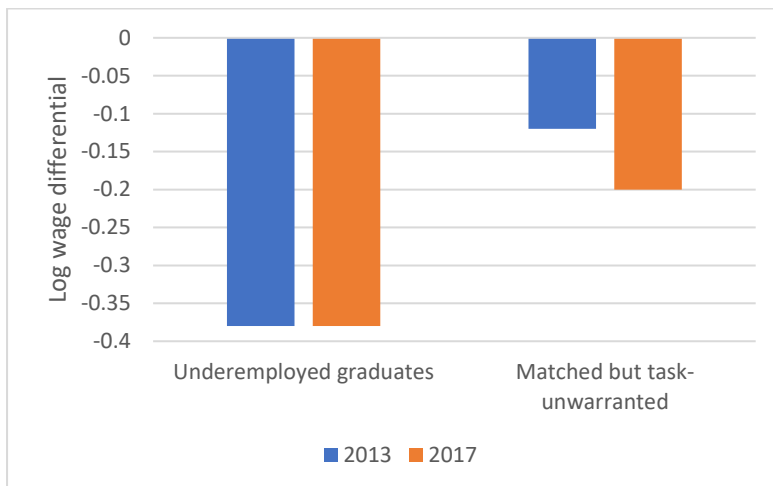
Figure 3 shows that higher education is associated with a very substantial wage premium in Singapore. Across the whole resident workforce in 2017, graduate hourly pay was more than twice ($= \exp(1.104)$) the mean pay for secondary school leavers. Further analyses show that the wage premium was similar in the male and female workforce but rising in age. It is larger in the age-bracket 35-65 years than for younger workers – a finding that is consistent with international evidence that higher education leads to faster wage growth over the course of careers. Over time the very high graduate wage premium held its ground, which is consistent with the balanced expansion of graduate supply with the demand for graduate skills.

Changes in the graduate wage premium are unlikely to provide a full account of pay dynamics over time within the graduate labour force. With rising higher educational attainment, graduate labour markets tend to diversify. One dimension along which outcomes diversify is the type of jobs graduates carry out; specifically, the extent to which graduate destinations require degree qualification and use graduate skills. Both underemployment and skills underutilisation have been found to come with a significant pay penalty.

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 at least a stable wage penalty 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.

Figure 4. Graduate pay by job match status



Note: Mean log wage differential by job match status of graduates adjusted for gender, 5-year age-groups, indicator for the presence of dependent children under 16 in the household, and cohabitation status.

Figure 4 displays the mean pay penalty associated with underemployment and underutilisation for graduates. Because the estimates do not adjust for the potential influence of individual 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 heavier wage penalty than being in a task-unwarranted graduate job. In 2017, average hourly pay for task-unwarranted graduates was about 18 per cent lower than for their well-matched peers. Its magnitude is notably less than the penalty experience by underemployed graduates, who earned on average 31 per cent ($=1-\exp(-0.38)$) less than graduates in task-warranted graduate jobs. The same ranking in earnings is found for all demographic subgroups in the data.

Second, we find no significant change in the wage penalties associated with underemployment and underutilisation. The finding of stable underemployment wage penalties in Singapore is consistent with trends in most European graduate labour markets (Green and Henseke, 2020).

In all, our analyses show a graduate labour market in good health. The surge in higher educational attainment in the workforce from 2013 to 2017 was met and exceeded by a rising share of jobs with degree requirements. The proportion of jobs with degree requirements rose by almost 10 percentage points between surveys. Almost all of the shift towards more degree requirement was found to be task warranted and thus routed in job upskilling. The positive picture is complemented by a substantial and stable graduate wage premium and no sign of increasing pay inequality by job match status.

1.6.3 The determinants of achieving a graduate job in 2017

Notwithstanding the overall picture just described, the inequality of wages is an ongoing issue. Even though more graduates were matched in task-warranted graduate jobs in 2017 than in 2013, there remain many graduates who were not so matched. As we have also seen, this matters for their pay. because matched graduates typically earn more than graduates in non-graduate jobs. Moreover, in other countries the probability of graduates working in graduate jobs is rarely equally distributed among socio-economic groups. Differences in this probability therefore often point towards wider inequities in the access to top jobs and in income.

In this section, we compare how the likelihood of working in a well-matched job differs among graduates according to three socio-economic categories. Figure 5 depicts the percentage point differences by gender, migration status and parental education. These differences are derived from a statistical analysis which adjusted for age, marital status, and whether there are dependent children in the household.

Figure 5. The likelihood of attaining a graduate job, according to gender, migration status and whether ‘first-in-family’.

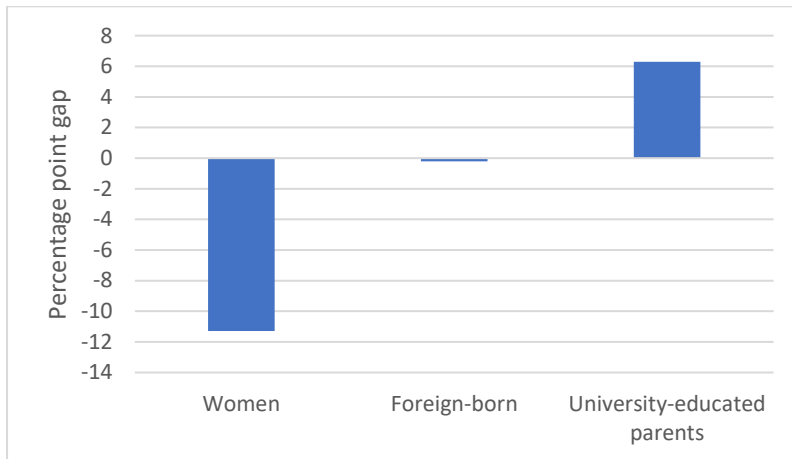


Figure 5 shows substantial differences in higher education leavers’ likelihood of working in graduate jobs in Singapore. Women graduates, particularly, were more than 10 percentage points less likely to attain a graduate job than their male counterparts, a gap that was statistically significant. Further detailed analysis suggest that the gender gap exists both in the younger workforce below 35 and more established workers aged 35 or above.

In Singapore, as in many other countries the chances of completing a university education differs significantly by parents’ educational attainment. But even among graduates, some differences in job destinations appear to persist. Our analysis suggests that there is a 6-point, statistically significant, advantage for graduates with university educated parents to attain a graduate job, compared with peers of the same age whose parents did not complete university (sometimes referred to as ‘first-in-family’ graduates).

By contrast, we find no differences between Singapore nationals and permanent residents in the likelihood of attaining a graduate job.

Graduate underemployment is sometimes framed as a symptom of skills heterogeneity whereby only less capable graduates find employment outside of graduate jobs. While our analysis here cannot rule out this explanation, previous research suggests that differences in observed skills can only account for a small difference in the variation of underemployment (Green and Henseke, 2016). It thus seems likely that the socio-demographic differences here are indicative of structural issues beyond the skills system.

1.6.4 Singapore’s Graduate Labour Market in International Comparison

Given the finding that Singapore's graduate labour market has achieved something of a dynamic balance between supply and demand growth, it is of interest to compare the parameters of the graduate labour market with those of other countries. As noted above, experiences have varied in recent decades, with some countries experiencing growing underemployment of graduates. The Singapore picture appears quite different from the graduate labour market trends in some European labour markets (for example in Ireland, Italy, Slovenia, Slovakia, Poland and Greece) – albeit using different data sources and definitions of key concepts (Green and Henseke, 2020).

To see how Singapore compares with other countries, consistent definitions and concepts are available in data from the OECD's Survey of Adult Skills (SAS). Table 3 shows the shares of graduates and graduate jobs (using the self-report measure) in 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 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. In New Zealand, around 64 % of 25-34-year-olds held post-secondary qualification followed by Korea (62%) and Japan (58%). Higher educational attainment was highest at about 40% in New Zealand and the Netherlands, and lowest in Denmark (31%).

Column (3) shows that, over the working age workforce, the proportions that have attained higher education range between Jakarta (ID) (11%) and New Zealand (34%).

Unfortunately, the scope for comparative analysis of workforce data with Singapore is considerably limited. This is because the SAS data for Singapore apply only to the residential workforce, while for other countries it includes the whole workforce. Using the same SAS data, some 32% of 25-65-year-old citizens and permanent residents of Singapore held a university degree or equivalent. 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 workers⁴), then the higher education attainment percentage of the whole workforce would be in the range 24% to 28% -- putting Singapore within the range of the other developed nations shown in the table.

A comparison of columns (3) and (1) illustrates the ongoing expansion of higher education attainment in the workforces of the current era. In almost all countries apart from the US and Indonesia (Jakarta), higher educational attainment in the young generation substantially exceeds the levels in the working-age population overall, especially in Korea (where the difference is 12 percentage points), Denmark, and England. Using the same data, the difference in attainment was particularly large in Singapore's resident workforce (17.5 points). Even without further expansion of higher education, university attainment in the populations of most countries, especially in Singapore's resident workforce, will rise from momentum alone.

Column (4) of Table 3 reports the percentage of graduate jobs. A substantial range is evident. 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. Making a similar approximate adjustment as above, the proportion of graduate jobs in the whole

⁴ <https://www.mom.gov.sg/passes-and-permits/s-pass/eligibility>

Singapore economy 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.⁵

Column (5) presents data on the underemployment wage penalty among graduates aged 25 to 65. This penalty ranges somewhat, from a low of 0.30 log points in Denmark to 0.49 log points in The Netherlands. Using the same data, the wage penalty in Singapore is 0.43 log points, within the range of other countries.

In summary, the lack of precision, owing to the differences in the definitions of the workforces surveyed in the SAS data, unfortunately prevents this report from drawing precise comparative conclusions using consistent concepts. Our approximate comparison suggests that neither higher education attainment, nor the proportion of graduate jobs, nor the penalty for underemployment are exceptional in Singapore. However, from the qualifications gap between younger and older workers, Singapore appears to be set on an especially high rate of expansion in the residential workforce's higher education attainment in the coming years.

Table 3. Graduate labour markets in international comparison, 2011-2016

	(1)	(2)	(3)	(4)	(5)
Country	Higher Education (25-34, %)	Post-secondary and tertiary professional (25-34, %)	Higher Education (25-65, %)	Self-reported Graduate jobs (%)	Underemployment pay penalty
Denmark	30.8 (1.53)	21.6 (1.41)	19.3 (0.54)	20.5 (0.67)	-0.301*** (0.027)
Jakarta (ID)	13.3 (1.05)	7.2 (0.75)	11.3 (0.54)	17.6 (1.03)	-0.430* (0.199)
Japan	34.7 (1.62)	23.4 (1.40)	26.6 (0.68)	20.9 (0.75)	-0.361*** (0.041)
Korea	35.9 (1.48)	26.2 (1.30)	23.9 (0.61)	22.6 (0.83)	-0.315*** (0.047)
Netherlands	39.7 (1.81)	1.8 (0.44)	31.1 (0.75)	37.8 (0.94)	-0.485*** (0.069)
New Zealand	40.1 (1.70)	23.6 (1.44)	33.5 (0.78)	33.6 (0.98)	-0.435*** (0.036)
United States	33.4 (1.26)	21.7 (1.16)	31.8 (0.73)	32.6 (0.93)	-0.482*** (0.045)
England (UK)	36.4 (1.75)	12.7 (1.21)	26.4 (0.74)	27.9 (0.97)	-0.441*** (0.046)

Secondary analysis of SAS. Columns (1) & (3): higher educational attainment (ISCED5A/6). Column (2): post-secondary and professional tertiary education educational attainment (ISCED3,4/5B). Column (4): percentage of jobs that require a degree to get, employed workforce 25-65 years. Column (5): 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.

⁵ This approximation assumes that the prevalence of second-job holding is low and not greatly varying across countries.

1.7 Policy Implications

The period before the COVID-19 pandemic appears, from the evidence presented here, to have been one where a successful dynamic balance was being maintained in the graduate labour market for Singapore citizens and residents. A steady, significant growth in the proportion of people with at least a bachelor's degree was being matched by a similar increase in the proportion of graduate jobs. Moreover, virtually all of this increase appears to have been 'warranted' by the rising numbers of jobs where typically graduate tasks were involved.

Looking to the future, however, this dynamic balance does not mean that there is no risk that an underutilisation of graduates could develop in the coming years. The growth in university enrolment, supplemented by the retirement of older, less qualified workers, implies that the supply of graduates is likely to continue to rise substantially through the current decade, unless there were to be a strict pause on enrolments. Whether and how fast the proportion of graduate jobs will continue to grow, however, is more difficult to predict. In addition to its dependence on the overall growth of the economy, the aggregate matching of supplies and demands also depends on the ebb and flow in the use of temporary migrant high-skilled workers entering Singapore with an Employment Pass. Both these factors are likely to have been significantly affected by the Covid-19 pandemic. It is impossible to be confident, therefore, that the broad balance in the graduate labour market can be maintained. To be sure that medium-term policy levers are used to best effect, it is recommended that ongoing efforts are made to monitor the growth and distribution of graduate jobs. Future waves of the Skills and Learning Study should be able to deliver this intelligence, for informing educational policymakers and university plans. We would also recommend that all segments of the workforce should be considered in the analysis, in order to gain the best picture of the evolving supplies and demands for graduate labour.

When skills are not being utilised fully at work, employees tend to express lower job satisfaction and, as we have seen, in Singapore underutilisation is associated with a very significant wage penalty. As many other countries have discovered, the risk of underutilisation of graduate labour is greater for some groups than for others. Only to a small extent can this differential exposure to underutilisation of their degrees be explained by heterogeneity among graduates' skills. In this study, we have found that women, and those whose parents had not been university graduates, are two important groups who are more likely to find themselves in jobs that do not match their attained qualifications. These differences contribute therefore to the gender pay gap in Singapore and reduce somewhat the social mobility that should be made possible through university education for those from less-advantaged backgrounds. Policies that can reduce the gap would therefore be beneficial for reducing socio-economic inequalities.

It must be noted finally that the failure to match graduates' qualifications and skills with jobs, where this occurs, does not mean that students' degree education is wasted. Under-employed graduates do have a chance of upgrading their job in subsequent years; and, even if they do not do so, their university education can have other benefits for those individuals – such as better health, and better well-being from non-work activities – and many 'external' benefits for others in Singapore society (Green and Henseke, 2016). Nevertheless, university education is costly, and the aspiration to obtain a graduate job is typically among the primary objectives of students, the world over, when choosing to study at university. Ensuring that the higher education system and the economy retain their dynamic balance over time is likely therefore to continue to be an important consideration for the foreseeable future.

2. The Effects of System Type and System Characteristics on Skills Acquisition in Upper Secondary Education and Training

Contributed by Andy Green, Neil Kaye and Hao Phan

The second part of this report turns attention away from the generation and utilisation of graduate skills to focus on a previous education stage. It examines the effects of upper secondary system types and characteristics on skills acquisition during the upper secondary phase of education and training and considers the implications for Singapore⁶.

There is an extensive cross-country literature on education system effects on skills acquisition during the primary and lower secondary phases of education. This draws on data on tested knowledge and skills, and on education system characteristics, from three international surveys: *The Progress in International Reading Literacy Study* (PIRLS) - which tests 4th graders at five-yearly intervals; *Trends in International Mathematics Study* (TIMSS) - which tests 4th and 8th graders at four-yearly intervals and *the Programme for International Student Assessment* (PISA) which conducts tests of proficiency in Reading, Mathematics and Science among students aged 15. The wide range of international data available on skills and education systems covering two decades (and more for TIMSS) has allowed researchers to make comparative estimates of country-level changes in the levels and distributions of core skills during primary and lower secondary phases of education (e.g., Hanushek & Woessmann, 2006). It has also made it possible to explore how far education system characteristics explain the substantial variation across countries in these changes during the primary and lower secondary phases.

Much less comparative research, however, has been conducted on skills acquisition during upper secondary education and training, partly, as we explain later, due to the relative paucity of international data for this phase. However, this is now beginning to change with the introduction of the OECD's *Survey of Adult Skills* (SAS - also known as PIAAC) which was first fielded in 24 countries and regions in 2011/12 and now tests proficiency in literacy, numeracy and problem solving in over 40 countries and regions. A number of reports were published using data from the first round of SAS (including OECD, 2013; Borgonovi, 2017; Green et al., 2014, 2015, 2016; Pensiero & Green, 2018) drawing tentative conclusions about the role of system characteristics in explaining the variation across countries in changes in skills levels and distributions during the upper secondary phase.

In this report we seek to build on earlier work and provide more robust evidence on system effects during the upper secondary phase in three ways. Firstly, we use data from the larger sample of countries in both waves 1 and 2 of SAS. Secondly, we test the effects of a considerably wider range of system indicators. Thirdly, we use a variety of statistical methods to analyse the relationships across countries between upper secondary system types and characteristics and changes in levels and distributions of skills between age 15 (in PISA) and the end of the upper secondary phase. Whereas our previous work analysed changes using quasi-cohort analysis of published data on skills from PISA (at age 15) and SAS (at age 25-29), thus allowing compounding effects from tertiary education and

⁶ The full detailed account of the research can be found at:
https://www.llakes.ac.uk/sites/default/files/LLAKES%20RP%2069%20-%20Green_Kaye_Pensiero_Phan.pdf

employment, here we use customised data from OECD on skills scores at age 18-20 to capture more precisely the skills at the beginning and end of upper secondary education and training.

Throughout the report we refer to 'skills' as 'core skills' defined by OECD. We are aware that other, non-cognitive skills are also important for graduates to enter the labour market and these skills are not necessarily linked to or predicted by the levels and distributions of core skills. However, due to the availability of cross-country data and our modelling approaches, we mainly focus on literacy and numeracy skills in this research. Our findings, therefore, should not be seen in isolation or taken out of the above-mentioned contexts.

The research involved:

- a review of the literature on education system effects on skills during the lower and upper secondary phases of education and training;
- the development of a typology of upper secondary education and training systems for the period under scrutiny (roughly 2008-2012);
- the construction of a descriptive dataset of system characteristics and measures of skills levels and distributions at ages 15 and 18-20;
- a statistical analysis of the effects of system types and characteristics, using linear regressions and Difference-in-Difference models;
- a consideration of the policy implications of the research, with particular reference to Singapore.

2.1 Review of the Literature and Typology of Education Training Systems

Our review focused predominantly on the research literature which provides direct evidence of the impact of system factors on Reading, Maths and Science scores at age 15 in PISA and on literacy and numeracy skills after the end of upper secondary education in SAS. The first part focussed on evidence on factors affecting changes in aggregate skills levels and the second part on evidence on factors affecting changes in skills inequalities. We also considered the main theories which seek to explain variations across countries in changes during this phase. The reviews considered the effects of a range of system factors under the following headings:

- *Institutional Structures and Organisation*
- *Governance, Regulation and Funding*
- *Curriculum, Pedagogy and Assessment*
- *Teacher Quality*

The review identified a range of factors which research shows may impact on skills outcomes at ages 15 and 18-20 and which may contribute to explaining variation across countries in changes in skills levels and inequalities between these ages. Although research findings are far from consistent, the predominant conclusions from the more rigorous research studies indicate that:

- the prevalence of early tracking and entirely privately funded schools is not consistently found across studies to have a positive impact on average skills levels (e.g. Schütz et al, 2008; Woessmann, 2008), but is generally associated with greater inequality in skills opportunities and outcomes (e.g. Werfhorst and Mifs, 2010; Hanushek and Woessmann, 2006; OECD, 2010; Schütz et al., 2008);
- school choice and diversity, and competition between schools, are not systematically associated across countries with better system outcomes, whereas a degree of school/professional autonomy - including through the private management of schools - is, at

least where this autonomy relates to curriculum matters, not budgets (e.g., Bol and Werfhorst, 2013; OECD, 2013);

- certain forms of curriculum standardisation (including through the use of common core curricula with the mandatory learning across tracks of Maths and the national language; the promotion of ‘curricula coherence’, and the use of centralised exit exams) tend to raise levels and narrow distributions of scores (e.g., Raffe et al, 1998; Bol, *ibid*);
- high levels of participation in vocational learning, particularly with elements of work-based learning, is associated with better overall outcomes and reduction in inequality (e.g., Bol, *ibid*).
- teacher pay, cognitive skills and professional development are generally associated across countries with better outcomes in different phases of education (e.g. Hanushek et al, 2019).

Boudonian theory argues that systems with more ‘branching points’ tend to increase inequality of outcomes. While the theory has been found to be widely applicable to primary and lower secondary education, it may be less so for upper secondary education and training, where preparation for higher education and the labour market requires greater specialisation and invariably involves some form of tracking. Raffe et al. (1998, 2001) have argued that tracking in upper secondary education is less important than relative ‘parity of esteem’ between academic and vocational provision. Whilst during the compulsory phase schools and educational programmes are organised hierarchically, according to a monotonic scale of academic prestige, in the upper secondary phase the tracks can be valued according to more differentiated criteria, whether it be their success in getting graduates into skilled jobs or into higher levels of education and training. Some more integrated systems, as with the Nordic comprehensive high schools, can be effective in raising average skills levels through greater standardisation of curricula in core areas and through generating higher normative expectations, through the provision of flexible progression routes and a common qualification framework. Some more tracked systems, as in countries combining academic high schools with the Dual Systems of apprenticeship, can also raise mean skills levels through establishing high normative standards in their vocational tracks by virtue of the prestige associated with high quality apprenticeships and the peer effects generated by the wider ability mix among students recruited to these apprenticeships.

2.2 Typology of Upper Secondary Education and Training Systems

Our typology is developed on the basis of the theories and typologies commonly found in comparative political economy and the comparative education and training literature which classifies systems according to institutional structures, forms of curriculum, pedagogy and assessment, and modes of governance and regulation (Busemeyer and Iversen, 2011; CEDEFOP, 2008; Dumas et al., 2013; Green, 2003; Greinert, 2004; Lasonen and Young, 1998; Maurice et al., 1986; McLean, 1999; OECD, 1985; Raffe et al., 1998, 2001; Verdier, 2013). However, we modify the typology in accordance with the latest empirical data on relevant indicators for the period under investigation. We identify six broad types of upper secondary education and training systems in OECD countries relating to how they were during the period when the 18-20 years olds tested in SAS (in 2011-2014) were going through upper secondary education (i.e., roughly between 2008 and 2014).

Type 1. These are predominantly school-based systems with general academic and vocational provision in different types of dedicated upper secondary institution and with apprenticeships representing separate but residual systems. Programmes normally last for two or - more usually – three years, and end with a qualification which gives access to general university higher education

(ISCED 5A), in the case of general education students, and vocational tertiary education (at ISCED Level 4 or 5B) for vocational students. The curricula in different general and vocational programmes today generally share certain common core elements but programmes are typically organised around a cluster of subjects specific to the disciplinary or vocational orientation of programme. Diplomas are normally based on externally administered 'grouped awards' which require passes in a range of subjects, including core areas of language, Maths (and sometimes Civics). **Type 1b.** A subset of Type 1 countries (Denmark, Netherlands, Finland and Singapore) is also distinguished by having high rates of participation on vocational programmes, often with a substantial element of work-based training as part of their vocational school provision. They represent a growing trend towards the hybridisation of upper system types, drawing on elements of both Type 1 and Type 3 systems (Verdier, 2013).

Type 2. These are predominantly comprehensive, school-based systems with academic and vocational provision within the same institution and with, again, apprenticeships representing a largely residual alternative form. Provision is organised either as a standardised, core plus options programme, as in most North American high schools, or in differentiated programmes with distinctive subject specialisms but overlapping cores of general education, as in Norway or Sweden. Study durations tend to be standardised at two or three years across all tracks in the US and Canada and at three years in the Nordic countries. These systems share most of the characteristics of Type 1 systems but tend to have a higher degree of integration of curricula and assessment across the range of provision (Raffe et al., 2001). They can be regarded generally as relatively standardised on one level – since there is only one main type of upper secondary institution and all programmes tend to have long cycles. However, governance and regulation vary considerably between the US and Scandinavian contexts, with school choice and diversity policies in the federal US system leading to much greater institutional variation than would be found in the more standardised and unitary Nordic systems. Because of differences in governance and regulation systems are best divided between **Type 2a** for the North American variant and **Type 2b** for the Nordic variant.

Type 3. These are systems with participation distributed relatively equally between school-based general education and employment-based Dual Systems of apprenticeship and are found exclusively in 'social market' type political economies (Hall and Soskice, 2001). In this kind of system, the provision at upper secondary level may be of similar duration across the different tracks (as with the normatively three-year apprenticeships and final stage *Abitur* courses in Germany), and the vocational track contains significant mandatory components of general education in all Dual System apprenticeships (Solga et al., 2014). However, the general and vocational tracks remain very distinctive, with sharp differences in forms of regulation, curricula, and assessment, and with clearly differentiated final qualifications and subsequent progression possibilities in education, training and work. In respect of their Dual Systems, Type 3 systems have distinctive forms of regulation based on the social partner organisations. This means that apprenticeship systems are closely integrated with labour market institutions and the world of work, and this has important effects on the labour market value of the qualifications they offer and the consequent incentives this provides for apprentices (Busemeyer and Iversen, 2011). Dual System apprenticeships are generally considered to be of high quality and the programmes attract a large number of students, coming from across the ability range, including a substantial proportion graduating from the academic *Gymnasium* or even university (Schneider and Tieben, 2011). These higher achieving entrants add to the prestige of the vocational system, the quality of its outputs, and the value of its qualifications on the labour market, the latter being boosted in addition by strong labour market demand for intermediate skills (Hall and Soskice, 2001). With such apprenticeship systems, it is argued (Raffe et al., 2001), there will be greater parity of esteem between

the academic and vocational tracks, and consequently expectation and achievement in the vocational tracks will be higher.

Type 4. These are 'Mixed Systems' which include many different school- and employment- based programmes of variable length and quality but with dominant academic tracks. Systems of this type tend to have pronounced status gaps between academic and vocational programmes with the most qualified students entering academic programmes and the least qualified entering vocational programmes which are often shorter in duration and do not necessarily offer progression routes into higher level programmes or high-quality jobs. Low rates of participation in vocational tracks, which are relatively under-funded by comparison with the academic tracks, offer further evidence of status gaps between general and vocational provision. Mixed systems are also notable for their lack of curriculum standardisation across programmes since they lack a common core curriculum and do not mandate the study of Maths and the national language across all tracks. Regulation and governance in mixed systems is generally more liberal and market-oriented than in other systems, with much diversity in programmes and types of providers, including private training organisations and, in the case of the UK, private awarding bodies. Systems in this group tend to have lower participation rates among 17- and 18-year-olds and relatively high rates of early school leaving (defined by the European Commission as those who leave education without qualifications above the ISCED 3C (short) level).

Based on our analysis of the literature, our hypotheses regarding the effects of system types on changes in outcomes during upper secondary education and training were as follows:

System Type effects on changes in skills levels:

- Type 2b and Type 3 systems will perform well in enhancing average skills levels, because they combine a degree of standardisation in key areas (e.g., core curricula, long-cycle programmes) with an emphasis vocational and work-based learning and high teacher quality.
- Type 2a and Type 4 systems will perform less well in raising mean skills levels because of the lower rates of participation in vocational learning and the relative lack of parity of esteem between academic and vocational tracks.
- Type 4 systems will be additionally disadvantaged by the lack of curriculum standardisation in core areas.

System Type effects on skills inequality:

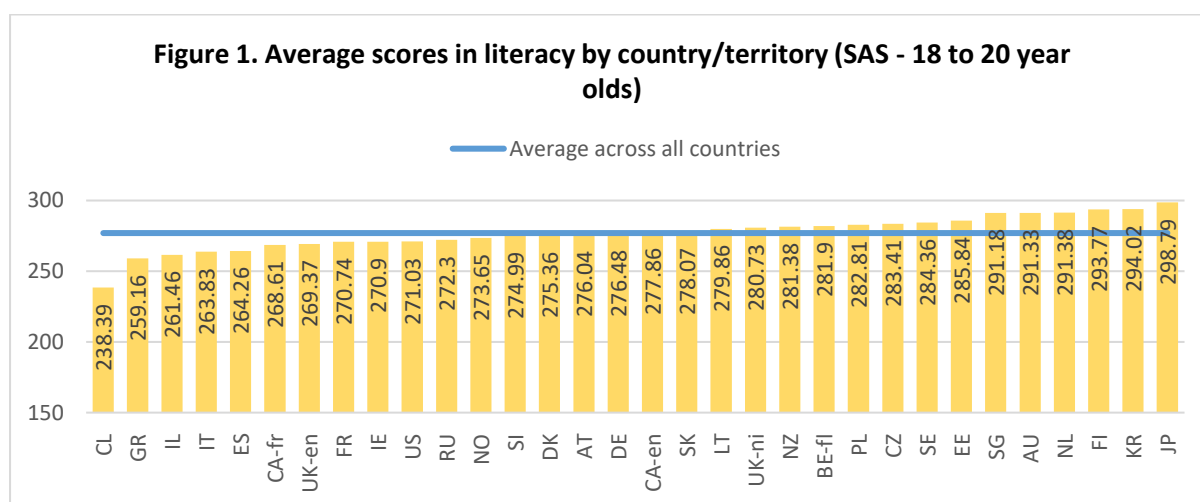
- Type 2b systems and Type 3 systems will reduce skills inequality because of curriculum standardisation in key areas (mandatory literacy and language provision; length of courses) and due to relative parity of esteem between academic and vocational tracks (particularly in Type 3 where work-based learning raises skills of vocational students).
- Type 4 systems will be less effective in reducing skills inequality because of system fragmentation and lack of curriculum standardisation in core areas, both of which undermine normative standards. Comparatively low recruitment to vocational programmes seen to be of low quality, and the large status gaps between these and academic programmes, will also tend to sustain skills inequalities in the upper secondary phase.
- Type 2a systems will be less effective in reducing skills inequality because of the relative absence of vocational learning.

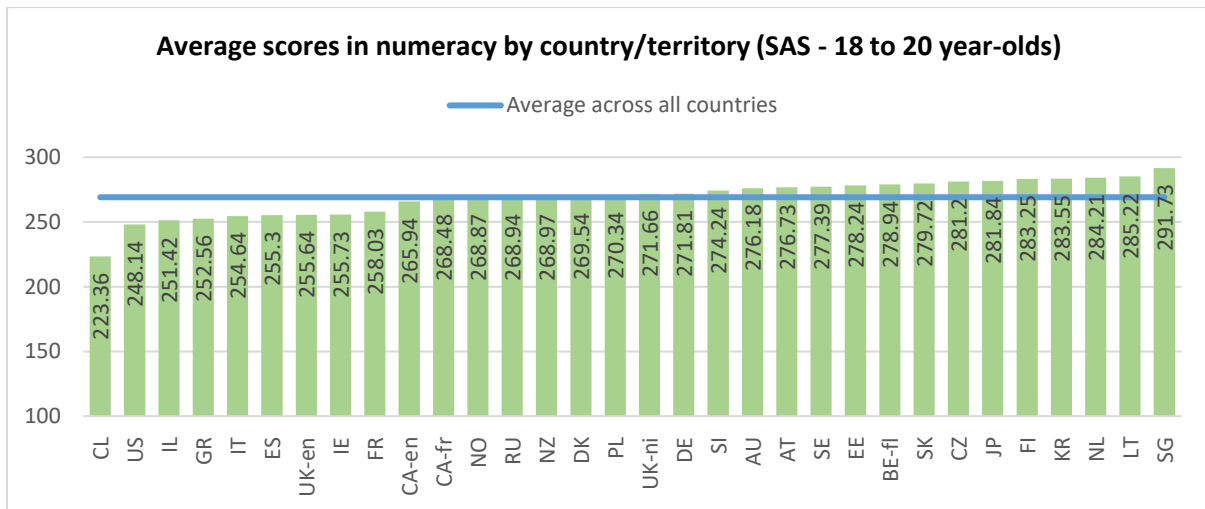
2.3 Descriptive Data on Skills Outcomes

Table 1. Countries included in the sample

Country	Country code	System Type	PISA wave	PIAAC round	Country	Country code	System Type	PISA wave	PIAAC round
Australia	AU	4	2006	2011/12	Italy	IT	1	2006	2011/12
Austria	AT	3	2006	2011/12	Japan	JP	1	2006	2011/12
Canada	CA	2a	2006		Korea	KR	1	2006	2011/12
Canada (English)	CA-en	2a		2011/12	Lithuania	LT	1	2009	2014/15
Canada (French)	CA-fr	2a		2011/12	Netherlands	NL	1b	2006	2011/12
Chile	CL	4	2009	2014/15	New Zealand	NZ	4	2009	2014/15
Czech Republic	CZ	1	2006	2011/12	Northern Ireland (UK)	UK-ni	4	2006	2011/12
Denmark	DK	1b	2006	2011/12	Norway	NO	2b	2006	2011/12
England (UK)	UK-en	4	2006	2011/12	Poland	PL	1	2006	2011/12
Estonia	EE	1	2006	2011/12	Russian Federation	RU	1	2006	2011/12
Finland	FI	1b	2006	2011/12	Singapore	SG	1b	2009	2014/15
Flanders (Belgium)	BE-fl	1	2006	2011/12	Slovak Republic	SK	1	2006	2011/12
France	FR	1	2006	2011/12	Slovenia	SI	1	2009	2014/15
Germany	DE	3	2006	2011/12	Spain	ES	4	2006	2011/12
Greece	GR	1	2009	2014/15	Sweden	SE	2b	2006	2011/12
Ireland	IE	4	2006	2011/12	United States	US	2a	2006	2011/12
Israel	IL	4	2009	2014/15					

The following descriptive analysis first looks at the average skills outcomes in literacy and numeracy for 18-to-20-year-olds, as measured in SAS, and their relation to PISA scores at age 15. Following this, we analyse the distribution of skills within systems using Gini coefficients of skills inequality. Our descriptive analysis looks at how inequality in literacy/reading and numeracy/mathematics changes between age 15 (PISA) and age 18-20 (SAS) and the relative performance of different system types.





Grouping countries by system type allows us to identify some underlying trends in relation to average scores in literacy and numeracy.

Type 4 systems score lower, on average, than those in other system types, and below the average for all systems by 7 points in literacy and 12 points in numeracy. There is a large within-group variation in Type 4; nevertheless, if removing Chile, the main outlier, the average for the group remains below the average for all systems by 2 points in literacy and 7 points in numeracy.

Type 2a systems (the US and the two regions in Canada) score, on average, below the country average in both literacy and numeracy, and below the average for other types, except Type 4. Anglophone Canada performs better than the other systems in the group in literacy, but all systems in the group perform below the system average in numeracy.

Type 1b systems perform, on average, higher than other system types in both domains, with average scores respectively 11 and 13 points higher in literacy and numeracy. This group includes Singapore, the Netherlands, Denmark, and Finland.

Type 1 systems – the largest group of countries/territories – perform at around the average seen across the sample in both literacy and numeracy.

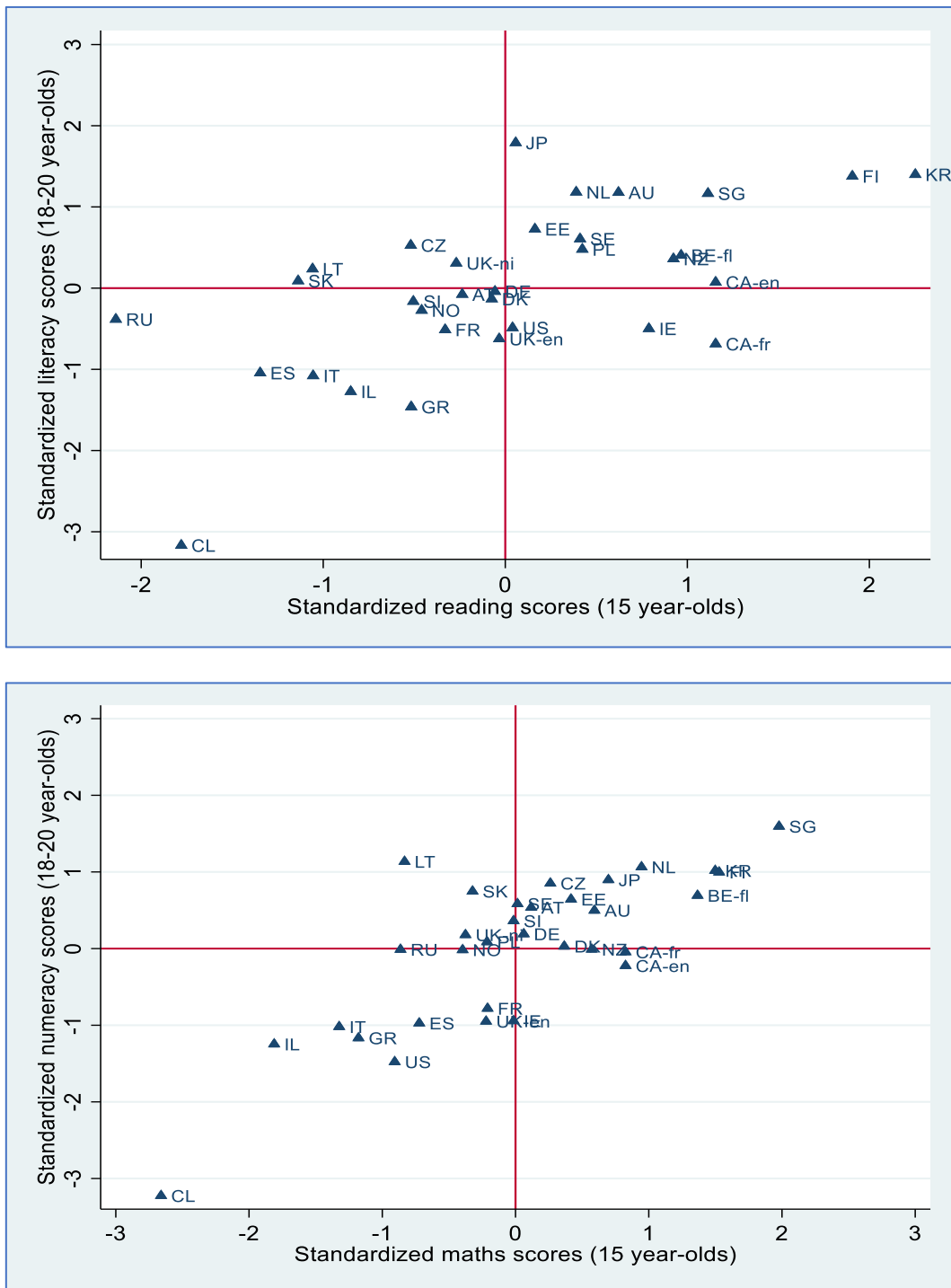
Type 3 systems (Austria and Germany) perform similarly in both domains. Their average is close to the system average in literacy scores, but five points above the system average in numeracy.

2.3.1 Correlation between PISA Scores and SAS Scores

It is to be expected that average scores of students at age 15 in reading and Maths will correlate highly with scores, respectively, in literacy and numeracy among 18- to 20-year-olds. In order to account for the different scales on which the PISA and SAS surveys are scored, average country-level scores are standardised to have a mean of zero and a standard deviation of one.

The graphs below (Figure 2) show a strong correlation between PISA and SAS scores for literacy ($r = .616, p < .001$) and numeracy ($r = .780, p < .001$). Countries such as South Korea, Finland and Singapore are relatively high-performing in literacy in PISA and at the end of upper-secondary education, whilst in Chile, Israel, Italy, and Spain scores show a consistent lower-than-average performance. In numeracy, Singapore, the Netherlands, and Korea are consistently high performing in both tests, whilst Israel, Italy, Greece, and the US are consistently low performing.

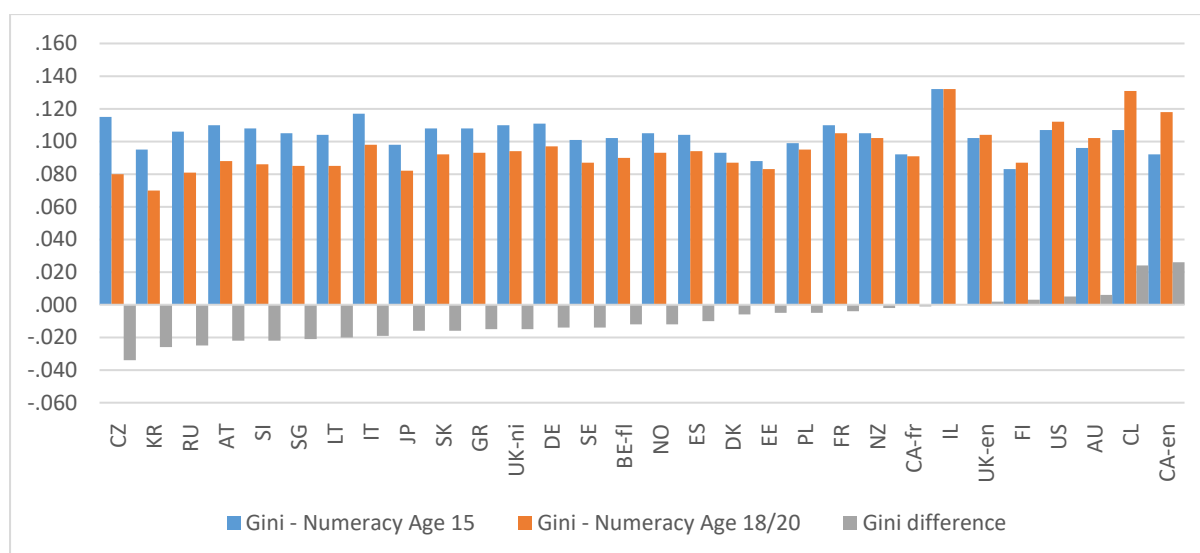
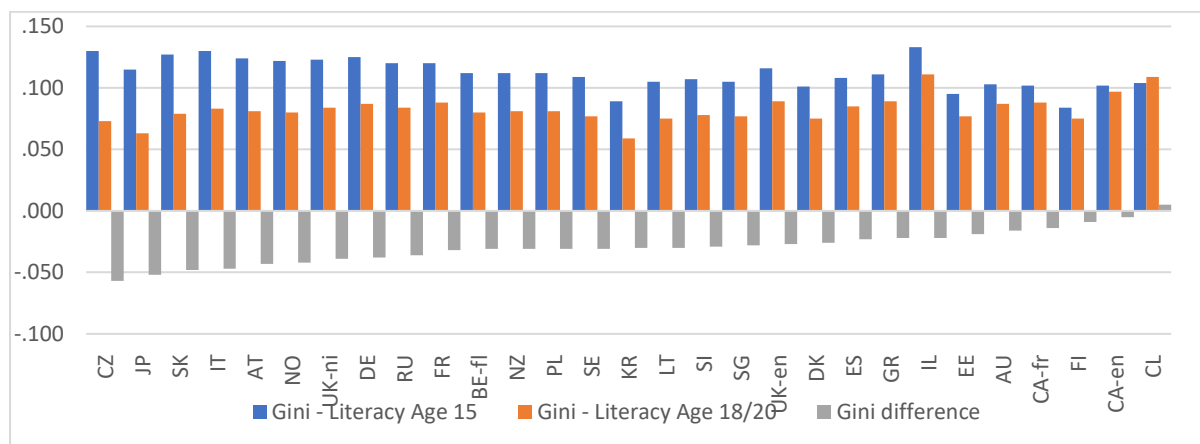
Figure 2. Scatterplot of standardised scores in reading/literacy and maths/numeracy by country/territory (PISA – 15-year-olds plotted versus PIAAC – 18-20-year-olds)



2.3.2 Changes in inequality of skills outcomes

Figure 3 shows that in literacy all countries, with the exception of Chile, managed to reduce inequality in scores during the upper-secondary stage, although there is a considerable variability in terms of the magnitude of this reduction. For numeracy, six countries see an increase in inequality, whilst for countries that see a reduction in inequality, these are typically more modest than those seen in literacy scores.

Figure 3. Gini coefficients of inequality in relation to scores in reading/literacy and maths/numeracy by country/territory (PISA – 15-year-olds and PIAAC – 18-20-year-olds)



The countries seeing the greatest reduction in inequalities for literacy (Czech Republic, Japan, Slovakia, and Italy) are in Type 1 systems, whilst Type 3 systems (Austria and Germany) also improve their relative inequality of scores. At the other end of the spectrum, the pattern is less clear-cut with the smallest reductions (or even increases) in inequality being seen in Chile and Australia (Type 4), Canada (Type 2a) and Finland (Type 1b).

Similarly, for numeracy, countries with Type 1 systems (again the Czech Republic, but also this time Russia, Korea, and Slovenia) see the greatest reduction in inequality, along with Austria and Singapore. The same countries that perform relatively badly in literacy are also those seeing increases in inequality for numeracy – Canada (English-speaking), Chile, Australia, and Finland. In addition, the United States and England also experience small increases in inequality for numeracy scores in upper-secondary education.

Comparing levels of inequality between PISA scores at age 15 and SAS scores among 18-to-20-year-olds by system type (Table 2), we can see that overall, for both reading/literacy and maths/numeracy, the distribution of scores has become less unequal. This reduction in inequality is notable in Type 1 and Type 2b systems and, particularly, in Type 3 systems, which see the most unequal scores at age 15, yet have substantially less unequal distribution of scores at the end of upper-secondary education.

By contrast, Type 2a North American systems see a smaller reduction in inequality in literacy and an increase in inequality in numeracy. Type 4 mixed systems see a reduction in literacy inequality but flat line in numeracy inequality.

Table 2. Gini coefficients of inequality in relation to scores in reading/literacy and maths/numeracy by system type (PISA – 15-year-olds and PIAAC – 18-20-year-olds)

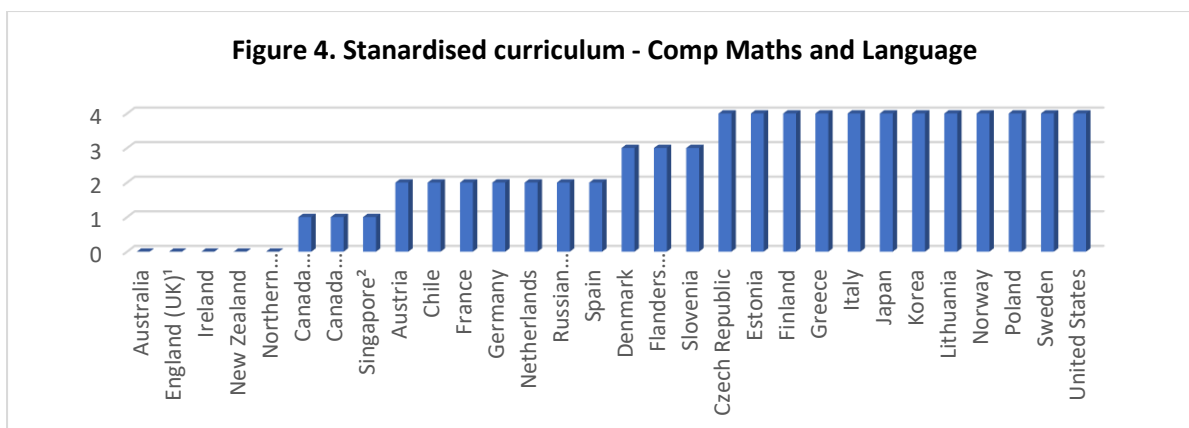
	Age 15 (PISA)	Age 18-20 (SAS)	Age 15 (PISA)	Age 18-20 (SAS)
	Reading	Literacy	Maths	Numeracy
Type 1: Differentiated systems	.113	.077	.104	.088
Type 1b: Differentiated systems, with school-based apprenticeships	.097	.076	.094	.086
Type 2a: Comprehensive systems – North American	.102*	.090	.097	.107
Type 2b: Comprehensive systems – Nordic	.115	.079	.103	.090
Type 3: Dual systems	.125	.084	.111	.093
Type 4: Mixed systems	.114	.091	.108	.107
TOTAL	.112*	.082	.104	.095

*The values exclude the US (as there are no data available)

2.4 Descriptive Data on System Characteristics

Our analysis focussed on ten system characteristics which differ systematically according to system type, and which research suggests may be relevant factors in explaining cross-country variation in changes in levels and distributions of literacy and numeracy skills during the upper secondary phase. We focus here on a selection of three of these which, as we show later, have significant effects according to our statistical analysis. Various indicators for typical duration of studies and graduation ages, and for the parity of funding across vocational and general programmes also seem relevant, although their impacts are less consistent in statistical terms.

Standardised curriculum score is a quantitative score ranging from zero to four, derived in relation to whether students are obliged to take courses in Maths and their national language at upper secondary level. A country's system is scored '1' if most of its programmes require compulsory mathematics/national language and '2' if all of its programmes have such a requirement. Scores for mathematics and national language are added together for a total score, which provides a proxy measure of curriculum standardisation.



Data are obtained via Hogden et al. (2010) and Eurydice (2019) and relate to the situation prevailing at around 2010 (when our SAS sample enters upper secondary education). Values are available for 30 out of 32 countries in our sample. Values range from zero (e.g., Australia, England, New Zealand, and Ireland) to four (e.g., United States, Sweden and Poland). Type 4 systems appear to have the least standardised curriculum in relation to compulsory Maths and national language (mean score of .57), whilst the Type 2b Nordic systems both have the maximum score of 4 and Type 1 systems close with 3.5, as consistent with our typology.

Table 3. Standardised curriculum score by system type

	N	Mean	SD
Type 1: Differentiated systems	12	3.50	.80
Type 1b: Differentiated systems, with school-based apprenticeships	4	2.50	1.29
Type 2a: Comprehensive systems – North American	3	2.00	1.73
Type 2b: Comprehensive systems – Nordic	2	4.00	.00
Type 3: Dual systems	2	2.00	.00
Type 4: Mixed systems	7	0.57	.98
TOTAL	30	2.47	1.53

Vocational prevalence refers to the proportion of students in upper-secondary education and training enrolled on vocational programmes (UNESCO, 2020). Data are available for all countries except for the United States.⁷ Overall, across all countries in our sample, approximately 46 percent of students are enrolled in vocational courses of study at upper-secondary level. However, there is a great degree of variability between countries and systems. In Canada, for example, only around 7 percent of students are in a vocational programme, whilst in Austria the figure is more than 75 percent.

⁷ In SAS the US authorities report all High School completers as having taken general courses. This seems reasonable given that the vast majority of High Schools provide vocational education only in the form optional courses, not as discrete vocational programmes, and there are no specific vocational qualifications awarded. UNESCO, however, record a missing value for the US for this indicator.

Figure 5. Vocational prevalence by country/territory

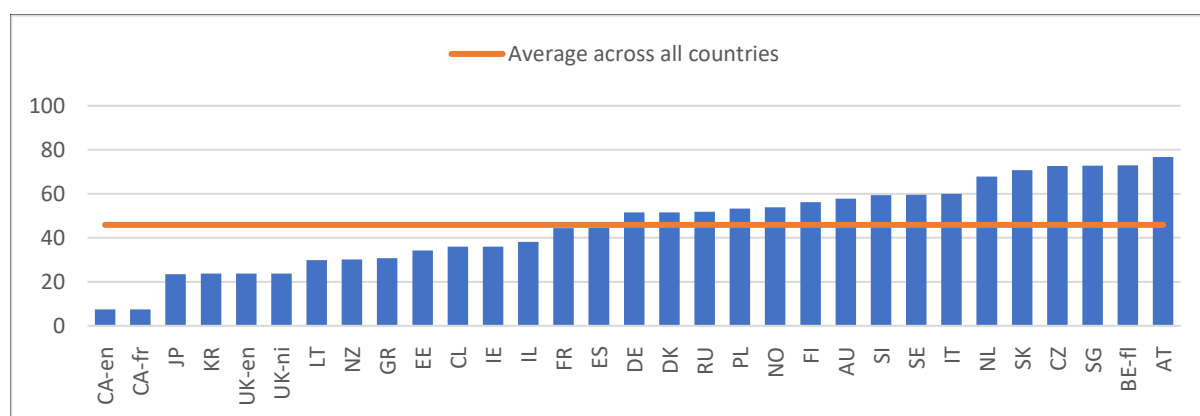


Table 4. Vocational prevalence by system type

	N	Mean	SD
Type 1: Differentiated systems	13	48.24	18.46
Type 1b: Differentiated systems, with school-based apprenticeships	4	62.10	9.90
Type 2a: Comprehensive systems – North American	2	7.49	.00
Type 2b: Comprehensive systems – Nordic	2	56.71	4.04
Type 3: Dual systems	2	64.13	17.88
Type 4: Mixed systems	8	36.26	11.24
TOTAL	31	45.88	19.42

As shown in the Table 4 above, Type 3 (Dual systems) and Type 1b (Differentiated systems with school-based apprenticeships) have the highest proportion of students in vocational programmes – with 64 percent and 62 percent respectively. By contrast, Type 4 (Mixed) and Type 2a (Comprehensive North American – which includes only Canada here) have significantly lower vocational prevalence.⁸ Interestingly, the Comprehensive Nordic systems (Type 2b) have more than half of the upper secondary cohort in vocational education (although the majority of these are taking vocational programmes within comprehensive high schools). This exceeds the proportion of those on vocational programmes in Type 1 (Differentiated) systems, where students on general programmes are typically still the majority.

Teacher workload is a derived variable calculated from two measures: average student-teacher ratio and average number of teaching hours per year (OECD, 2012). Both measures refer to the upper secondary level only. These two values are multiplied together to obtain a measure of the average number of teaching hours undertaken, accounting for the average number of students for which teachers are responsible. This provides a reasonable proxy for the measurement of teacher workload across different systems. Complete data is available for 29 of the 32 regions in our sample.

⁸ The value for Type 2a would be even lower were we to include the USA with a value of zero.

Figure 6. Teacher workload (student-hours per year) by country/territory

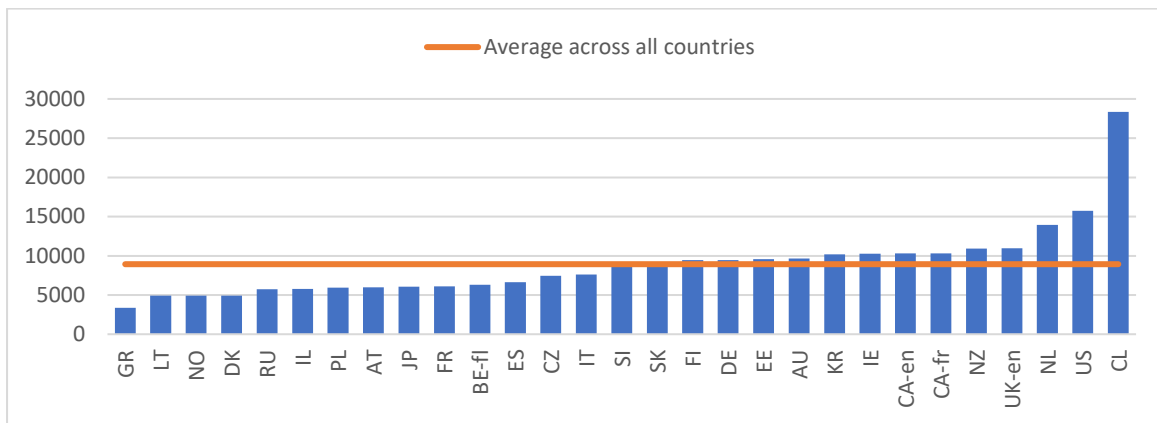


Figure 6 shows that teacher workload in Chile is far greater than seen in the other territories included in our sample. England, the Netherlands and the US also have relatively high teacher workloads. By contrast, teachers in Greece, Lithuania, Norway and Denmark have relatively-less-demanding workloads.

Table 5. Teacher workload (student-hours per year) by system type

	N	Mean	SD
Type 1 (Differentiated systems)	13	7,032.08	2,010.16
Type 1b (Differentiated systems, with school-based apprenticeships)	3	9,440.06	4,508.29
Type 2a (Comprehensive systems – North American)	3	12,121.43	3,143.17
Type 2b (Comprehensive systems – Nordic)	1	4,928.69	.
Type 3 (Dual systems)	2	7,706.36	2,458.39
Type 4 (Mixed systems)	7	11,788.61	7,592.53
TOTAL	29	8,929.77	4,687.33

Looking at teacher workload by system types, we can see that teachers in Type 2a systems have the highest workloads, with those in Type 4 also experiencing higher-than-average workloads (although this is skewed considerably by data on Chile, reflected in the high standard deviation). By contrast Norway (the only included Type 2b system) and the Type 3 and Type 1 systems have lower-than-average workloads overall.

2.5 Modelling the Effects of System Characteristics and Types on Skills Acquisition

We adopt two parallel modelling approaches to analyse the effect of system characteristics and system types on skills acquisition and inequalities in skills outcomes.

First, we undertake ordinary least-squares (OLS) regression to assess the extent to which different system types (and individual system-characteristic indicators) are associated with better or worse performance in literacy and numeracy at the end of upper secondary education. We include system-level PISA scores in (respectively) Reading and Maths as control variables in order to account for the strong correlation between performance at age 15 and outcomes following completion of upper secondary schooling.

Additionally, in order further to control for omitted systemic time-invariant factors that are likely to affect outcome scores, we adopt a difference-in-difference (DID) approach. In this analysis, we

compare change over time (from age 15 to post-upper secondary) in average scores across different systems (or according to the level of different system-characteristic indicators). The DID estimator is equivalent to the interaction term of the outcome score with a binary indicator that is '0' at time₁ (age 15) and '1' at time₂ (age 18-20). Both methods of calculation are also applied in the estimation of effects on changes on inequality of skills outcomes (measured using skills Ginis).

2.5.1 The Effect of System Type on Skills Outcomes

Table 6 presents the results of OLS regression analysis to model scores for literacy and numeracy at age 18-20 in SAS, controlling for the equivalent score at age 15 in PISA, and comparing different system types to the reference group (Type 1 - Differentiated systems). All scores are standardised to have a standard deviation of 1 and a mean of 0.

Table 6. OLS regression analysis of the effects of system type on literacy and numeracy scores

	Literacy – Age 18-20 (Standardised values)		Numeracy – Age 18-20 (Standardised values)	
	OLS estimate	S.E.	OLS estimate	S.E.
System type (ref: Type 1 – Differentiated systems)				
Type 1b	.024	(.449)	-.282	(.343)
Type 2a	-1.210**	(.494)	-1.074***	(.350)
Type 2b	-.147	(.558)	.119	(.413)
Type 3	-.292	(.557)	-.010	(.413)
Type 4	-.765**	(.330)	-.709***	(.252)
Literacy – Age 15 (standardised values)				
	.654***	(.147)		
Numeracy – Age 15 (standardised values)				
			.745***	(.115)
Constant	.329	(.207)	.306*	(.151)
Observations	32		32	
R-squared	.566		.762	

Statistically significant: * p < .05; ** p < .01; *** p < .001

There is, as expected, a strong correlation between country-level average scores for Reading and Maths at age 15 with scores, respectively, in literacy and numeracy at age 18-20. In comparison to the reference group, average scores for literacy are significantly lower in Type 2a comprehensive systems (North American) and in Type 4 mixed systems. Lower average scores are also seen in Type 2b comprehensive systems (Nordic) and Type 3 systems, although these are not found to be statistically significant. A similar relationship can be seen in numeracy scores, with comprehensive systems (North America) and mixed systems having significantly lower average scores compared with Type 1 differentiated systems. Type 1b systems have higher average scores than the reference group in literacy and lower in numeracy but the difference is not significant.

Undertaking the same analysis but using a DID approach yields similar results. The DID models (table 7) show that, compared to Differentiated Type 1 systems, countries with Type 2a comprehensive systems (North American) perform statistically-significantly worse in both literacy and numeracy. Whilst not attaining standard levels of statistical significance (as seen in the OLS regression above),

Type 4 mixed systems also have a relatively large negative effect size on literacy and numeracy, in comparison to Type 1 systems (respectively .772 and .575 standard deviations). Of note is the relatively large (-.604 standard deviations) negative effect on numeracy outcomes for students in countries with Type 1b systems, which was found to be much smaller under the OLS approach.

Table 7. DID estimates of the effects of system type on literacy and numeracy scores

	Literacy (Standardised values)		Numeracy (Standardised values)	
	DID estimate ($\gamma_{1Y.age1820}$)	SE	DID estimate ($\gamma_{1Y.age1820}$)	SE
System type (ref: Type 1 – Differentiated systems)				
Type 1b	-.355	(.786)	-.604	(.712)
Type 2a	-1.571*	(.880)	-1.151⁺	(.798)
Type 2b	-.229	(1.044)	.154	(.947)
Type 3	-.332	(1.044)	-.047	(.947)
Type 4	-.772	(.618)	-.575	(.548)
Constant	-.262	(.270)	-.055	(.245)
Observations	32		32	
R-squared	.208		.325	

Statistically significant: ⁺ p < .2; * p < .1; ** p < .05

2.5.2 The Effects of System Characteristics on Skills Outcomes

What system-specific characteristics, then, can account for these relative differences in performance? The subsequent analysis seeks to model the effect of individual characteristics of educational systems at upper secondary level to allow for a more fine-grained examination of specific indicators that may influence some systems to improve their performance more than others.

Table 8 (in the Appendix) reports the OLS and DID estimates for twelve models that examine the independent effect of system-level characteristics summarised before. Models 1 to 3 look at the effect of duration and timing of key transition points within the upper secondary system. *Theoretical duration of upper secondary programmes* (model 1) has a positive effect on both literacy and numeracy scores, but it is not significant. *Educational stage of first selection* (model 2) does show some negative effects on literacy and numeracy scores where selection is on entry to upper secondary education, but this is only significant in the case of the OLS regression. Model 3 examines the effect of the *theoretical age at which students are expected to complete their upper secondary education*. The estimates are positive, with effect sizes of between 0.4 and 0.6 in literacy and 0.6 and 0.7 in numeracy, which indicates an improvement in skills outcomes for students expected to continue in upper secondary to age 19. However, this association is only statistically significant for the OLS model for numeracy scores (0.66; p < .01).

Models 4 to 6 assess the effect of financial and human resources in upper secondary education. The effect of teachers' salaries (model 4) appears to be negligible and non-significant in all cases. Similarly, there is no significant effect from upper secondary level *expenditure per FTE student* (relative to per capita GDP (model 5)). By contrast, the derived measure for *teacher workload* (model 6) does have a small negative effect on students' skills acquisition on both calculations (-0.07 for both literacy and numeracy in the OLS regression) but is significant only in the OLS case.

Models 7 to 11 assess the effects of types of provision in upper secondary education and training. *Number of school types* (model 7), an indicator of the level of differentiation within a system, has a negative but non-significant effect on literacy and numeracy in both OLS and DID analyses. The effect of *standardised curriculum* (model 8) is modest (effect sizes between 0.12 and 0.18) yet positive, indicating that students who are required to study Maths and/or their national language outperform those within systems with less-standardised curricula. This appears to be more strongly the case in relation to numeracy, where the effect size is between 0.17 and 0.18 and, in the case of the OLS estimate, statistically significant to the $p < .05$ level. The proportion *completing upper secondary education* (model 9) has small positive effects for literacy and numeracy on both calculations, but neither are statistically significant. This remains the case, when a composite indicator of *cohort years* (combining theoretical duration of upper secondary education with the actual proportion of students who complete this) is included in the analysis (model 11).

What appears to matter most is the proportion of students in a system who are enrolled on vocational programmes. The effect sizes for *vocational prevalence* (model 10) are small (between 0.01 and 0.020) yet significant in most cases (with the exception of the DID estimates for numeracy scores). Small positive model estimates indicate that those systems with relatively more students in vocational education at upper secondary see modest improvements in literacy and numeracy outcomes. Moreover, when combined with stage of first selection (model 12), these effect sizes increase, notably in the models for numeracy, where for countries with higher prevalence of vocational students, later selection, on entry to upper secondary education or during this stage, is associated with better outcomes.

2.5.3 The Effect of System Types and Characteristics on Inequality of Skills Outcomes

The following analysis looks at the effect of system types and characteristics on changes in inequality of skills outcomes. The analysis uses two parallel modelling approaches, as above. In this case, our dependent variable is the Gini coefficient of literacy and numeracy scores for 18-to-20-year-olds as calculated from scores in SAS.

Table 8 (Appendix) reports the findings of thirteen models, which examine the effect of system type and ten system characteristics on inequality of skills outcomes in literacy and numeracy. The final two models examine interaction effects of theoretical duration of upper secondary and completion rates (as a measure of the overall cohort years of study at upper secondary level); and of vocational prevalence and educational stage of first selection (as a measure of the extent to which early or later selection affects systems with a greater or lesser proportion of vocational students).

Similar to the analysis of the outcomes themselves, we can see that system type does have a significant effect on changes in inequality in the distribution of these outcomes. In particular, compared to the most-common Type 1 systems, Type 2a comprehensive (North American) systems and Type 4 mixed systems become relatively more unequal between age 15 and post-upper secondary in both literacy and numeracy outcomes. In addition, for literacy outcomes, Type 1b systems are significantly more unequal at the end of upper secondary education, compared to the reference Type 1 group.

Model 2 shows that theoretical duration of upper secondary has a significant effect on inequality in literacy (between -0.005 and -0.009, $p < .05$) which is negative in the OLS estimation and positive in the DID estimation. For numeracy scores, whilst both models show negative effects, returning similar effect sizes, the estimates attain statistical significance only in the DID model (-0.0067, $p < .1$). This implies that systems with longer programmes in mainstream upper secondary education return less-unequal skills outcomes, at least in numeracy. Model 3 shows small positive effects on literacy and numeracy inequality from later selection which are significant in the DID estimates and in the OLS

estimate for numeracy. The DID models provide evidence for an increasing (and statistically-significant) positive effect on inequality as selection happens later – with the largest effect size being seen for systems selecting during upper secondary, as compared to those selecting on entry to lower secondary (0.02, $p < .05$). Theoretical age at completion of upper secondary education (Model 4) shows small but consistently negative effects on inequality in both skills domains on both calculations for completion at 19 years as opposed to 17/18 years of age, although these effects do not reach statistical significance.

Neither of the models that look at teachers' salaries (model 5) or public expenditure on upper secondary education (model 6) return statistically significant results, although there is non-significant negative association of public expenditure and skills inequality. By contrast, whilst the effect sizes are small, there is a statistically significant ($p < .05$) positive effect of teacher workload on inequality in both literacy and numeracy scores (model 7) – teachers under greater workload pressure being associated with worsening inequalities in score distributions.

Model 8, examining the effect of the number of types of school, indicates that systems with fewer school types are associated with greater skills inequalities. Nonetheless, the estimates only attain statistical significance in the DID model for literacy scores ($p < .1$). The effect of *standardised curriculum* scores (model 9) indicates that systems with less-standardised curricula have greater inequality of skills scores for both literacy and numeracy; results are significant except in the case of the DID estimation for literacy. The magnitude of this effect appears to be greater for numeracy than for literacy, which may be explained by the fact students continue to practise their language skills across subjects more than will the case for numeracy even when there are no mandatory classes. Whilst there appears to be no statistically significant effect of the overall upper-secondary completion rate within a country (model 10), when examined in conjunction with programme duration to assess overall cohort year of upper secondary (model 12), there is a small, yet marginally significant effect. This indicates that fewer cohort-years of upper secondary education are associated with greater inequality in score distributions for literacy and numeracy.

For systems with greater prevalence of vocational students in upper secondary education (model 11), there appears to be a negative effect on inequality, suggesting that skills acquisition is more equally distributed in systems with higher levels of vocational provision. Whilst these results are statistically significant for literacy in the DID model only, the effect can be seen for numeracy in both the OLS and DID models.

2.6 Discussion

The most notable finding from our statistical analysis is that the Type 2a (North American comprehensive) systems and the Type 4 (mixed) systems perform consistently poorly relative to other system types in both literacy and numeracy skills acquisition between age 15 and age 18-20. They also do less to mitigate skills inequalities during the upper secondary phase than other system types.

We have also identified five system characteristics (some with multiple indicators) with broadly consistent effects across countries in both raising skills levels and mitigating skills inequalities during upper secondary education. These relate to 1) the length of upper secondary study; 2) the proportion of the cohort completing long cycle level 3 courses; 3) curriculum standardisation; 4) vocational prevalence; and 5) teacher workload.

Taken together, these characteristics seem to go some way towards explaining the variations across countries and between system types in changes in skills levels and distributions during the upper secondary phase.

According to the theoretical framework which informs our typology and hypotheses, systems will perform better when the participation in vocational learning is relatively high and where greater parity of esteem between the vocational and general tracks is established through the provision of consistently high-quality apprenticeships and/or through system integration measures which promote standardisation in key areas of the curriculum. The same characteristics seem to improve skills acquisition and reduce inequalities in skills outcomes.

Countries in the System Types (1, 1b, 2b and 3) which do better in raising core skills levels and mitigating inequalities may have comprehensive or tracked systems (as we predicted), but they generally exhibit key forms of standardisation and achieve relatively greater parity of esteem between general and vocational learning than other systems. These types of system generally have high rates of participation in long-cycle upper secondary education and training leading to level 3 qualifications; most require continued learning of Maths and the national language across all programmes; and all have relatively high rates of participation in vocational programmes, often including work-based learning.

The lower-performing Type 2a (North American) and Type 4 (mixed) systems are distinctive both for the low rates of participation in vocational learning and for their weak or partial standardisation measures. The Type 2a systems have the advantage in the latter in that their high school programmes include compulsory Maths and English, and are typically of the same duration, which is not the case in Type 4 systems. However, graduation is typically at age 17/18, as in Type 4 systems, rather than at age 19, which our analysis suggests is associated with higher performance. In Type 4 systems participation in worked-based learning is also relatively low, though substantially higher than in Type 2a systems, and (except in Israel) is relatively under-funded. The relatively poor performance of Type 4 systems may derive from the lack of curriculum standardisation and limited vocational learning whereas in Type 2a systems it can be mostly attributed to the lack of vocational learning. Countries in both system types have, on average, relatively high teacher workloads which our analysis suggests is associated with poorer performance.

2.7 Implications for Policy in Singapore

In this section, we discuss the policy implications of our findings for Singapore. Firstly, we present our findings on the levels and distributions of literacy and numeracy scores before and after the upper secondary phase and how these change over this phase of the life course in Singapore. Secondly, we examine the factors influencing skills outcomes in Singapore in the light of our analysis of the effects of system characteristics on skills outcomes across countries. Finally, we identify potential pathways Singapore could follow to increase core skills levels and reduce inequality in skills distributions among upper secondary students.

It is noted that we do not seek to discuss all possible factors contributing to Singapore's performance in core skills acquisition and distribution. Our goal, instead, is to understand how our cross-country findings are applicable in the case of Singapore and which country-specific indicators, mostly qualitative in nature, help to explain the mismatches. The policy recommendations, therefore, are based on our cross-country analysis and thorough review of literature concerning areas where Singapore does not seem to do so well, in terms of reduction of skills inequality. We do not suggest that Singapore would need to undergo fundamental institutional changes to address these policy recommendations. Singapore has maintained a high performance in international tests; however, that does not mean that its education system cannot be improved further.

2.7.1 Singapore data on core skills levels and skills inequality

From our analysis of the research literature and our data on system characteristics, we categorise Singapore as a Type 1b system, together with Denmark, Netherlands, and Finland. These countries have differentiated, dedicated upper secondary institutions, with high rates of participation on vocational programmes, often with a substantial element of work-based training. As such, they represent an emerging hybridisation of upper secondary systems, combining elements of Type 1 school-based provision and Type 3 work-based learning through apprenticeships or other forms of work experience (Méhaut, 2013; Verdier, 2013). Systems of this type perform better than other types of system, on average, on skills means at age 15 and at age 18-20. Countries in this group generally maintain their position relative to other groups in both literacy and numeracy means (except in the case of the Netherlands, which improves its position in literacy, and Denmark, which loses ground in numeracy). However, they begin from a high base line, and are not notably more effective than several other groups in raising average skills levels or reducing skills inequalities during this phase (Tables 7 and 8).

Singapore certainly stands out for its impressive performance in international tests of proficiency in literacy and numeracy. It came top among countries and territories for mean scores at age 15 in both Reading and Maths in PISA 2015 (OECD, 2015); having ranked 5th in Reading and 3rd in Maths in the PISA 2009 survey which we use as the baseline for Singapore in our study (OECD, 2010). At age 18-20 in SAS, among the countries with values in our sample, Singapore ranked first in numeracy and sixth in literacy. According to our analysis of relative changes in skills between age 15 and 18-20, Singapore maintains its high position relative to other countries in both literacy and numeracy skills, although it does not significantly improve on it during the upper secondary phase.

Given the tracked nature of its lower and upper secondary systems - often associated across countries with greater inequality in skills (Werfhorst and Mifs 2010) - Singapore also has rather less unequal skills outcomes that might be expected. In PISA 2009 Singapore's country rank position on the skills Gini measures of inequality was low to average – 20th out of 28 countries for Reading and 15th out of 30 countries for Maths. Notably, Singapore had a very low proportion scoring at below level 2 in Reading (12 percent against the OECD average of 19 percent), with only five countries scoring better on this measure (OECD, 2010). Skills inequality at age 18-20 in SAS (2014) was again quite low in both skills domains, with Singapore ranked 23rd out 32 countries on the skills Gini measure of inequality for literacy and 26th out of 32 countries on that measure for numeracy. According to our analysis, almost all countries reduce inequality in literacy skills during the upper secondary phase, with the sole exception being Chile. Singapore was less successful than many countries in reducing inequality in literacy, with 17 countries doing better and 11 worse. However, in numeracy it was among the most successful in inequality mitigation, with only five of 32 countries doing better.

2.7.2 Explaining Singapore outcomes based on cross-country findings

How far does our analysis of the effects of system characteristics explain skills outcomes in Singapore? We identified six system characteristics with broadly consistent effects across countries in both raising skills levels and mitigating skills inequalities during upper secondary education. These are:

- Theoretical Duration/Age of completion of upper secondary
- Rate of completion at ISCED Level 3/cohort years of upper secondary
- Curriculum standardisation
- Vocational prevalence
- Equality of funding per student in academic and vocational tracks
- Teacher workload

How far do these characteristics explain skills outcomes in the Singapore case? We discuss the effects of these six indicators under three main headings: standardisation, parity of esteem and teacher quality. We also explore several other factors relating to pedagogy, assessment, and culture which are not quantified in this analysis but may still contribute significantly to shaping skills outcomes.

Standardisation

The first three indicators show how certain forms of standardisation promote skills acquisition and mitigate skills inequality. Taken together, the indicators for *theoretical duration*, *age of completion* and *cohort years* capture the degree to which participation in long cycle upper secondary education and training has become universalised and ‘normalised’. In the current analysis, as in our previous analyses, higher scores on these indicators are associated across countries with higher mean scores and lower inequality in both literacy and numeracy skills. Singapore has a relatively high score on all these indicators, with upper secondary education typically lasting 2-3 years and ending at 18/19 years, with 98 percent of the age cohort attaining upper secondary qualifications. This normalisation of long cycle upper secondary education and training appears to contribute to raising skills levels and reducing skills inequality in Singapore, in line with the relationship established across countries.

The other aspect of standardisation relates to the degree to which the learning of Maths and the national language is mandated across all programmes in upper secondary education and training. This is captured by our *curriculum standardisation* indicator. In our comparative analysis high scores on this measure are associated with raising skills levels and reducing inequality in skills during the upper secondary phase. Singapore scores relatively low on this indicator (1 on our 4-point scale), reflecting the fact that classes in Maths and English are not mandated on all programmes in Junior Colleges, Polytechnics and ITE (Hodgen et al. 2017). It should be noted here that, in contrast to other multilingual contexts (e.g., Canada, Belgium), it is not able for Singapore to be geographically disaggregated on linguistic lines. Moreover, the ‘English-knowing’ bilingual policy shifts focus onto English education, as the language of business and administration, in addition to mother-tongue learning in schools. Whilst students may converse in their mother tongues at home, assessments, such as PISA and PIAAC are undertaken in English, which may have the effect of limiting skills proficiency for bilingual students in these measures, as well as distorting the interpretation of what mandatory ‘national’ language means in the Singaporean context. Nonetheless, Singapore still manages to avoid high levels of skills inequality, particularly in numeracy.

A number of other factors may explain the outcome in numeracy, including the high level of attainment in Reading and Maths achieved in Singapore’s lower secondary education system. The national mathematics curriculum is centrally designed to provide students with sufficient mathematical skills before entering ‘post-secondary’ education (upper secondary in comparative classifications) (Hodgen et al. 2017). This may provide many students in ITE and Polytechnics with a sufficiently strong foundation to progress their mathematical skills through their usage of these in vocational areas, even if they do not take any of the mathematically based optional courses available to them. In any case, many Diploma courses in Polytechnics do require maths-based courses, as with Business Statistics modules for courses in Tourism and Resort Management and the Statistics and Quantitative Research Methods modules for the Diploma in Psychology Studies. Where Maths courses remain optional, the learning of vocationally oriented Maths is often embedded in vocational modules (and taught by vocational teachers). ITE programmes do not generally require modules in Maths but they include ‘life skills’ as core components and these may also contribute somewhat to skills acquisition. Students in Junior Colleges, meanwhile, elect their A level subjects, but the colleges generally apply rules of combination which ensures that most students take some Maths courses, at least in year one. For example, every science student chooses to take one or two Maths subjects, while

Arts student will take Maths as a contrasting subject.⁹ This partially optional approach to mathematical skills in the different institutions may be sufficient. However, we argue below that more could be done to reduce inequalities in literacy skills.

Apart from the quantitative analysis, our review of related literature shows that other aspects of standardisation might contribute to the normalisation of the high standards expected of Singaporean students (Green 2013, Schleicher 2011, Hogan 2011, 2013, 2014). Singapore has a highly tracked system in upper secondary education is therefore not standardised in terms of its institutional structures. However, within each track, there is a high level of standardisation in the curriculum, pedagogy, assessment, and other aspects of policy. Policy making is centralised and there is a high degree of alignment between policy, policy implementation and classroom practise (Hogan, 2011; Deng and Gopinathan, 2016). The Singapore National Curriculum statement (2010) shows a high level of 'curriculum control' evidenced by strong statements of aims and values and an obvious commitment to development of broad social skills. Moreover, Singapore's high standards in education are secured through a centralised process of developing, assessing, and endorsing textbooks and teaching materials by the Ministry of Education (Oates ,2010).

Parity of esteem

A number of indicators in our study represent the status of vocational tracks and the degree of parity of esteem between academic and vocational tracks.

From our findings, *vocational prevalence* is associated with higher average levels of core skills and less skills inequality, particularly where the vocational learning is via apprenticeships, or some form of work-based learning. Although Singapore scores relatively highly on the indicator for the proportion of students on vocational programmes (more than 70 percent), the number of students participating in school-based, or hybrid apprenticeships is rather small (less than 10 percent of students in ITE). Apprenticeships and 'Work-Study' opportunities in Singapore are generally aimed at graduates from ITE and the Polytechnics, and the Polytechnics provide only limited opportunities for internships for those on their courses. This delayed provision of work-based learning opportunities may be limiting the otherwise beneficial effects of the high rates of vocational learning on inequality reduction.

We also use descriptive data on the ratio of spending per student in vocational programmes and general 'academic' programmes as one proxy for parity of esteem, with the assumption that higher ratios represent greater relative parity for vocational education. Type 2b and Type 3 systems score relatively highly on this measure, but Type 1b systems score at average levels. We do not have values for Singapore for this OECD indicator, but other sources suggest that Singapore performs well on this. The 2018 MOE data show that government spending per student in ITEs averages two thirds of that in higher education (14743 SGD vs 22192 SGD/per student/per year) whereas in the UK, for instance, it is estimated that the ratio for further and higher education is more like one to three (Green, 2018). In line with the long-term strategy to improve the reputation and attractiveness of vocational and technical education in Singapore, the Government has provided a high level of capital funding to improve the facilities and educational equipment in ITE and Polytechnics and to create a 'campus-like' environment for prospective students (Schleicher, 2011; Varaprasad, 2016). Equipment is usually state of the art and to current industry standards. The substantial investment in ITE and Polytechnic infrastructures shows a strong commitment to transforming the status of vocational tracks and raising 'parity of esteem' for vocational students and some polling on this issue suggests this has had a

⁹ Personal communication with Dr N. Varaprasad, 27th May 2021.

positive impact on public perception of vocational education, although there may still be some way to go for ITE (Law, 2015).

Teacher quality

In our analysis of the effects our various indicators for teacher quality we do not find any significant impact on skills acquisition, except in the case of the measure for *teacher workload*, but we do not have values for Singapore on this latter indicator. Our comments here therefore relate to the findings in the research literature which suggest that countries where average levels of cognitive skills among teachers are high generally perform better on student skills outcomes at age 15 (Hanushek et al, 2019). There is a wealth of evidence attesting to the high quality of secondary teachers in Singapore. Singapore only hires teachers from the top 30 percent of their school graduates (Barbe & Mourshed, 2007). Its teacher training programme accepts roughly one in eight applicants, and they must belong to the top 30 percent of their cohort based on grades, national exams, and the teacher entrance proficiency exam. About 80 percent of candidates in recent years have already completed a first university degree. Singapore is also notable for the extensive continuing professional development of teachers (Steward, 2010) and for its measures to enhance teacher performance, including its system of annual teacher appraisals focussing on student outcomes, professional outcomes, and organisational outcomes (OECD, 2013a). As OECD note, teacher appraisal via student learning outcomes can create and strengthen incentives for teachers to commit themselves to helping all students to meet standards and achieve goals within the national curriculum (OECD, 2013). Various studies on Singapore suggest that teacher quality has been key to successful student outcomes at the end of lower secondary education. It seems likely that this would also be the case for upper secondary education and training, although it would be valuable to have further research on this.

Pedagogy and culture

There are several other factors relating to pedagogy and culture, which may nevertheless have positive impacts on skills acquisition in upper secondary education and training. We also recognise the role of postcolonial history, educational policies, and governance in shaping Singapore skills outcomes¹⁰, which we have not been able to quantify and therefore go beyond the scope of this report.

With regard to pedagogy and culture, the impact of ‘mastery learning’ on core skills and how the effects of mastery learning are supported by cultural values in Singapore is of particular interest here.

Mastery learning is considered a typical learning style in Singapore’s lower secondary classrooms and to a certain extent, in upper secondary institutions such as ITE. Mastery learning focuses on repeated practice, memorisation, and spiral approaches to reinforcing key concepts and skills. It is also said to be characterised by a strong orientation towards the passing of tests and examinations (Hogan, 2011). Since mastery learning is designed to enable students of different abilities to achieve the same level of mastery with similar materials, it can be quite efficient in raising the basic skills of lower achievers. The use of this pedagogic approach may partly account for the fact that Singapore does quite well in reducing numeracy skills inequalities during the upper secondary phase. However, since the mastery approach has been uniquely effective in the East Asian region, it seems likely that its cultural contexts also play a part. In Singapore it is nurtured by a collective culture which encourages a performance-driven mentality and the pursuit of excellence by all. Singaporean students are therefore motivated

¹⁰ Personal communication with Professor Zongyi Deng, 27th May 2021.

to excel academically and their high performance in international tests can be seen as a reflection of this culture of collectivism (Wang et al., 2017).

However, an over-emphasis on academic performance as the sole measure of individual success can also present challenges for the promotion of vocational education. Specifically, it leads to a paper chase or college mania mindset in Singapore society where parents and students perceive vocational and technical education as being reserved for low achievers and thus a 'last resort' (Law, 2015). Singaporean collective values include a strong belief in the virtue of a meritocratic society, where rewards are based on hard work and academic achievement. This motivates students to achieve in general education. However, it can have negative effects in vocational education, where this is not considered to have a high academic status.

Polytechnics have become well regarded because of the high quality of their teaching and facilities and because of the good employment prospects conferred by a Polytechnic Diploma. Singapore has a high rate of vocational learning because of the very high proportion of the cohort attending Polytechnic courses. However, recruitment to the ITEs, although growing, remains much lower. Internships and work experience placements are gradually becoming more prevalent in Polytechnics and in NITEC 3 courses in ITEs, but apprenticeships are only a marginal part of initial vocational education and training, being reserved mainly for graduates of Polytechnics and ITE. This may represent a lost opportunity in Singapore to judge from developments in other countries. In countries such as Austria, Germany and Switzerland, where Dual System apprentice training is available across the range of occupations and attracts up to half the cohort, apprenticeships are generally considered to be of high quality. The skills and qualifications gained through apprenticeships offer young people the prospect of well-paid jobs in a range of skilled and professional occupations. Apprenticeships in Singapore cater for only limited range of occupations, and do not yet seem to have acquired this level of prestige and popularity. This may be for the cultural reasons discussed above, or because the nature of the labour market in Singapore - with its profusion of foreign-based multi-national corporations, and relatively high staff turnover rates - has traditionally retarded the growth of apprenticeship provision (Sakamoto, 2006).

2.7.3 Policy recommendations

From the above discussion, we identify two areas where policies might be strengthened in Singapore to reduce inequality in core skills.

The first relates inequality in literacy skills. As discussed, Singapore does not mandate the learning of Maths and English for all students in upper secondary education, as is the case in most of the countries which substantially mitigate literacy and numeracy skills inequality during this phase. This does not appear to have been unduly detrimental for numeracy skills in Singapore. However, the same is not true for literacy, where inequalities are reduced less, and remain higher at age 18-20, than in most other countries. This suggests that there is room for improvements which would reduce inequalities in literacy. It is noted that due to the 'English-knowing' bilingual policy, students have to take English and their respective mother tongues in schools. While English continues to be the official language in business and administration, and the language of assessment in PISA or PIAAC is normally English, students from different ethnicities might converse in their mother tongues at home. This might affect the level of literacy skills measured for bilingual students¹¹. Moreover, our analysis may not apply in the Junior Colleges whose entry criteria already require high levels of literacy from students. However, students in the ITEs and Polytechnics might benefit from compulsory English/language courses taught

¹¹ Personal communication with Dr N. Varaprasad and Professor Zongyi Deng, 27th May 2021.

as separate subjects by teachers specialising in the subject. Moreover, having high-quality English courses in ITE would be likely to improve academic writing skills of ITE students and thus enhance their prospects of progression into the Polytechnics and Universities. The rate of progression of ITE graduates into Polytechnics has increased since 2005, now standing at around 25 percent (Ang, 2020), but this remains a narrow gateway for progression. Improving progression rates still further would be likely to do more to boost the popularity and prestige of ITE provision. We note that reforms to enhance general education components in vocational education in Austria and Switzerland have effectively raised rates of progression into tertiary education, thereby forestalling the decline in apprentice numbers precipitated by the tendency to ‘academic drift’ in other countries.

This leads into our second point regarding the potential benefits to increasing apprenticeship take-up in Singapore. High quality apprenticeships, which recruit widely from across the ability spectrum, and which give access well-paid skilled and professional jobs, are widely believed to be effective in raising skills levels, particularly among lower achievers, and thus to reduce skills inequalities (Busemeyer, 2014). They have also been shown to raise the esteem of vocational education generally. Our own analysis shows that Type 3 systems, which offer these opportunities, do relatively well on these criteria. In Singapore apprenticeships are generally reserved for graduates of from Polytechnics and ITE, and are not, in any case, widely available across all sectors of the economy. Other forms of work-based learning, such as internships and work experience placements, are also far from universally available to students in ITE and Polytechnics. Delaying the availability of apprenticeships and other forms of work-based learning for students in upper secondary education and training, may be denying lower achieving students in vocational education the opportunity to close skills gaps with their peers in general education and also reducing their chances of progression within the education system. It may also be forfeiting an important means for enhancing the prestige of vocational tracks in the upper secondary system.

Conclusion

This report has presented the findings of research on important questions surrounding the articulation of Singapore’s skills and employment systems, of potential interest both in Singapore and to a wider global audience. The successes of its school system, at least as measured by international comparative tests of core skills at the end of lower-secondary education, are well known. This new research was prompted by the realisation that, in the latest period of Singapore’s development, the changing way that skills are developed, sustained and utilised after the end of lower secondary schooling is central to the support of a successful knowledge economy. Many questions arise following the introduction of a new orientation to skills development policy under the SkillsFuture programmes. Two issues, in particular, have been examined in depth in this report: the dynamic matching of the rapidly growing supplies of university graduates with graduate jobs, and the changes in the level and inequality of skills during the post-lower-secondary phase.

Each part of the report has noted its own policy suggestions. Part 1 notes the success of Singaporean planning and labour market institutions in coordinating skills supply and demand and the ongoing importance of this and of ensuring the full utilisation in the workplace of the knowledge and skills acquired through the education system. It also references the ambition of SkillsFuture to provide a more comprehensive approach to lifelong learning by ensuring its availability to all individuals at

different stages in their lives. As part of this SkillsFuture has been promoting new ways of integrating learning, work and earning through the provision of 'work-study' programmes as part of continuing education and training. The ongoing dynamic matching of supply and demand in the graduate labour market is a promising sign, but, as noted in this part of the report, we advise against complacency in respect of this growing part of the labour market and advocate ongoing monitoring of the issue.

Part 2 of our report also underlines the substantial benefits to be reaped from integrating forms of work-based learning in upper secondary education and training, even where this is predominantly school-led, as in Singapore. Our comparative analysis, based on new evidence that incorporates data from many other countries, indicates that it is not only in countries with Dual systems of apprenticeship where these benefits are realised. Other countries with largely school-based systems manage to incorporate substantial elements of work-based learning in their upper secondary provision, through the use of work-experience placements, internships or hybridised types of state-led apprenticeship. There would seem to be much scope for extending the reach of the SkillsFuture work-study ethos into both adult working life and initial vocational training.

References

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.

Ang, Jolene, *5% of ITE grads go on to get degrees from local public unis*, January 21st 2020. <https://www.straitstimes.com/singapore/education/5-of-ite-grads-go-on-to-get-degrees-from-local-public-unis>

Ashton, D., F. Green, D. James and J. Sung (1999) *Education and Training for Development in East Asia The Political Economy of Skill Formation in East Asian Newly Industrialised Economies*, Routledge, London and New York.

Barber, M. and Mourshed, M. (2007) *How the World's Best-Performing School Systems Come out on Top*, McKinsey & Company.

Bol, T. and Van de Werfhorst, H. G. (2013) 'Educational systems and the trade-off between labor market allocation and equality of educational opportunity', *Comparative Education Review*, 57 (2), 285-308.

Borgonovi, F., Pokropek, A., Keslair, F., Gauly, B. and Paccagnella, M. (2017) *Youth in Transition: How Do Some of The Cohorts Participating in PISA Fare in PIAAC?* OECD Education Working Papers, 155, OECD, Paris.

Busemeyer, M. and Iversen, T. (2011) 'Collective skills systems, wage bargaining and labour market stratification' In: M. Busemeyer & C. Trampusch (eds) *The Political Economy of Collective Skill Formation*, Oxford University Press, Oxford.

Busemeyer, M. (2014) *Skills and Inequality: Partisan Politics and the Political Economy of Education Reforms in Western Welfare States*, Cambridge University Press, Cambridge.

CEDEFOP (2008) *Initial Vocational Education and Training (IVET) in Europe: Review*, European Centre for the Development of Vocational Training, Thessaloniki.

Deng, Z. and Gopinathan, S. (2016) 'PISA and high-performing education systems: explaining Singapore's education success,' *Comparative Education*, 52 (4), 449-472.

Dumas, A., Méhaut, P., and Olympio, N. (2013) 'From Upper Secondary to Further Education: European Models of Post-Compulsory Learning' In: Janmaat J.G., Duru-Bellat M., Green A., Méhaut P. (eds) *The Dynamics and Social Outcomes of Education Systems. Education, Economy and Society*, Palgrave Macmillan, London.

Green, A. (2003) 'The many faces of lifelong learning: Recent education policy trends in Europe', *Journal of Education Policy*, 17 (6), 611-626.

Green, A., Green, F. and Pensiero, N. (2014) *Why are Literacy and Numeracy Skills in England so Unequal? Evidence from the OECD's Survey of Adult Skills and other International Surveys*, Research Paper 27, Centre for Learning and Life Chances in Knowledge Economies, Institute of Education, London.

Green, A., Green, F. and Pensiero, N. (2015) 'Cross-country variation in adult skills inequality: why are skill levels and opportunities so unequal in anglophone countries?', *Comparative Education Review*, 59 (4), 595-618.

- Green, A. and Pensiero, N. (2016) 'The effects of upper secondary education and training systems on skills inequality. A quasi-cohort analysis using PISA 2000 and the OECD Survey of Adult Skills', *British Education Research Journal*, 45 (5), 756-779.
- Green, F. and D. James (2003) 'Assessing skills and autonomy: the job holder versus the line manager', *Human Resource Management Journal*, 13 (1), 63-77.
- Green, F. and G. Henseke (2016) 'Should governments of OECD countries worry about graduate underemployment?', *Oxford Review of Economic Policy*, 32 (4), 514-537.
- Green, F. and G. Henseke (2020) 'Graduate Employment and Under-Employment: Trends and Prospects', In: C. Callender, W. Locke and S. Marginson (Eds), *Changing Higher Education for a Changing World*, Bloomsbury, London.
- Green, F. and G. Henseke (2021) 'Europe's Evolving Graduate Labour Markets: Supply, Demand, Underemployment and Pay', *Journal for Labour Market Research*, Online.
- Green, C., P. Kler and G. Leeves (2007) 'Immigrant overeducation: Evidence from recent arrivals to Australia', *Economics of Education Review*, 26 (4), 420-432.
- Green, F. and Y. Zhu (2010) 'Overqualification, Job Dissatisfaction, and Increasing Dispersion in the Returns to Graduate Education' *Oxford Economic Papers* 62(2): 740-763.
- Greinert, W. (2004) 'European vocational training 'systems' - some thoughts on the theoretical context of their historical development', *European Journal of Vocational Training*, 32, 18-25.
- 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), 523-535.
- Hall, P. and Soskice, D. (eds) (2001) *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, Oxford University Press, Oxford.
- Henseke, G. and Green, F. (2020) *Singapore's Graduate Labour Market, 2013/2017: A Task-based Analysis*, published by the Centre for Learning and Life Chances in Knowledge Economies and Societies at: [http:// www.llakes.ac.uk](http://www.llakes.ac.uk)
- Hodgen, J., Pepper, D., Sturman, L., & Ruddock, G. (2010) *Is the UK an Outlier*, Nuffield Foundation, London.
- Hodgen, J., Wake, G. and Dalby, D. (2017) *Mathematics in the Successful Technical Education of 16-19 Year Olds*. Gatsby Foundation. Available at: <https://www.gatsby.org.uk/uploads/education/reports/pdf/maths-in-international-systems.pdf>
- Hogan, D. (2011) *Why is Singapore's School System so Successful and is it a Model for the West? The Conversation*. Available at: <https://theconversation.com/why-is-singapores-school-system-so-successful-and-is-it-a-model-for-the-west-22917>
- Hogan, D., Chan, M., Rahim, R., Kwek, D., Maung Aye, K., Loo, S. C., Sheng, Y. Z., & Luo, W. (2013) 'Assessment and the logic of instructional practice in secondary 3 English and mathematics classrooms in Singapore', *Review of Education*, 1 (1), 57-106.
- Hogan, D. (2014) *East Asian Pedagogy and Metaphysical Anxiety: Whence Singapore? Whither Australia?*, Plenary Address (Extended Version) AARE Conference, Brisbane December 1, 2014.

- Hanushek, E. A. and Woessmann, L. (2006) 'Does educational tracking affect performance and inequality? Differences-in-differences evidence across countries', *Economic Journal*, Royal Economic Society, 116 (510), 63-76.
- Hanushek, E. A., Piopiunik, M. and Wiederhold, S. (2019) 'The value of smarter teachers: international evidence on teacher cognitive skills and student performance', *Journal of Human Resources*, 54 (4), 857-899.
- Kracke, N. and M. Rodrigues (2020) 'A Task-Based Indicator for Labour Market Mismatch', *Social Indicators Research*, 149 (2), 399-421.
- Lasonen, J. and Young, M. (1998) *Strategies for Achieving Parity of Esteem in European Upper Secondary Education. Final Report on the Project*, Institute for Educational Research, University of Jyväskylä, Finland.
- Law, S. S. (2015) *A Breakthrough in Vocational and Technical Education: The Singapore Story*, World Scientific Publishing Company, Singapore.
- Lin, B. C. (2006) 'A sustainable perspective on the knowledge economy: A critique of Austrian and mainstream views', *Ecological Economics* 60 (1), 324-332.
- McGuinness, S. and P. J. Sloane (2011). "Labour market mismatch among UK graduates: An analysis using REFLEX data." *Economics of Education Review* 30(1): 130-145.
- McLean, M. (1990) *Britain and a Single Market Europe-Prospects for a Common School Curriculum*, Kogan Page, London.
- Maurice, M., Sellier, F. and Silvestre, J.J. (1986) *The Social Foundations of Industrial Power*, MIT Press, Cambridge, Mass.
- Mok, K. H. and J. Jiang (2018) 'Massification of higher education and challenges for graduate employment and social mobility: East Asian experiences and sociological reflections', *International Journal of Educational Development*, 63, 44-51.
- National Centre on Education and the Economy (NCEE) (2016), *Empowered Educators: How High-Performing systems shape teaching quality around the world-Teacher Appraisal and feedback*, Policy Brief. Available at: <http://ncee.org/wp-content/uploads/2017/02/ProfLearningPolicyBrief.pdf>
- Oates, T. (2010), *Could do Better: Using International Comparisons to Refine the National Curriculum in England*. Available at: <https://www.cambridgeassessment.org.uk/Images/112281-could-do-better-using-international-comparisons-to-refine-the-national-curriculum-in-england.pdf>
- OECD (1985) *Education and Training Beyond Basic Schooling*, OECD, Paris.
- OECD (2010) *PISA 2009 Results: Overcoming Social Background. Equity in Learning Opportunities and Outcomes (Vol. 11)*, OECD, Paris.
- OECD (2012) *Education at a Glance 2012*, OECD, Paris.
- OECD (2013) *PISA 2012 Results: What Makes Schools Successful? Resources, Policies and Practices*, vol. IV, OECD, Paris.
- OECD (2013a) 'Procedures for Teacher Appraisal', In: *Teachers for the 21st Century: Using Evaluation to Improve Teaching*, OECD Publishing, Paris.
- OECD (2016) *PISA 2015 Results: Excellence and Equity in Education*, OECD, Paris.

- OECD (2019), *PISA 2018 Results (Volume I): What Students Know and Can Do*, PISA, OECD Publishing, Paris.
- Pensiero, N. and Green, A. (2018) 'The effects of post-compulsory education and training systems on literacy and numeracy skills: a comparative analysis using PISA 2000 and the 2011 Survey of Adult Skills', *European Journal of Education*, 53 (2), 1–16.
- Powell, W. W. and K. Snellman (2004) 'The knowledge economy', *Annual Review of Sociology*, 30, 199-220.
- Raffe, D., Brannen, K., Fairgrieve, J. and Martin, C. (2001) 'Participation, inclusiveness, academic drift and parity of esteem: A comparison of post-compulsory education and training in England, Wales, Scotland and Northern Ireland', *Oxford Review of Education*, 27 (2), 173-203.
- Raffe, D., Howieson, C., Spours, K. and Young, M. (1998) 'The unification of post-compulsory education: towards a conceptual framework', *British Journal of Educational Studies*, 46 (2), 169-187.
- Sakamoto, A. (2006) *Employment, skills and tripartite relations: the evolution of skill development systems in Japan and Singapore*, PhD Thesis, Institute of Education, University of London.
- Schleicher, A. (2011) 'Lessons from the World on Effective Teaching and Learning Environments', *Journal of Teacher Education*, 62 (2), 202–221.
- Schütz, G., Ursprung, H.W. and Woessmann, L. (2008) 'Education policy and equality of opportunity', *Kyklos*, 61, 279-308.
- Solga, H., Protsch, C., Ebner, C. and Brzinsky-Fay, C. (2014) *The German vocational education and training system: its institutional configuration, strengths and challenges*, Discussion Paper, University of Cologne and Federal Institute for Vocational Education and Training, Bonn.
- Steward, V. (2010) 'Dream, Design, Deliver: How Singapore developed a high-quality teacher force', *KAPPAN online*, 91 (7), 85-86.
- Van de Werfhorst, H. G. and Mifs, J. (2010) 'Achievement inequality and the institutional structure of educational systems: A comparative perspective', *Annual Review of Sociology*, 36 (1), 407-428.
- Varaprasad, N. (2016) *50 Years of Technical Education in Singapore: How to Build a World Class TVET System*. World Scientific Publishing, Singapore.
- Verdier, E. (2013) 'Lifelong learning regimes versus vocational education and training systems in Europe: The growing hybridisation of national models', In: Janmaat J.G., Duru-Bellat M., Green A., & Méhaut P. (eds) *The Dynamics and Social Outcomes of Education Systems-Education, Economy and Society*, Palgrave Macmillan, London.
- Wang, L-I., Li, J-Y., Tan, L-S. and Lee, L. (2017) Contextualizing Teacher Efficacy in a High-Performing System: A Research Agenda, *British Journal of Educational Studies*, 65 (3), 385-403.
- Woessmann L. (2008) 'How equal are educational opportunities? Family background and student achievement in Europe and the US', *Betriebswirtsch*, 78, 45–70.
- Wu, N. and Q. Y. Wang (2018) 'Wage penalty of overeducation: New micro-evidence from China', *China Economic Review*, 50, 206-217.
-

Appendix for Part 2

Table 8. OLS and DID estimates of the effect of system characteristics on skills outcomes

			Literacy (Standardised values)				Numeracy (Standardised values)			
			OLS estimate (S.E.)	R-sq.	DID estimate y1Y.age1820 (S.E.)	R-sq.	OLS estimate (S.E.)	R-sq.	DID estimate y1Y.age1820 0 (S.E.)	R-sq.
Model (N: 32)	1	Theoretical duration of upper secondary education	.167 (.190)	.396	.156 (.338)	.010	.178 (.151)	.626	.137 (.334)	.035
Model (N: 32)	2	Educational stage of first selection (ref: on entry to lower secondary)		.472		.057		.714		.151
		On entry to upper secondary	-.661** (.312)		-.668 (.580)		-.721*** (.236)		-.562 (.550)	
		During upper secondary	-.686 (.432)		-.870 (.792)		-.771* (.316)		-.672+ (.752)	
Model (N:32)	3	Age at completion of upper secondary (ref: 17 or 18 years)		.435		.020		.713		.046
		19 years	.483 (.286)		.576 (.520)		.659*** (.202)		.672 (.513)	
Model (N: 29)	4	Teachers' starting salary (US\$ thousands)	-.009 (.015)	.434	-.015 (.026)	.028	-.019 (.010)	.734	-.022 (.025)	.044
Model (N: 32)	5	Expenditure per FTE student at upper secondary (% per capita GDP)	.018 (.025)	.390	.017 (.044)	.006	-.012 (.020)	.612	-.017 (.044)	.009
Model (N: 29)	6	Teaching workload (thousand student-hours per year)	-.074** (.031)	.477	-.074 (.058)	.059	-.070*** (.024)	.687	-.055 (.053)	.148
Model (N: 32)	7	Number of school types	-.035 (.096)	.383	-.0003 (.167)	.019	-.039 (.076)	.611	-.028 (.168)	.010
Model (N: 30)	8	Standardised curriculum score (0–4)	.123 (.097)	.419	.148 (.174)	.013	.165** (.072)	.679	.177 (.171)	.020

Model 9 (N: 28)	Upper secondary completion rate (%)	.012 (.017)	.460	.002 (.030)	.071	.010 (.039)	.652	.005 (.031)	.059
Model 10 (N: 31)	Vocational prevalence (%)	.015** (.007)	.468	.018* (.014)	.031	.012** (.006)	.657	.011 (.013)	.062
Model 11 (N: 28)	Cohort years of upper secondary (Duration of upper secondary*completion rate)	.002 (.002)	.473	.001 (.004)	.076	.002 (.002)	.662	.001 (.004)	.130
Model 12 (N: 31)	Voc. prevalence*Edu. stage at fi selection (ref: entry lower secondary)		.542		.122		.790		.228
	On entry to upper secondary	.026+ (.019)		.036 (.035)		.028** (.013)		.036 (.032)	
	During upper secondary	.025 (.024)		.035 (.044)		.042** (.016)		.053+ (.040)	

Statistically significant: + p < .2; * p < .1; ** p < .05; *** p < .01

Table 9. OLS and DID estimates of the effect of system characteristics on inequality of skills outcomes

		Inequality in literacy scores (Gini coefficient)				Inequality in numeracy scores (Gini coefficient)					
		OLS (S.E.)	estimate	R-sq.	DID estimate γ1Y.age1820 (S.E.)	R-sq.	OLS (S.E.)	estimate	R-sq.	DID estimate γ1Y.age1820 (S.E.)	R-sq.
Model 1 (N: 32)	System type (ref: Type 1: Differentiated)			.490		.760			.595		.477
	Differentiated, w/sch-based app's	.00309 (.00613)			.0147* (.00869)		.00482 (.00690)		.00911 (.00868)		
	Comprehensive (N. American)	.0183** (.00680)			.0232** (.0101)		.0237*** (.00688)		.0267*** (.00915)		
	Comprehensive (Nordic)	.000514 (.00657)			-.00101 (.0109)		.00326 (.00767)		.00375 (.0109)		
	Dual	.00354 (.00681)			-.00458 (.0109)		.00112 (.00780)		-.00134 (.0109)		
	Mixed	.0144*** (.00405)			.0122* (.00657)		.0189**** (.00480)		.0161** (.00656)		
Model 2 (N: 32)	Theoretical duration of upper secondary education	-.00543** (.00255)	.213		.00856** (.00372)	.673	-.00573 (.00322)	.240	-.00673* (.00399)		.175

Model (N: 32)	3	Educational stage of first selection (ref: on entry to lower secondary)		.155		.673		.334		.222
		On entry to upper secondary	.00721 (.00480)		.0142** (.0066)		.0109 (.00542)		.0128* (.00689)	
		During upper secondary	.00687 (.00653)		.0124 (.00924)		.0182** (.00710)		.0200** (.00929)	
Model (N:32)	4	Age at completion of upper secondary (ref: 17 or 18 years)		.186		.654		.242		.198
		19 years	-.00711 (.00379)		-.00662 (.0059)		-.00862 (.00477)		-.00713 (.00606)	
Model (N: 29)	5	Teachers' starting salary (US\$ thousands)	-.0000282 (.000216)	.066	.000068 (.00031)	.627	-.0000061 (.000258)	.176	.000041 (.00032)	.113
Model (N: 32)	6	Expenditure per FTE student at upper secondary (% per capita GDP)	-.000553 (.000313)	.174	-.000402 (.00049)	.661	-.000587 (.000422)	.208	-.00033 (.00049)	.233
Model (N: 29)	7	Teaching workload (thousand student-hours per year)	.00123*** (.000437)	.309	.00151** (.00067)	.654	.00167*** (.000470)	.448	.00159** (.00067)	.244
Model (N: 32)	8	Number of school types	-.000128 (.00152)	.076	-.00329* (.00173)	.706	-.000544 (.00185)	.153	-.00163 (.00190)	.222
Model (N: 30)	9	Standardised curriculum (0-4)	-.00312** (.00112)	.262	-.00191 (.00181)	.698	-.00333** (.00153)	.179	-.00298* (.00178)	.258
Model (N: 28)	10	Upper secondary completion rate (%)	-.000105 (.000234)	.144	.000128 (.000338)	.691	-.000157 (.000266)	.289	-.000111 (.00035)	.217
Model (N: 31)	11	Vocational prevalence (%)	-.000169 (.000103)	.162	-.000303** (.00015)	.663	-.000274** (.000123)	.283	-.000321** (.00016)	.208
Model (N: 28)	12	Cohort years of upper secondary (Duration of upper secondary*completion rate)	-.00006* (.0000293)	.275	-.0000736+ (.0000463)	.693	-.0000697* (.0000345)	.387	-.0000693+ (.0000475)	.245
Model (N: 31)	13	Voc. prevalence*Edu. stage at first selection (ref: entry lower secondary)		.262		.688		.464		.286
		On entry to upper secondary	.000066 (.0002498)		.000079 (.0003931)		.0000346 (.0002783)		.0000206 (.0004025)	
		During upper secondary	-.0003453 (.0003131)		-.0004231 (.000492)		-.0006226* (.0003493)		-.0006478 (.0005039)	

Statistically significant: + p < .2; * p < .1; ** p < .05; *** p < .01; **** p < .001