South African teacher shortages as revealed through class sizes and learner-educator ratios

An exploratory analysis

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Teacher Demographic Dividend.

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South African teacher shortages as revealed through class sizes and learner-educator ratios: An exploratory analysis

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Abstract

Rising learner-educator (LE) ratios in South Africa from 2012 to 2021 present a concern for worsening class sizes, which were already high by developing country standards over a decade ago. Further increases in LE ratios are expected in a budget constrained environment and as teacher resignations accelerate with the aging of the teacher workforce. Against this context, this paper aimed to provide more specificity on primary grade class sizes in South Africa and explores their relationship to LE ratios. This inquiry was guided by a conceptual framework that may explain deviances across the two measures and is situated within a global analysis of class sizes and LE ratio linkages. While nationally the alignment between class sizes and LE ratios in South Africa is in line with norms in other Southern and East African countries, there is room for improvement. Controlling for differences in LE ratios, enrolment, resourcing, pedagogical structures and observed teacher utilisation factors across schools, much larger primary grade class sizes in some South African provinces remain. The association between class sizes and LE ratios varies significantly across provincial administrations and by school socio-economic status. For this reason, the significant costs of reducing LE ratios are expected to yield varied reductions in class size across contexts. In a fiscally constrained environment, it is incumbent upon provincial administrations to tackle difficult issues of teacher utilisation within schools so that class sizes are better managed. This should be prioritised alongside provincial-specific programmes to reduce very large class sizes through improved learner-educator ratios.

JEL: I29, H73

Keywords: learner-educator ratio, pupil-teacher ratio, class sizes, South Africa, efficiency, teacher allocation, teacher shortages

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Executive summary

As South Africa faces rising learner-educator (LE) ratios in a context of education budgetary cuts and large-scale teacher retirement (Gustafsson 2022c), exploring what this means for class sizes becomes important in the management of excessively large classes. This paper sets out to provide more specificity on primary grade class sizes and learner-educator (LE) ratios in South Africa and considers their relationship to each other.

As reflected in the 2017/18 School Monitoring Survey, the national learner-to-public-educator ratio averaged 35 in public schools with a representative sample of grade 6 learners. The hiring of privately paid School Governing Body (SGB) educators helps to reduce LE ratios by 2 learners from 35 to 33 among this sample.[2] Roughly 34% of grade 6 learners in the public education system in South Africa were in schools that employed at least one SGB educator, although wealthier Quintile 5 schools (82%) are far more likely to hire SGB educators than Quintile 1-3 schools (20-25%).

Class sizes in South African primary schools exceed LE ratios, and considerably exceed suggested guidelines on ideal class sizes. The average (learner-weighted) grade 3 class size in the SMS 2017/18 sample was 41 learners compared to an LE ratio of 33. Grade 3 class sizes should not exceed 35 learners, as reflected in national guidelines; yet almost 70% of grade 3 learners are in classes greater than 35, 49% are in classes greater than 40, 17% are in classes greater than 50 and 6% are in classes exceeding 60 learners. Nationally, grade 3 enrolment numbers had been rising from about 2011 and peaked in 2017 before starting to decline slightly in 2021 (Gustafsson 2022a, p10-11). Holding other things constant, grade 3 class sizes will be similar or slightly smaller in 2023 than what is seen in these 2017/18 SMS estimates. But with worsening LE ratios, class sizes could have also increased.

National averages mask considerable heterogeneity in class sizes, and particularly the occurrence of very large class sizes in less resourced school contexts and in certain provinces. Learners in Quintile 5 schools are far less likely to face very large class sizes than learners in poorer Quintile 1-3 schools. Just 4% of grade 3 learners in Quintile 5 schools are in classes of over 50 learners. By contrast, 23% of grade 3 learners in Quintile 1 schools are in classes exceeding 50 learners. Less than 4% of grade 6 learners in Quintile 5 schools have teachers with classes exceeding 50 while about 47% and 29% of grade 6 learners in Quintile 1 schools have teachers that are likely to face a large class of over 50 and 60 learners respectively. This study also shows that average class sizes at one grade level (e.g. grade 3 in the case of the SMS 2017/18) can mask very high class sizes experienced by educators in other grades. In the SMS

[2] All estimates apply learner weights.

2017/18, the learner-weighted average largest class size taught by grade 6 educators is 51 learners compared to a learner-weighted average of 41 learners in grade 3 classes.

Compared with other Southern and Eastern African countries with similar primary level LE ratios, South Africa's containment of class size for a given LE ratio is at an expected level. Nevertheless, there is still room to better utilise the existing stock of teachers to contain class sizes. Taking the ratio (referred to here as an alignment ratio) of grade 3 class size to LE ratios in the SMS 2017/18 grade 6 school sample, a figure of 1.2 is obtained. This is roughly in line with that calculated using median grade 6 class sizes and LE ratios in SACMEQ 2007. Compared to other middle-income countries (Brazil, Russian Federation and Mexico) that achieve alignment ratios at the primary or lower secondary levels that are close to one, benefiting from the use of multi-shift schooling systems, South Africa's alignment ratio of 1.2 is higher. There are also some African countries with higher average LE ratios than South Africa, that overall do slightly better at containing class sizes for a given LE ratio in the absence of a school shift system.

Possibilities for class size improvement in South Africa become even more evident when looking at differences in the management of class sizes across provinces. By example, the largest class sizes experienced by grade 6 educators in the Western Cape is on average 39 learners, compared to an average of 61 in Limpopo, 59 in Mpumalanga and 54 in KwaZulu-Natal.[3] There are stark differences in the association between class sizes and LE ratios across provinces and by school Quintile even after controlling for differences in school resources, school enrolment, pedagogical structures and observed teacher utilisation factors. Extremely large classes taught by grade 6 educators in Limpopo, KwaZulu-Natal and Mpumalanga are not explained by differences in observed characteristics. With a particularly steep association between class sizes and LE ratios in Limpopo, this province struggles to contain class sizes at LE ratios over 30. By contrast, the Western Cape and Northern Cape's capacity to manage very large class sizes as LE ratios rise compared to other provinces is evident, even after controlling for school differences across provinces. Nevertheless, even in provinces that manage to better contain class size increases as LE ratios rise, average predicted Grade 3 class sizes are above a maximum policy ideal of 35 (but less than 40).

In modelling the association between class sizes and LE ratios in South Africa, results suggest that leveraging LE ratios as a tool to manage class sizes will yield differing results across provincial administrations. Although further longitudinal analysis is needed to confirm this finding, the results so far suggest that the significant costs of reducing LE ratios may not result in desired reductions in class sizes in some provinces. This leads to a situation where

[3] All estimates are learner-weighted.

children experience a perceived teacher shortage even if learner-educator ratios are improved. Furthermore, where class size impacts on learning outcomes are mixed in developing country contexts, including in countries with very large class sizes (Duflo et al. 2015; Datta & Kingdon 2021), more cost-effective approaches to reducing class sizes than hiring more teachers should complement efforts to reduce LE ratios. In a fiscally constrained environment, it is incumbent upon provincial administrations to tackle difficult issues of teacher utilisation within schools so that class sizes are better managed. Echoing findings in an earlier report on post-provisioning (Department of Education 2006), addressing teacher utilisation problems should be prioritised, and this should occur alongside context-specific programmes to reduce class sizes through improved learner-educator ratios. Such efforts should also be weighed against further empirical work that interrogates class size effects on learning.

Addressing inefficiencies in teacher utilisation at the provincial and school level is preferred over policy mandates that set class size ceilings (DoE 2006, p58; Miles & Darling-Hammond 1998). However, there could be room for an equity-focused approach to this problem, first to 'eliminate all class sizes in excess of 60, then in excess of 50 and so on' rather than applying an overall class size ceiling limit (Spaull et al. 2022). To do this, monitoring of class sizes is critical. The first step to addressing hidden inefficiencies in class size management could involve tracking class sizes more effectively. South Africa has not been systematically measuring class sizes. It is not sufficient to track class sizes at just one or two grade levels. This needs to be done across grades, capturing the range of class sizes experienced in a school and across Phase levels. Finally, qualitative research is needed to interrogate reasons for very large class sizes that cannot be explained by observed differences across schools. This will require inquiry into school level timetabling practices, within-school teacher allocation dynamics and the actual time educator's spend teaching.

"In many countries, teachers are not well allocated in relation to student numbers…Without a strong monitoring system and an enforcement of effective teacher allocation rules, a policy aimed at hiring more teachers to reduce class size may not even manage to do so."

(Crawfurd & Le Nestour, 2022 p90)

1. Introduction

Narrowly defined teacher shortages refer to the "insufficient production of new teachers, given the size of student enrolments and teacher retirements" (Sutcher et al. 2019, p4). In this regard, South Africa is currently facing a shortage, with a wave of teacher retirements expected to disrupt teacher supply over the next decade (Van der Berg et al 2021, Gustafsson 2022c). Concerns have also been expressed about the absorption of trained teachers into the schooling system in times where teacher production levels have kept pace with teacher demand (Gustafsson 2022c, p34). Regardless of the reasons for there not being enough teachers, societies experience a teacher shortage if there are not enough teachers allocated to schools and classrooms to create optimal learning conditions.

In the decade preceding an accelerated disruption in teacher supply from an aging teacher workforce, South Africa had already been experiencing teacher shortages expressed in rising learner-educator ratios (elsewhere referred to as pupil-teacher ratios or student to teaching staff ratios). Nationally, the average learner-educator (LE) ratio for public ordinary schools (grades 1-12) increased from 27.4 in 2012 to 29.8 in 2021 (Gustafsson 2022b, p3-4). Class sizes have also been getting larger despite being high over a decade ago by developing country standards (van der Berg et al. 2020, p37, Department of Education (DoE) 2006, p9). The Trends in International Mathematics and Science Study (TIMSS) suggests that the percentage of grade 5 children in South Africa in classes of at least 50 learners rose from 16% in 2015 to 34% in 2019 (Spaull et al. 2022). Some of this rise may be attributed to an unusual birth surge raising primary grade enrolments (Gustafsson 2018). Studies have also documented considerable variation in the incidence of very large class sizes across provinces and by schools' socio-economic profile (Spaull et al. 2022).

Although related, LE ratios and class sizes are not the same things despite confusion in public debate (see for example Nkosi 2022). Interchangeable use of these terms may confound how people think about class size and accomplish class size reduction (Pain-Bate et al. 2002). A LE ratio is typically obtained by dividing the number of full-time equivalent learners by the number of full-time equivalent educators at a given level of education (OECD 2019, 2021). This administrative statistic helps account for the distribution of staffing resources and is an indicator of the quality of the school system (Pain-Bate et al. 2002). Class size is defined as the average

number of students that are grouped together in a classroom or may be defined as the number of learners a teacher teaches at the same time.

Class sizes should be optimised to support learning. Unfortunately, no causal estimates of class size effects on learning exist for South Africa. For this reason, ideal class sizes are rather drawn from policy guidelines. However, non-causal evidence suggests that class size effects may vary across the school system. At the secondary school level in South Africa, extreme class sizes are concentrated in poorer schools, but class size is only negatively associated with learner outcomes in wealthier (and typically more functional) schools (Köhler 2022). Internationally, evidence on this relationship is also mixed. In contrast to perceived wisdom, in low- to middle-income countries (LMICs) participating in the Programme for the Analysis of Education Systems (PASEC) there is a positive class size effect from reducing class sizes in smaller classes, but not in larger classes (Crawfurd & Le Nestour 2022). Large class size reductions had little to no impact on learning outcomes in Kenya and India (Duflo et al. 2015; Datta & Kingdon 2021), although these results may only hold in the absence of enabling factors for learning, such as good formative assessment or individualised instruction.

Despite this mixed evidence, expecting major improvements in teachers' instructional or assessment practices seems unreasonable in contexts of very large class sizes. Large class sizes could hamper learning, particularly in the early grades where teacher-child interactions should be more individualized (Crawfurd & Le Nestour 2022, p89). Large classes may limit the effective use of instructional time (Spaull & Pretorius 2022) and inhibit opportunities for differentiated learning strategies such as 'teaching at the right level (TARL)'. Studies have also not sufficiently examined class size impacts on other child outcomes (Hattie 2005), such as a well-being or drop-out, or on teacher's motivation and performance (Crawfurd & Le Nestour 2022).

Even if there are null impacts of class size reductions on learning in South Africa, should this preclude addressing large class sizes? One could argue to the contrary if the costs of reducing class sizes are contained by improving efficiencies in the management of an existing teacher stock. Education policy is set at a national level in South Africa, but school implementation (including budget management and teacher hiring) is delegated to nine provincial administrations. In this paper, class sizes are shown to be much higher in some South African provinces than they should be for a given teacher allocation reflected in learner-educator ratios and after controlling for four sets of observed factors: school resources, school composition including size, pedagogical structures and teacher utilisation factors.

The relationship between learner-educator (LE) ratios and class sizes has been inadequately analysed in the past yet is important for debates about how better teacher distributions can support

educational quality improvements, particularly in LMICs (Van der Berg et al. 2020, p1). Countries with similar LE ratios may face vastly different average class sizes (OECD 2021), but little is understood about the underlying reasons for this. Drawing on a literature on teacher allocation systems (Miles & Darling-Hammond, 1998; Tournier 2015; Asim et al. 2017; Walter 2020; Zubairi 2020), and various South African education planning documents, a conceptual framework highlighting four broad factors is developed in this paper to explore why class sizes may be higher (or lower) than LE ratios in a primary school context. The framework is then applied to survey and administrative data.

The paper aims to answer four research questions:

- How large are class sizes and LE ratios in South Africa, and how has this changed over time?
- How do class sizes relate to LE ratios, and how does this compare to other countries?
- How does the association between class sizes and LE ratios in primary school contexts vary across different parts of the South African education system, including provincial administrations and socio-economic school profiles?
- Using the conceptual framework developed, do observed differences across schools explain the divergence between class sizes and LE ratios in South Africa?

To answer these research questions, the paper relies on secondary analysis of local administrative and international data, and new analysis of South Africa's 2017/18 School Monitoring Survey (SMS) – a large nationally and provincially representative survey of schools offering Grade 6.

After outlining a framework for examining class sizes and LE ratio linkages, section 3 provides background on teacher shortages, class sizes and LE ratios in South Africa. Section 4 then postitions the South African analysis within a global perspective on class sizes and LE ratios. Section 5 interrogates in more detail South African class sizes and LE ratios (and their linkages) through analysis of the 2017/18 SMS using both descriptive and multivariate estimation. Section 6 concludes considering the implications of the findings for policy.

2. A framework for examining class size and learner-educator ratio linkages

An existing literature on teacher allocation systems (Miles & Darling-Hammond 1998; Miles & Roza 2006; Tournier 2015; Asim et al. 2017; Walter 2020; Zubairi 2020) provides explanations for inequities and inequalities in LE ratios within countries. For example, poor teacher allocations may arise due to administrative bottlenecks in allocating teachers to schools; difficulties in matching teacher specialisations to enrolment or subject needs; regional migration of school populations; imbalances across locales in teachers' preferences for where they teach (Sutcher et

al. 2019) or through hiring freezes. Education bureaucracies may also be slow to respond proactively to changing population dynamics, and thus meeting teacher demands, where personnel hiring decisions lag population changes or lag policy changes such as the introduction of fee-free schooling (Crawfurd & Ali 2022). Political interference and power imbalances in education systems can also contribute to poor teacher allocations (Brunner et al. 2020; Zubairi 2020).

Once teacher allocations within education decision have been made, a limited literature exists on why class sizes may deviate widely from LE ratios. Large class sizes may occur because even if educators are allocated to schools, they are not necessarily allocated to classes by school management (DoE 2006, p9). In education planning literature, coherence or randomness measures are used to identify how well or poorly teachers are assigned across schools with respect to total enrolment (IIEP/Pole de Dakar 2016). These are important measures in exploring teacher allocations across schools but do not account for inefficiencies in the utilisation of teachers within schools once allocated. In the descriptive analysis of class sizes and LE ratios, I use the concept of an "alignment ratio" – simply the ratio between class size and a LE ratio – to explore efficiencies in teacher utilisation.

Then drawing on findings in education planning documents and literature on teacher allocations, I consider four broad sets of factors, as summarised in Table 1, that may further explain why class sizes may be higher (or lower) than LE ratios. First, resourcing constraints may raise class sizes above LE ratios (DoE 2006). Even if there are enough teachers, the limited availability of classrooms may result in large classes (Tournier 2015). The second set of factors relates to school composition including school size and relative grade size (Kadzamira 2022). A school's student composition may inform subject offerings, in turn influencing class sizes. For example, where multiple languages are offered as the medium of instruction in a multi-lingual student context, this can present complexities for optimal allocations of students to teachers (Department of Basic Education (DBE) 2016; Van der Berg et al. 2020). The third set of factors include the structure or pedagogical structure of schooling such as decisions taken around grade combinations in schools, the use of shifts or platooning, the extent of complexities of subject provisioning allowed (Tournier 2015), and the allocation of teaching loads across school managers (DoE 2006).[4] Sudden changes in grade repetition patterns may also result in sub-optimal class sizes for a given LE ratio (Wills & van der Berg 2022). Finally, teacher utilisation, inefficiencies or weak teacher management systems can also result in unnecessarily high (or low) class sizes for a given LE ratio. Utilisation challenges relate to weak timetabling practices, educator absenteeism and

[4] Not all educators have equal teaching loads. School management team members (including principals, deputy principals and heads of department), particularly in larger schools, may not have full teaching loads (see DBE 2016 pA-9).

suboptimal allocations of teaching loads across available educators. Teachers themselves may influence how class sizes are allocated in schools with some teachers having more bargaining power in being allocated smaller class sizes, for example, if they are more senior, hold management positions or specialise in esteemed subjects such as mathematics.

Applying this framework to schooling and administrative data could help to shed light on why class sizes may deviate widely from LE ratios, albeit some, although not all factors contributing to suboptimal class sizes for a given LE ratio can be quantified through surveys.

Table 1: Conceptual framework of four sets of factors that may cause class sizes to deviate from LE ratios in primary school contexts

Dimension	Sub-dimensions
1. Structure or pedagogical structure of schooling	• Grade combinations and highest grade offered • Use of multi-shift systems • Complexities of subject provisioning • Norms informing teaching loads across school managers • Grade repetition practices
2. Student composition	• School size • Relative grade size • Language offering: multiple languages as the medium of instruction
3. Resourcing constraints and resource utilisation	• Availability of classrooms • Classroom usage
4. Teacher utilisation challenges	• Timetabling practices • Educator absenteeism levels • Allocations of teaching loads across available educators • Time spent teaching • Teacher bargaining power in being allocated smaller classes

3. Background on teacher allocations, learner-educator ratios and teacher utilisation in South Africa

Inequities in teacher allocations

South Africa has faced teacher misallocation challenges at various points in time and relatively within the system. Inequities in teacher allocations across grades or provinces have occurred through differential population growth in the school-going population. Migration out of high unemployment areas such as the Eastern Cape to economic hubs such as Gauteng and the Western Cape has shifted school enrolment distributions across provinces (Gustafsson 2022a). An

unexpected increase in births in the years 2003 to 2005 of around 13% (Gustafsson 2018), also had implications nationally for 'temporal' grade-specific teacher shortages.[5] And during Covid-19, unanticipated shifts in grade enrolment numbers through changing patterns of grade repetition have had implications for class sizes (Wills & Van der Berg 2022). Temporary teacher shortages may also arise where posts are left vacant due to challenges of attracting teachers to hard-to-staff schools, bottlenecks in appointment processes or due to hiring freezes, particularly of school manager posts (Gustafsson 2022d, p2). In 2017/18, 78% of South African primary and secondary schools combined had all their teaching posts filled, although primary schools were substantially more likely to have all their posts filled (80%) compared to secondary schools (72%) (DBE 2018, p7). Certain provinces may face higher vacancies such as the Eastern Cape with just 63% of primary and secondary schools with all posts filled in 2017.[6] Nationally, it is also more common for wealthier Quintile 5 public primary schools to have all posts filled (86%) than poorer schools, with the lowest percentage of all posts filled in Quintile 3 schools (76%) (DBE 2018, p7).

Rising learner-educator ratios

In post-apartheid South Africa, there have been periods where LE ratios declined nationally. At the primary level, specifically, LE ratio reductions were experienced from 2006 to 2011 but improvements had almost entirely been eroded by 2017 (DBE 2020, p31). Nationally, the average grades 1-12 learner-to-public educator ratio in public ordinary schools (including primary and secondary schools) rose from 27.4 in 2012 to 29.8 in 2021 (Gustafsson 2022b, p3-4) as seen in Figure 1, part A. Increases in LE ratios over this period occurred in eight of nine provinces.[7] Rising LE ratios are attributed to a combination of increasing learner enrolments and above-inflation wage increases that have placed the basic education sector under significant financial pressure (DBE 2020, p30).

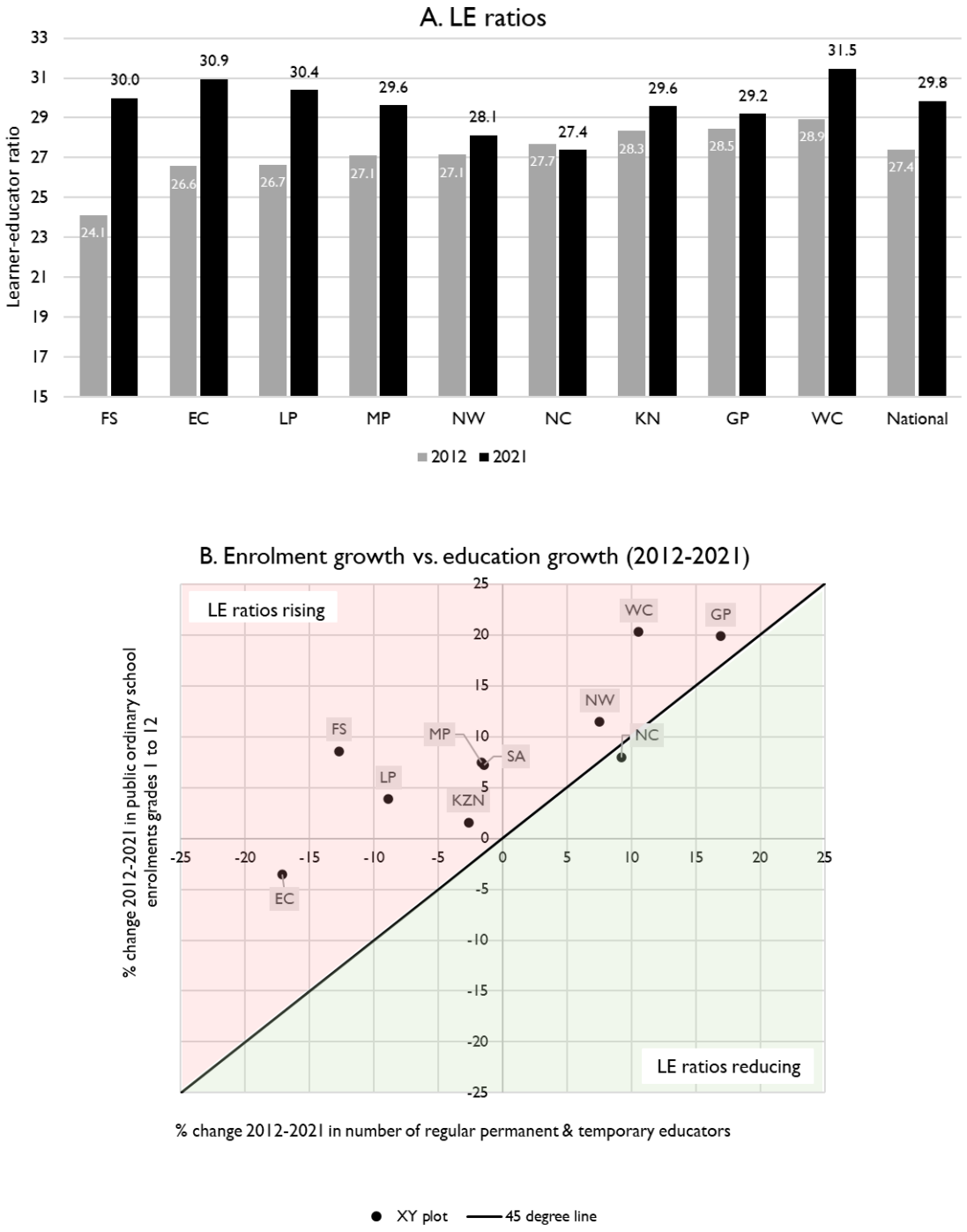
With teacher appointments devolved to nine South African provinces, provincial differences in learner-educator ratios are expected. Provinces may take different approaches to allocating education budgets to personnel spending (Deloitte 2013) and accommodating changes in school-aged population sizes.[8] LE ratios will, by definition, increase if learner enrolments increase relative to educator numbers or there are declines in educator numbers relative to enrolments. With exception of the Northern Cape (NC), enrolment growth has out-paced educator growth in

[5] In 2022, this demographic surge reached grade 12, with the largest cohort of Grade 12s expected and this being augmented by reduced repetition in grades 10 and 11 during pandemic-affected years (Gustafsson 2022a, p11-12).
[6] Whereas less than 0.5% of primary and secondary schools in other provinces faced a situation with only 50-74% of allocated posts filled, this estimate was as high as 5.4% in the Eastern Cape.
[7] The learner-to-public-educator ratios in Figure 1 are calculated using provincial totals and therefore reflect LE ratios at the provincial level. School LE ratios may be higher where educators and learners are not equally distributed across schools.
[8] This is exacerbated by lags in available population estimates that inform provincial education department funding allocations.

eight provinces (Gustafsson 2022b). In four provinces (the Free State (FS), Mpumalanga (MP), Limpopo (LP) and KwaZulu-Natal (KZN)), positive enrolment growth has occurred concurrently with declines in educator numbers from 2012-2021. This is seen in Figure 1, part B. The percentage change from 2012 to 2021 in grade 1-12 enrolments in public ordinary schools is plotted against the percentage change over the same period in the number of regular permanent *and* temporary educators employed, as reflected in public payroll data (Persal). The 45-degree line shows where growth in learner enrolment equates to the growth in educator numbers. Any plot value lying above the 45-degree line reflects a situation where enrolment growth has out-paced educator growth resulting in rising LE ratios (and the further left the plot point is away from the 45-degree line, the worse the decline in LE ratios). LE ratios improve right of the 45-degree line. With exception of the Northern Cape (NC), enrolment growth has out-paced educator growth in eight provinces and nationally (Gustafsson 2022b).

To return to a national learner-educator ratio as experienced in 2012, almost 35,000 more educators were required nationally in 2021 (Gustafsson 2022b, p6), raising the current stock of public teachers from about 405,000 in 2021 (DBE 2022). Despite the need for many more educators to restore LE ratios to 2012 levels, demographic trends point to further reductions in educator numbers if vacancies from a teacher retirement wave are not filled. Gustafsson (2022c, p19) estimates that "By 2030, at least 19% of the existing workforce will have left, as they are age 56 or older in 2021. And a whole 42% of the workforce will have aged beyond 65 in 2035 and would therefore have left the workforce."

Figure 1: National and provincial learner-to-public-educator ratios in 2012 and 2021, grades 1 to 12 in public ordinary schools in South Africa



Data source: Gustafsson (2022b, p3-4), Table 3 'Regular' permanent and temporary educators 2012 to 2021 by province (p3) and Table 4 'Public ordinary school enrolments grades 1 to 12', applying own calculations. Notes: These LE ratios are at the provincial level but school level LE ratios may be higher. National average LE ratios agreeswith Figure 4 in Gustafsson (2022b, p6). FS = Free State, EC = Eastern Cape, LP = Limpopo Province, MP = Mpumalanga Province, NC = Northern Cape, KZN = KwaZulu-Natal, GP = Gauteng, WC = Western Cape, SA = South Africa.

Teacher utilisation

An in-depth study on teacher utilisation in South Africa (DoE 2006) highlighted serious inefficiencies in the early 2000s. Simulating what class sizes would be if there was an optimal utilisation (following policy) of existing teachers within each school, two-thirds of learners should have been in classes with 40 learners or fewer, and 10% of learners should have been in classes with more than 48 learners (DoE 2006, p35). In reality, in 2004 only 40% of learners in South Africa were in classes with fewer than 40 learners, and 10% of learners were in classes exceeding 69 learners. Due to inequities in how classrooms and teachers are distributed, thousands of class teachers in some parts of the system found themselves without classrooms even though numbers of full-time teachers substantially exceed available classrooms. However, the report concludes that "dealing with classroom shortfalls in the schooling system is important, but without other accompanying interventions aimed at a better utilisation of educator time, additional classrooms will not on its own solve the problem of excessively large classes" (DoE 2006, p47). A pressing concern is low teaching time. In 2004, the average full-time teacher (excluding managers with lower teaching loads) in South Africa taught 3.6 hours a day. The net result is that learners receive far less contact time than the 5.2 hours prescribed in policy at the time (DoE 2006, p48).

Rising class sizes

Policy on maximum class size does exist in South Africa, although it is suggestive rather than prescriptive in nature (Köhler 2022, p129). In post-provisioning policy (DOE 2002; DBE 2016, pA-13) 'ideal' maximum class sizes are provided for grades R–4 at 35, whilst it is 40 for grades 5–6 and 37 for grades 7–9. In higher Further Education and Training (FET) Phase grades (grades 10-12), ideal maximum class sizes vary by subject taken but never exceed 37 (DBE, 2016, pA-15). Although policy on school infrastructure varies slightly from post-provisioning guidelines, setting the acceptable class size norm at a maximum of 30 for grade R and a maximum of 40 learners in all other grades (South Africa 2013, p13).

Nine years ago, the majority of Foundation Phase (grades 1-3) learners were in classes that exceed these norms, in some instances by a significant margin, with large inter-provincial differences noted. The percentage of grade 1-3 children in classes over 35 ranged from 57% in the Northern Cape to 79% in Gauteng (Spaull 2016). In Limpopo and the Eastern Cape, 27% of grade 1-3 learners were in classes over 50. These very large class sizes could be attributed to a large temporary increase in births of 13% between 2003 and 2005 (Gustafsson 2018). As a consequence, in 2013 (the year for which Spaull (2016) estimates grade 1-3 class sizes) grade 3 enrolments were unusually high, reaching a maximum in 2017 before tapering off by 2018 (Gustafsson 2022a, p10-11).

Juxtaposing a situation of rising LE ratios against teacher utilisation challenges, raises the question as to whether lowering learner-educator ratios will result in lower class sizes? For this reason, the paper examines the links between class size and LE ratios, both internationally and locally. As will be discussed, significant attention will need to be given to improved management and allocation of *existing* teachers within the system, where this applies to some provinces more than others.

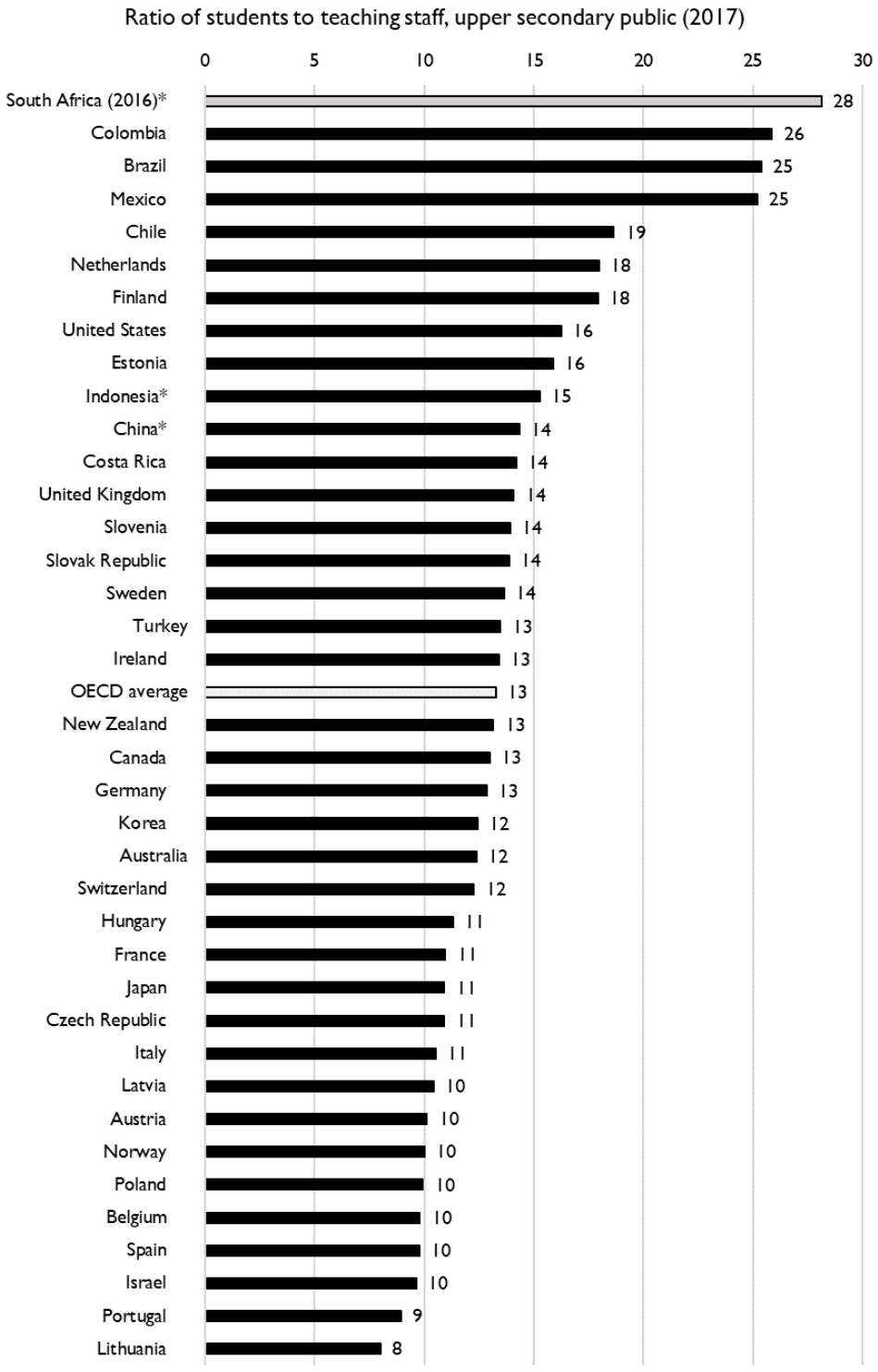
4. A global perspective on class sizes and learner-educator ratios

The OECD publishes statistics on average class sizes and 'student to teaching staff ratios' (akin to LE ratios or pupil-teacher ratios) (OECD 2019, 2021). On average across OECD countries, there are 15 students for every full-time equivalent teacher in primary education and 13 students per teacher in both lower and upper secondary schools (OECD, 2021). The average OECD country school class has 21 students in primary education and 23 in lower secondary education.

Class size averages for South Africa as a 'partner' country are not available in the 2019 or 2021 OECD indicators but a student to teaching staff ratio at the upper secondary level of 28 is identified in 2016. This is the highest student to teaching staff ratio of 46 countries shown (see Figure 2), trumping other developing countries including Columbia (26), Brazil (25), Mexico (25), Chile (19) and China (14).

Compared to OECD averages and even the high estimates for South Africa, other African country contexts face much higher average class sizes and student to teaching staff ratios. LE ratios in public primary education were as high as 70 in Malawi (2013), 63 in Rwanda (2013), 45 in Tanzania (2013) and 36 in Zimbabwe (2014) (IIEP/Pole de Dakar 2016, p5). Building a global school-level data set on public primary education in 91 countries, Walter (2020) finds that pupil-teacher ratios in developed countries are low on aggregate and vary little between schools. In contrast, in developing countries aggregate LE ratios are high and between school differences in LE ratios are large pointing to problems of teacher misallocations (Walter 2020, p3). With higher LE ratios in developing countries, larger class sizes are expected (especially in low-income countries) compared to developed countries. An analysis of 17 PASEC surveys from 2007 to 2014, reveals averages of 53 students per class (Crawfurd & Le Nestour 2022, p89).

Figure 2: Student to teaching staff ratios in upper secondary public institutions, averages in OECD and partner countries in 2017



Data source: OECD (2019) using Table D2.3. 'Ratio of students to teaching staff, by type of institution (2017)'. Own graph. Partner countries shown by a *.

A positive relationship is expected between LE ratios and class sizes. In six developing countries (Kenya, Mozambique, Pakistan, Tanzania, Uganda & Zambia) with available class size data, higher school-level LE ratios are associated with larger class sizes (Walter 2020, p17). Positive associations are also observed using OECD indicator data and data from the Southern and Eastern African Consortium for Measuring Educational Quality (SEACMEQ). Figure 3 compares average country class sizes to student to teaching staff ratios at the lower secondary school level in public institutions (panel A) and in public primary schools (Panel B) in OECD or partner countries. (Unfortunately, 2017/19 OECD indicators on both class sizes and student to teaching staff ratios are not available for South Africa.) Along the 45-degree line average student to teaching staff ratios equate to average class sizes.

There are two notable findings from Figure 3. First, for a given student to teaching staff ratio, there can be considerable differences across countries as to how this translates into class sizes. Second, average class sizes almost always exceed student to teaching staff ratios across countries. The only exception is Mexico in Panel A and Brazil and the Russian Federation in Panel B that manage to achieve lower class sizes than student to teaching staff ratios. This may be possible through multi-shift schooling (otherwise referred to as platooning) which has been common in these three countries[9] (Da Mota Darós Parente 2020).

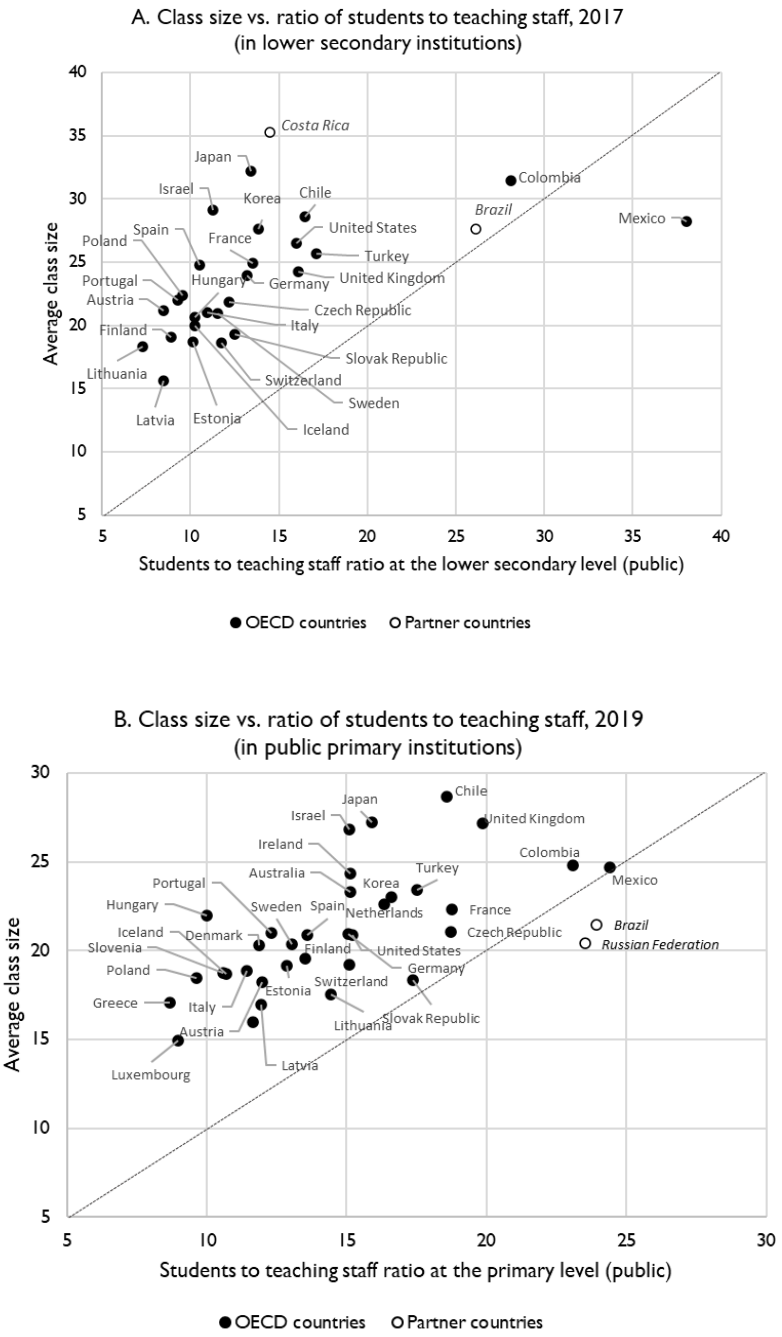
Then the OECD data is used to generate "alignment ratios", defined here as the ratio of class size to student to teaching staff ratios. In Figure 4, each country's alignment ratio is plotted against its student to teaching staff ratio at the lower secondary level (panel A) and primary level (panel B). Relative to student to teaching staff ratios, average class sizes are on average 1.9 times greater at the lower secondary level across 26 OECD countries and 1.5 times greater at the primary level (drawing on 34 OECD countries in panel B). Costa Rica has the highest average class size, which exceeds their student to teaching staff ratio by 2.5 times at the lower secondary level.

It appears that where teaching resources are constrained, reflected in higher student to teaching staff ratios, countries have little choice but to more effectively utilize and allocate the teachers that they do have to prevent class sizes from becoming excessively high. The higher are student to teacher ratios, the lower is the 'alignment ratio' as seen in Figure 4. Some developing countries with high student to teaching staff ratios (specifically Brazil, Columbia and Mexico) have managed to align their average class sizes to the same levels (i.e. almost an exact mapping of class sizes to student to teaching staff ratios), possibly through the use of multi-shift schooling. At

[9] About 22% of all Russian schools implemented double shifts in 2008 (https://web.archive.org/web/20081101192754/http://www.ed.gov.ru/uprav/stat/1849/)

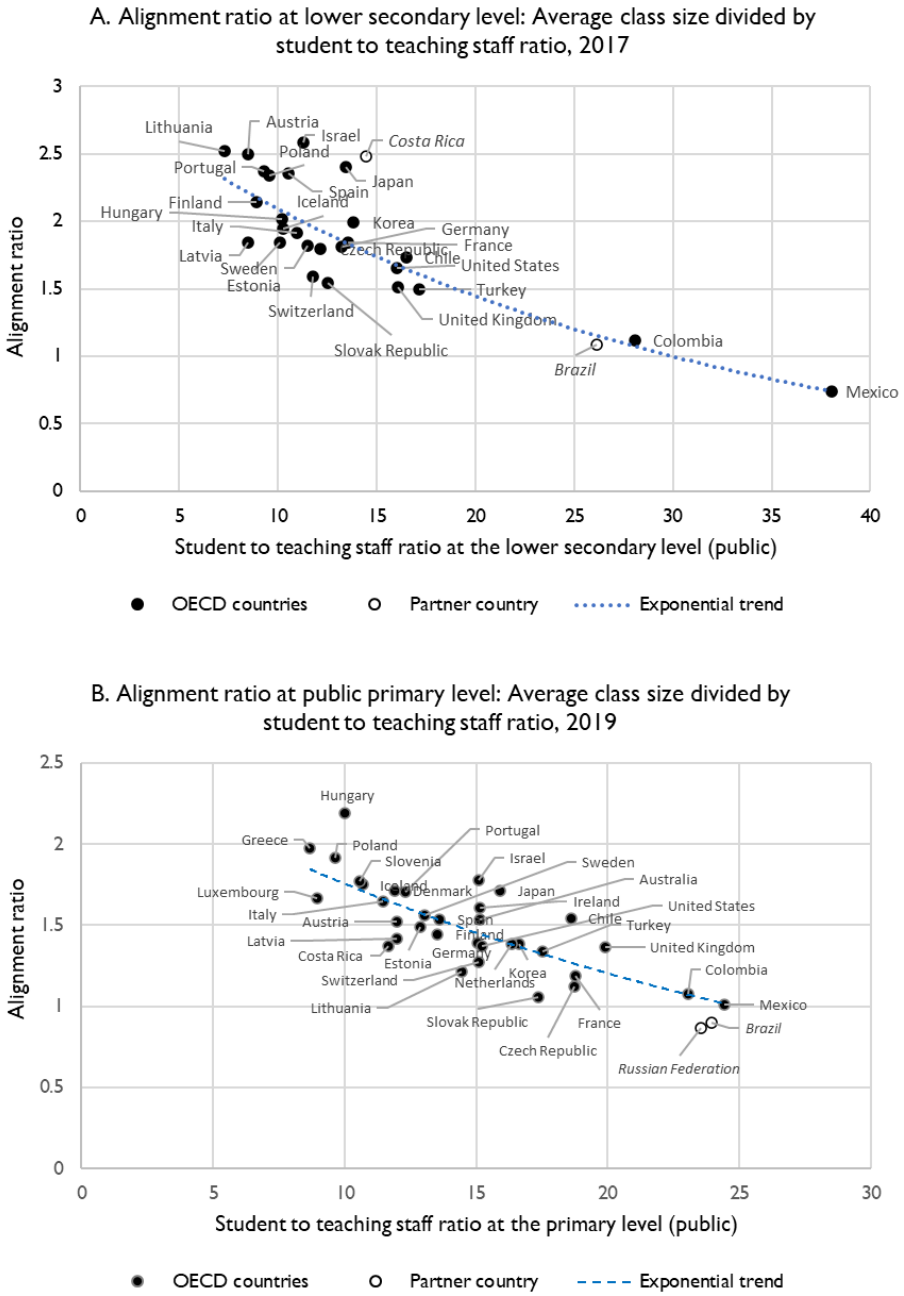
about a primary grade LE ratio of 23-25, alignment ratios approach 1 across the OECD or partner countries.

Figure 3: Class size vs. students to teaching staff ratio in lower secondary (A) and primary public (B) institutions (OECD and partner countries)



Data source: OECD 2019 and 2021. Lower secondary level estimates in 2017 from Table D2.3. 'Ratio of students to teaching staff, by type of institution (2017)' and Table D2.1. 'Average class size by type of institution (2017) and index of change between 2005 and 2017'. Primary level estimates in 2019 from Table D2.2. 'Ratio of students to teaching staff in educational institutions, by level of education (2019)' and Table D2.1. 'Average class size, by type of institution and level of education (2013 and 2019)'. Own graph. There is data for both indicators in 2017 for 26 OECD countries and 2 partner countries. There is data for both indicators in 2019 for 34 OECD countries and 2 partner countries. Staff are full time equivalents.

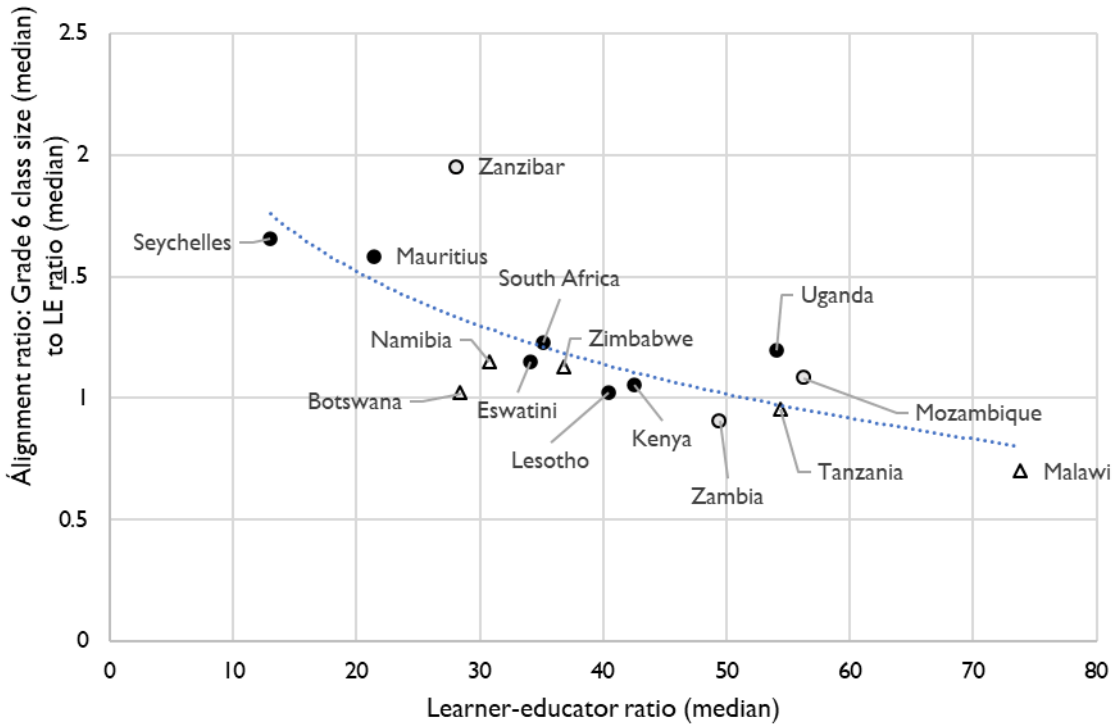
Figure 4: Alignment ratios vs. student to teaching staff ratio, OECD country averages at the lower secondary level (panel A) and for primary public institutions (Panel B)



Data source: Panel A - OECD 2019 using Table D2.3 and Table D2.1. Panel B - OECD 2021 using Table D2.2. and Table D2.1. See Figure 3 for notes. Own calculations and graph.

In contexts where higher LE ratios are observed, the negative association between alignment ratios and LE ratios still holds. This is seen in Figure 5 for a sample of schools (with a representative sample of grade 6 learners) from Southern and Eastern African countries in 2007. In SACMEQ 2007, the median LE ratio across 14 countries is 36. South Africa, without a multi-shift school system, achieved a median alignment ratio of 1.2 given a median grade 6 class size of 42 and LE ratio of 34. When compared to 14 other participating countries in SACMEQ, South Africa's median alignment ratio was at an expected level for its student to teaching staff ratio at the time. But there remains room for improvement. By comparison, Kenya or Lesotho with higher LE ratios manage to achieve alignment ratios close to 1 without a multi-shift system.

Figure 5: Alignment ratio vs. learner-educator ratio in Southern and East African countries, SACMEQ 2007 (Median value in each country shown)



Source data: SACMEQ 2007, own calculations. Learner-weighted. Notes: Filled circle marker reflects no multi-shift system. Unfilled circle (O) marker signals that more than 50% of grade 6 students in the country are in schools that implement multi-shift systems. Triangular marker: 5-50% of grade 6 students are in schools with multi-shift system. Dashed trendline (logarithmic function). Schools in each country sample are representative of a grade 6 population of students. LE ratios or class sizes are missing for 36% of the Zambian school sample, and 14% of the Zimbabwean school sample. The LE ratio reported does not necessarily capture full-time equivalent teaching staff in its derivation. Median LE ratio and median alignment ratio shown for each country sample.

5. Primary grade class sizes and learner-educator ratios: An analysis of the 2017/18 School Monitoring Survey

To further investigate primary-level class sizes and their relationship with LE ratios in South Africa specifically, this paper relies on the 2017/18 School Monitoring Survey (SMS) linked to administrative data on learner and educator enrolment numbers from the Department of Basic Education's (DBE) Education Management Information System (EMIS). After describing the data, descriptive statistics on class sizes and LE ratios are each discussed. Then the links between the two are examined both descriptively and in a multivariate regression context.

a) Data

The goal of the SMS 2017/18 was to collect information to investigate progress in the schooling sector towards achieving the key goals and indicators in national Action Plans and Strategic Frameworks (DBE 2018). The 2017/18 SMS was sampled to be nationally representative of i) schools with grade 6 learners and ii) schools with grade 12 learners. For this study, the main analysis is restricted to the grade 6 sample, among whom 84% are in schools where the highest grade offered is Grade 7. The sample is stratified by province and then by the DBE's school quintile system which proxies for school socio-economic status (DBE 2018, p11). Typically, Quintile 1-3 schools are no-fee charging schools serving poorer learners, while Quintile 4-5 schools are fee-charging.[10]

Sample

To examine class sizes and LE ratios, educator questionnaire data for Grade 3 and 6 sampled educators is used, linking this to school level data from principal and school observation questionnaires. Up to two grade 3 educator questionnaires and up to five (but typically two) grade 6 educator questionnaires were administered at the school during school visits. The surveyed educators either teach Mathematics or Language. In the Foundation Phase, the grade 3 educator is typically a class teacher teaching both Mathematics and Language. In the Intermediate Phase, a grade 6 educator may be a subject specialist.

The maximum realised school sample offering Grade 6 (978)[11] and the realised school sample offering Grade 3 (929) for which there is at least one surveyed educator is shown in Table 2. The corresponding number of grade 3 and 6 educators that were successfully surveyed across these schools is also shown. In multivariate regression analysis, the sample size declines to about 903 schools (1,503 grade 3 educators) in estimating grade 3 class sizes and to 950 schools (2155 grade

[10] The boundaries between fee payments and the Quintile system have become increasingly blurred in recent years.
[11] There were meant to be 1000 schools sampled offering Grade 6. The realised sample was slightly less at 989, and reduces to 978 schools with at least one educator surveyed.

6 educators) in estimating largest class sizes taught, due to some missing information on other explanatory variables of interest.

Table 2: SMS 2017/18 primary level sample (school offers grade 6)

	Maximum available sample size	**Available sample size for multivariate analysis**
Number of grade 3 educator responses	1 543	1503
Number of schools with grade 3 educator response	929	903
Number of grade 6 educator responses	2 214	2155
Number of schools with grade 6 educator response	978	950
Number of schools with principal response	986	

Class size measure

In the 2017/18 SMS, the grade 3 educator was asked to identify how large their class was (assuming they typically teach all subjects to one class or that they are class teachers), while the grade 6 teacher was asked to identify the size of the largest class that they teach (acknowledging that they may teach a subject to different classes or grades). Additionally, at the grade 3 level, the fieldworker conducted a head count of the number of learners in the class. Due to learner absenteeism, self-reported class sizes are slightly higher than observed class sizes but the two measures are highly correlated (0.98) suggesting that self-reported measures are reliable.

In lieu of the sampling approach, interpretations of class sizes at the grade 3 level are in relation to schools offering grade 6. This is an important qualification where 6.5% of schools nationally offering grade 3 but not grade 6 are excluded from the SMS 2017/18 sampling frame (DBE 2018, p20). Applying learner weights, a technically accurate interpretation of the class size data for Grade 3 should be in relation to Grade 6 but such language is cumbersome for readers to follow. So for clarity, when this paper reports that X% of grade 3 class sizes are greater than Y, this actually means X% of grade 6 learners are in schools where grade 3 class sizes are greater than Y.

Learner-educator ratio measure

Learner-educator ratios (including educators hired privately through the school-governing board (SGB)) are derived for the SMS 2017/18 sample using learner and educator numbers in the 2018 EMIS Masterlist. The LE ratios derived from the Masterlist are preferred over those derived from self-reports of learner and educator numbers in principal questionnaires. The LE ratio derived

from the EMIS Masterlist is likely more reliable, displaying slightly[12] higher correlations with self-reported class sizes.

LE ratios excluding SGB educators are not available in the Masterlist. Where required, they are derived from principal self-reported values in the SMS 2017/18, dividing total learner enrolment (Grade R-12) by the total number of public educators from responses to questions in the SMS 2017/18 (see Appendix Table A1). Across 985 schools in the grade 6 SMS sample, 333 schools record having at least one SGB educator (see Appendix Table A2).

b) Descriptive results

Estimates of primary grade class size in South Africa in 2017/18

Using learner-weights, analysis of the SMS 2017/18 reveals an average grade 3 class size reported by educators of 40.8 learners while the grade 3 class headcount averaged 39.6 learners (see Table 3). Whether learner or school weights are applied makes a large difference to estimates obtained. Using school weights, the average grade 3 class size is 34.5 rather than 40.8.

Although grade 3 class sizes should not exceed 35 learners, as reflected in national guidelines, almost 70% of grade 3 learners are in class sizes greater than 35, 49% are in class sizes greater than 40, 17% are in class sizes greater than 50 and 6% are in class sizes exceeding 60 learners.

Table 3: Class sizes, learner-educator ratios and 'alignment ratios' in schools with a representative sample of Grade 6 learners (SMS 2017/18)

	Mean	Lower 95% CI	Upper 95% CI	N (schools)
Average grade 3 class size	40.8	39.8	41.8	929
Average grade 3 class size (head-count in class by fieldworker)	39.6	38.5	40.6	929
% of learners with grade 3 class size over 35	68.9	65.7	72.1	929
% of learners with grade 3 class size over 40	48.5	45.1	51.9	929
% of learners with grade 3 class size over 50	16.6	14.0	19.2	929
% of learners with grade 3 class size over 60	6.4	4.6	8.2	929
% of learners with grade 3 class size over 80	1.7	0.8	2.7	929
Largest class taught by grade 6 teacher	51.4	49.7	53.1	978
LE ratio (incl. SGB educators, from masterlist)	33.2	32.8	33.7	929
LE ratio (excl. SGB educators, self-report)	35.0	34.6	35.4	926
Alignment ratio: Grade 3 class size / LE ratio (incl. SGB educators, masterlist)	1.23	1.2	1.3	929
Alignment ratio: Grade 3 class size / LE ratio (excl. SGB educators, self-report)	1.18	1.2	1.2	926
Alignment ratio: Grade 6 class size / LE ratio (incl. SGB educators, masterlist)	1.54	1.49	1.59	977
Alignment ratio: Grade 6 class size / LE ratio (excl. SGB educators, self-report)	1.49	1.44	1.54	973

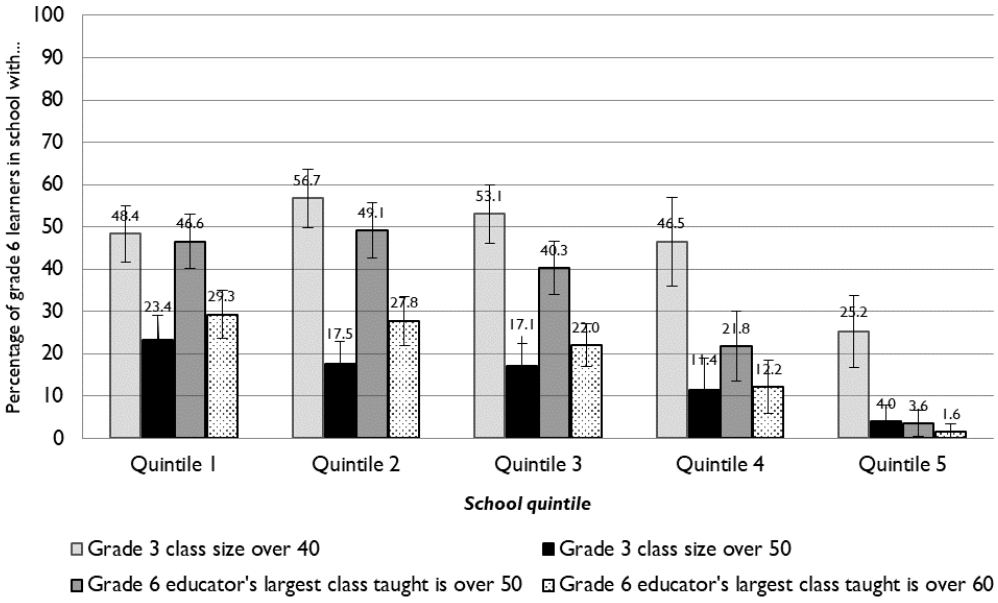
Source data: SMS 2017/18 linked to EMIS Masterlist 2018. Notes: Learner weights applied. Educator level reports of class size are averaged within a school to get school level estimates of average grade 3 class size. Unless indicated, all class sizes are self-reported by grade 3 or grade 6 educators.

[12] Across the SMS and Masterlist 2018, the correlation on learner enrolment numbers is as high as 0.99. The correlation across the two data sources on educator numbers (including SGB educators) is 0.96. However, where privately paid school-governing body (SGB) educators are more likely to be hired in Quintile 4 and 5 schools, this creates more opportunity for mismatch across the SMS and EMIS Masterlist educator values with lower correlations observed in Quintile 4 and 5 (0.91) schools compared to Quintile 1-3 schools (0.98).

Grade 6 learners are taught by Language or Mathematics educators whose largest class reported is 51 learners on average (applying learner-weights)[13]. This is an indicator of the largest class taught by educators in primary schools. With rising enrolment in the Intermediate Phase (grade 4-6) since 2017/18 until 2021 (Gustafsson 2022a, p10), the largest classes in this phase more recently in 2022 may be higher than already very high estimates in 2017/18.

National averages mask considerable heterogeneity in class sizes, and particularly the occurrence of very large class sizes in less resourced school contexts and in certain provinces. Learners in Quintile 5 schools are far less likely to face very large class sizes as seen in Figure 6. Just 4% of grade 3 learners in Quintile 5 schools are in classes of over 50 learners. By contrast, 23% of grade 3 learners in Quintile 1 schools are in classes exceeding 50 learners. Less than 4% of grade 6 learners in Quintile 5 schools have teachers with largest class sizes exceeding 50 while about 47% and 29% of grade 6 learners in Quintile 1 schools have teachers that are likely to face a class of over 50 and 60 learners respectively.

Figure 6: Percentage of learners in large classes by school's socio-economic profile (school Quintile) (SMS 2017/18)



Data source: SMS 2017/18. Learner-weighted. Educator responses averaged at school level. Estimates should be interpreted in relation to grade 6 learners.

Provincial estimates of the percentage of learners in schools with grade 3 class sizes exceeding 40 are below the national average of 49% in the Northern Cape (17%), Western Cape (28%) and the Eastern Cape (42%) (see Figure 7). There is a high incidence of grade 3 class sizes of over 40 in the Free State (56%), Limpopo (60%), and the North West (64%), although the depth of the

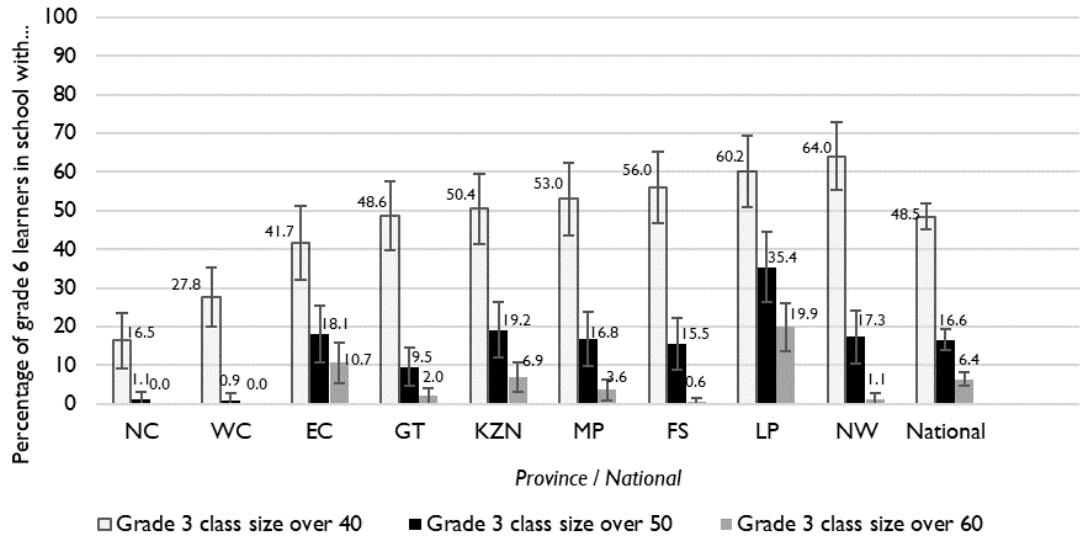
[13] If school-weights are applied the largest average class size taught by a grade 6 educator is 41.5 learners.

class size problem is particularly acute in Limpopo and the Eastern Cape. Compared to a national average of 17%, 36% of grade 3 learners in Limpopo are in classes of over 50. Furthermore, 20% of Grade 3s in Limpopo are in class sizes of at least 60 learners. Although the Eastern Cape does not stand out as a major outlier with respect to average class sizes, the incidence of learners in Eastern Cape schools with very large grade 3 class sizes of at least 60 is as high as 11%.

Relative to other provinces, the Western Cape and Northern Cape better contain the problem of extreme class sizes in both the Foundation Phase and Intermediate Phase (grade 4-6). In these provinces, less than 1% of Grade 3s are in class sizes that exceed 50 (see Figure 12). At most 3% of grade 6 learners in the Western Cape are in schools where the largest class size taught by a grade 6 educator exceeds 50 (see Figure 8).

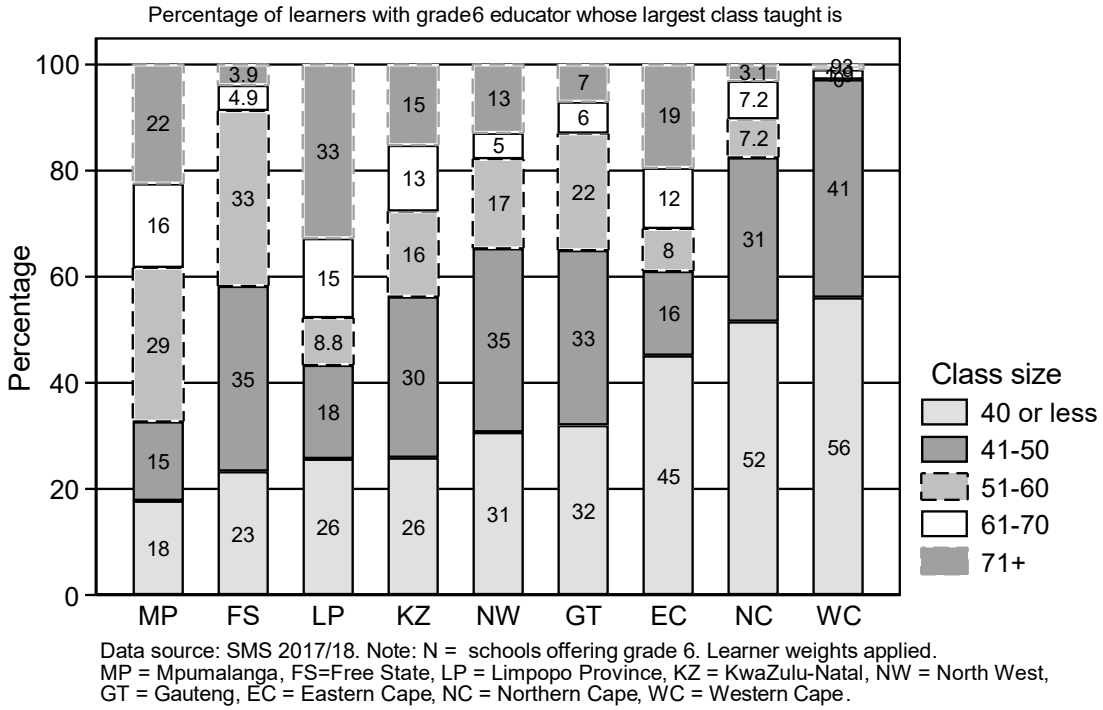
The problem of very large class sizes experienced by grade 6 educators affects all provinces, but particularly so in Mpumalanga and Limpopo: 48% and 38% of grade 6 learners respectively are in schools where the largest class size taught by their educators was over 60 learners (see Figure 8).

Figure 7: Percentage of learners in schools with grade 3 class sizes over 40, over 50 and over 60 by province (SMS 2017/18)



Data source: SMS 2017/18. Learner weights applied. Educator responses averaged at school level. Technically estimates should be interpreted in relation to grade 6 learners. FS = Free State, EC = Eastern Cape, LP = Limpopo Province, MP = Mpumalanga Province, NC = Northern Cape, KN = KwaZulu-Natal, GP = Gauteng,

Figure 8: Percentage of grade 6 learners in schools with an educator reporting that their largest class is in the following class size category, disaggregated by province (SMS 2017/18)



Data source: SMS 2017/18. Note: N = schools offering grade 6. Learner weights applied.
MP = Mpumalanga, FS=Free State, LP = Limpopo Province, KZ = KwaZulu-Natal, NW = North West, GT = Gauteng, EC = Eastern Cape, NC = Northern Cape, WC = Western Cape.

Learner-educator ratios in the 2017/18 SMS grade 6 school sample

Using learner-weighted averages, the national ratio of learners to public educators (including grade R practitioners) was 35 in 2017/18 using the grade 6 SMS sample.[14] School-based hiring of school governing body (SGB) paid educators contributes to lowering LE ratios overall by 2 learners to 33 (see Table 3). (If school-weights are used, the LE ratios including SGB educators is 30.3 for this sample.) This benefit is largely experienced by Quintile 4 and 5 schools that can hire school-governing body educators by charging fees to parents. In the grade 6 SMS sample, Quintile 4 (56%) and Quintile 5 (78%) schools are considerably more likely to have at least one SGB paid educator compared to Quintile 1 (29%), Quintile 2 (17%) and Quintile 3 (20%) schools that are typically not allowed to charge fees (see Appendix Table A2).

Across provinces, average LE ratios (including SGB educators) range from about 30 to 37, and favour wealthier Quintile 4-5 schools. The hiring of SGB educators makes a significant difference to LE ratios in the Western Cape, then Gauteng and the Eastern Cape as schools in these provinces are significantly more likely to privately hire SGB educators than in other provinces (see

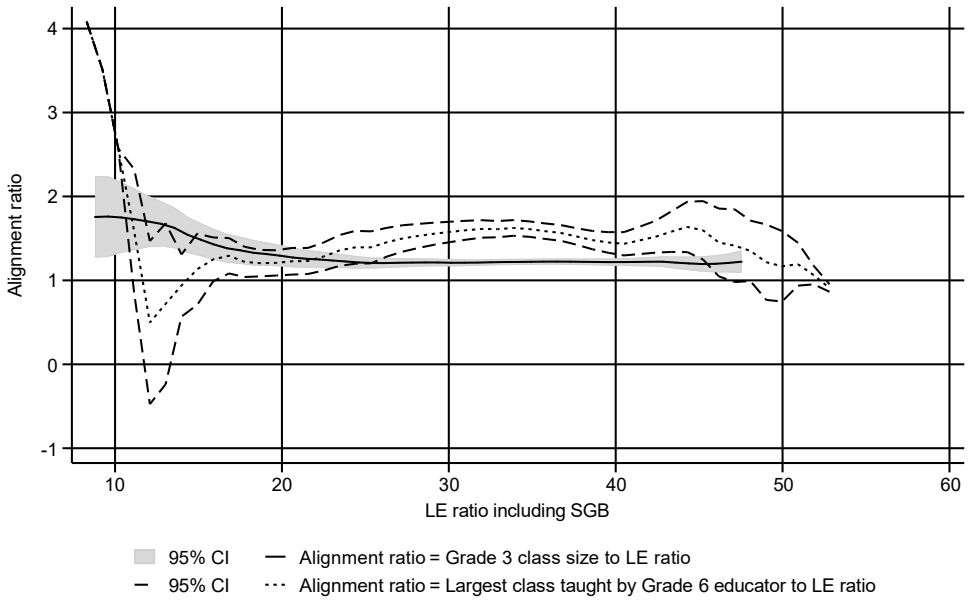
[14] This value should not be directly compared to the learner-to-public-educator ratio of 30 provided for an entire national distribution of primary and secondary public ordinary schools in 2021 (Gustafsson 2022b). Not only does the sample differ but the calculation methods differs. Gustafsson's estimates provide an LE ratio at the provincial level using provincial level totals of educators and learners. Using the SMS 2017/18 for a representative sample of grade 6 learners, the LE ratio is calculated for individual schools and weighted at the learner level. Gustafsson also excludes grade R enrolment and grade R educators.

Appendix Table A2). LE ratios calculated excluding SGB educators, however, are relatively equal across Quintiles although provincial differences remain. In addition to Appendix Table A2 which summaries key statistics on class sizes, SGB educators and LE ratios by school quintile and province, the cumulative distribution of LE ratios (including SGB educators) by school quintile in Figure A1, is illustrative of inequities in teacher allocations after private contributions to teacher hiring are considered.

Comparing class sizes to learner-educator ratios in South African primary schools

How do class sizes in South African primary schools compare to LE ratios? Nationally and in all nine provinces, average class sizes are significantly higher than average LE ratios. For the representative sample of schools with grade 6 learners, the grade 3 alignment ratio (including SGB educators in calculations) is about 1.2 nationally (see Table 3). If the largest class taught by grade 6 educators is used as the class size estimate, the alignment ratio rises to 1.5 nationally with considerable variation across provinces ranging from 1.2 in the Western Cape to 1.8 in Mpumalanga (see Appendix Table A2). [15]

Figure 9: Alignment ratio to LE ratios (including SGB) nationally (SMS 2017/18, grade 6 sample)



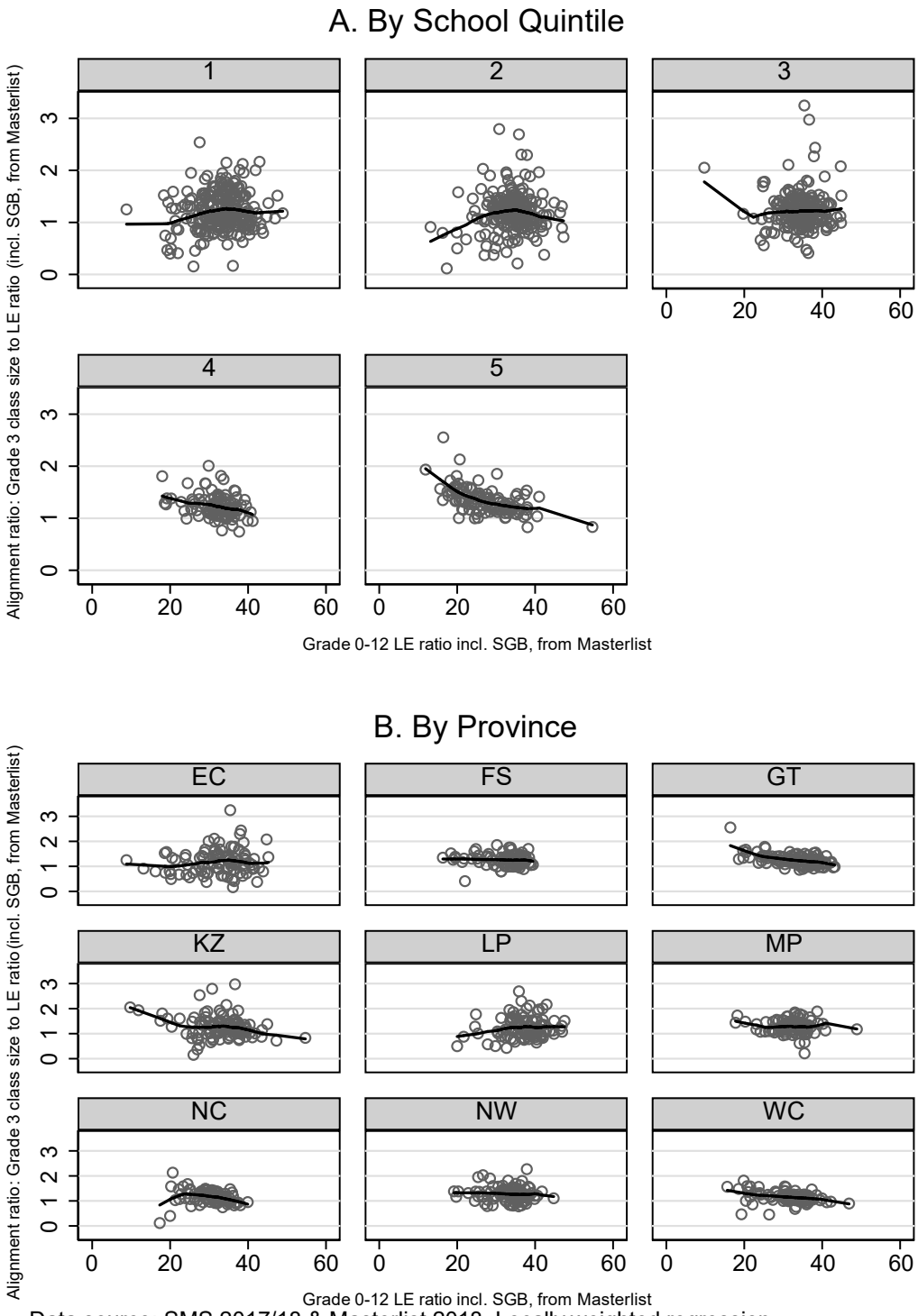
Source: SMS 2017/18 linked to Masterlist 2018, own calculations Learner weighted

[15] These national alignment ratios are relatively unchanged if the sample is limited to schools where the highest grade offered is grade 7. Thus, the national averages are not notably affected by combined schools that may have different educator requirements at higher grade levels.

The global picture in Figure 4 and 5 suggested that there is a tendency across countries to better contain class sizes as LE ratios rise. Overall, this is not the case within South Africa where the alignment ratios remain quite constant as LE ratios rise (see Figure 9). However, this association varies across provinces and by school Quintile as seen in locally weighted regressions in Figures 10-11. A negative association between grade 3 alignment ratios and LE ratios is only observed in wealthier Quintile 4 and 5 schools. These better resourced and typically more functional schools are better at containing class sizes as LE ratios rise compared to less resourced Quintile 1-3 schools.

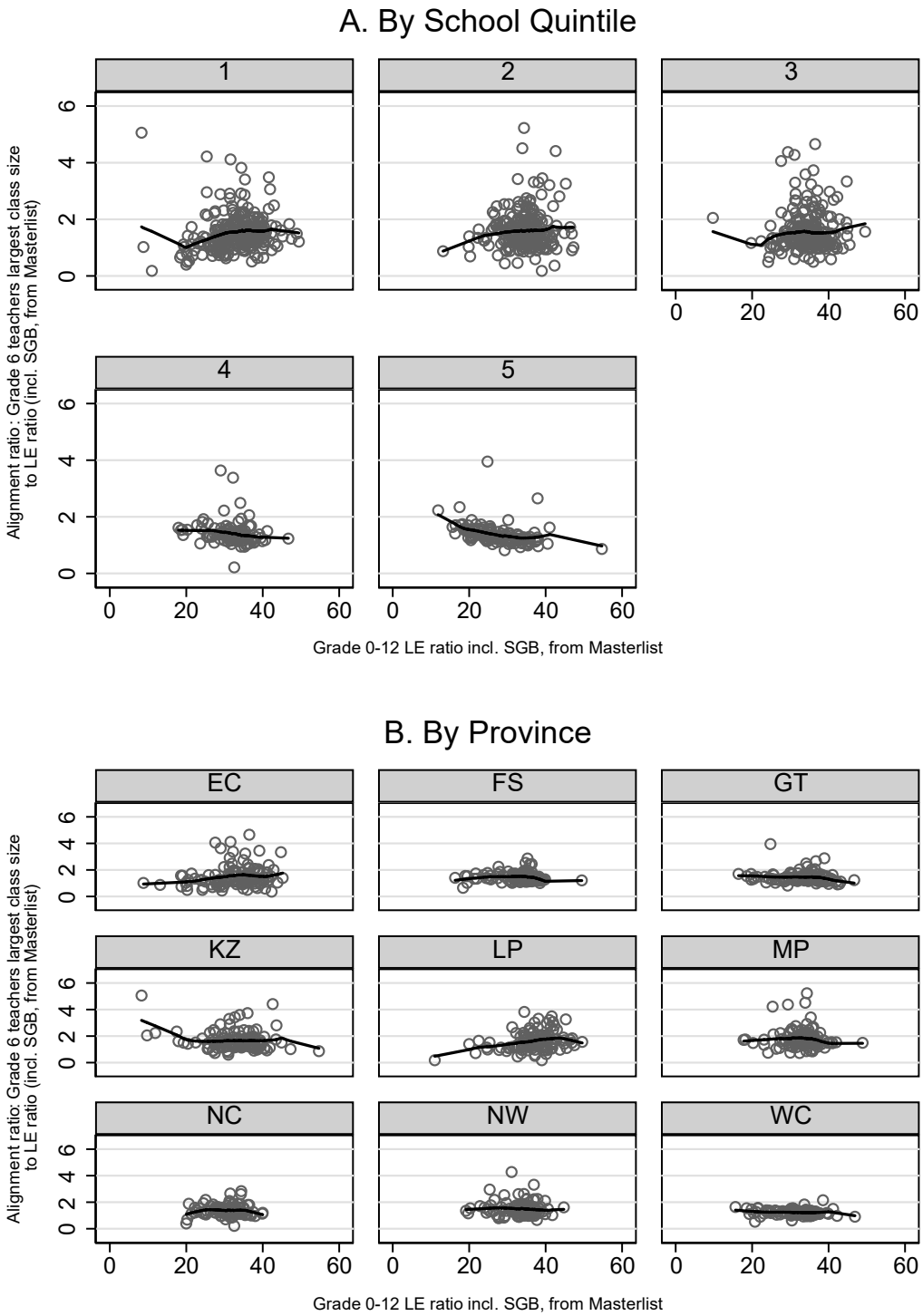
In Gauteng, the Western Cape and the Northern Cape there appears to be a slightly negative association between grade 3 alignment ratios and LE ratios (see Figure 10). In these three provinces, as well as in the Free State and Mpumalanga, grade 3 class sizes seldom (if ever) reach or exceed twice the LE ratio. By exception, grade 3 alignment ratios exceed twice the LE ratio in quite a few schools in the Eastern Cape, KwaZulu-Natal, North West and Limpopo. It is not uncommon for largest class sizes taught by a grade 6 educator to be four times (or more) than a school's LE ratio in the Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga (see Figure 11). Using multi-variate estimation and drawing on the conceptual framework in section 2, the next section explores whether variation in school characteristics and processes may account for differences between class sizes and LE ratios.

Figure 10: Association between grade 3 alignment ratio and LE ratio (including SGB) by school Quintile and by Province



Data source: SMS 2017/18 & Masterlist 2018. Locally weighted regression .
Each dot represents a unique school.

Figure 11: Association between largest class size alignment ratio and LE ratio (including SGB) by school Quintile and by Province



Data source: SMS 2017/18 & Masterlist 2018. Locally weighted regression.
Each dot represents a unique school.

c) Estimating class sizes: Regression analysis

Model

In addition to viewing class sizes as a function of teacher allocation processes at the level of provincial administrations reflected in LE ratios, the conceptual framework suggests that class sizes would be influenced by four sets of factors: school resourcing characteristics, school composition factors, pedagogical structures which may constrain how classes are organised within schools and teacher utilisation factors (including teacher characteristics that may alter how class sizes are allocated). The following variables from the SMS 2017/18 map to these factors as follows:

- School resourcing characteristics include the availability of classrooms (including mobile classrooms) relative to learners; the Quintile status of schools (as a proxy for school socioeconomic status); and the extent of disrepair of school buildings that may affect classrooms utilisation.
- School composition and pedagogical structures include total grade R-12 enrolment; how large the grade in question is relative to total enrolment; highest grade offered at the school; whether the teacher teaches a multi-grade class; total languages offered at the school; and the intensity of SMT activity in the school which may reduce the availability of educators to teach (this is proxied by the frequency of reported head of department visits to a teacher, and the ratio of all educators to managers[16].
- Teacher utilisation factors include teacher absenteeism (the proportion of educators who did not sign the register on the Friday before the visit); educator vacancy rates (percent of allocated public educator posts that are vacant); counts of the number of ordinary classrooms that are not used for teaching purposes; and school autonomy in teacher hiring and management (proxied by the extent to which financial management functions are transferred to schools rather than handled by provincial administrations).
- The following characteristics of the reporting teacher are controlled for: years of experience; teaching mathematics; and holding a management position.

A regression framework is used to control for observed differences in these factors as follows:

$$Y_{is} = \beta_0 + \beta_1 LE_s + \beta_2 PROV + \beta_3 R_s + \beta_4 S_s + \beta_5 P_{is} + \beta_6 U_s + \beta_7 T_{is} + \varepsilon_{is} \quad (1)$$

where Y_{is} is the class size reported by educator i in school s; R is a vector of school resourcing characteristics; and PROV are province fixed effects. S is a set of school composition indicators and P is a set of structural indicators reported by teacher i in school s; U is a vector of teacher utilisation factors and T is a vector of characteristics of teacher i in school s. With more than one

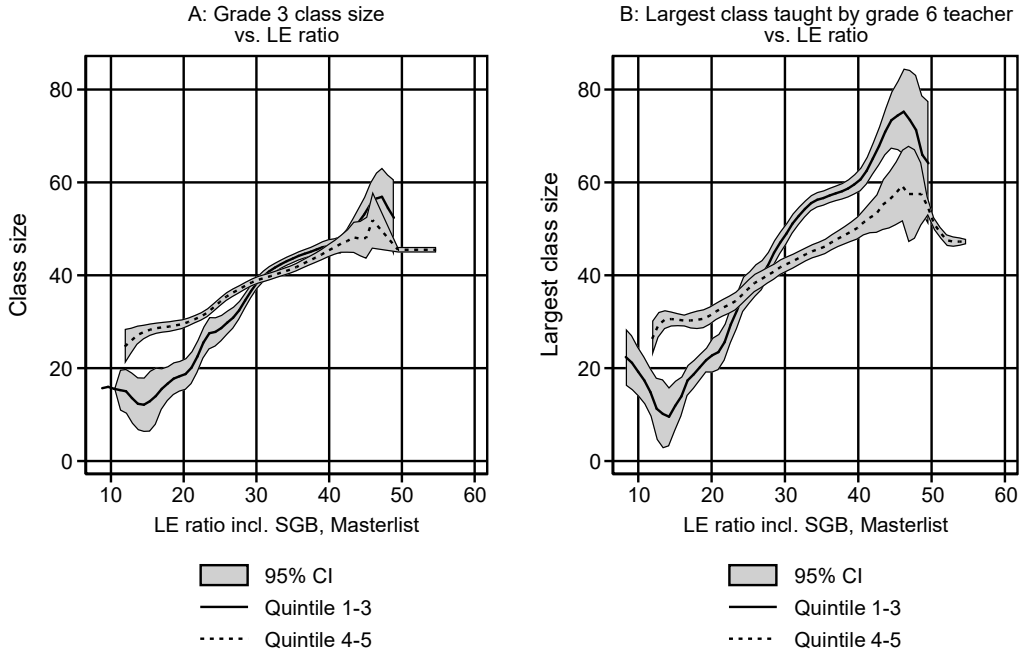
[16] Also referred to in South Africa as School Management Team (SMT) members.

grade 3 or 6 educator sampled per school, standard errors are clustered at the school level and all estimations are learner-weighted.

Class sizes are modelled here in relation to LE ratios derived from the 2018 EMIS Masterlist where educator numbers include SGB educators. Non-parametric associations between class size and LE ratios are shown in Figure 12. Overall a strong positive association is identified albeit a flatter association is observed in wealthier Quintile 4 and 5 schools compared with less resourced Quintile 1-3 schools. There is some indication of non-linearities in Quintile 1-3 schools with a slight flattening in the association at LE ratios above 30. To account for nonlinearities, class sizes are also modelled including LE ratios in a quadratic form.

Regression results estimating grade 3 class sizes or largest classes taught by grade 6 educators are summarised in Table 5 and 6 for a nationally representative sample of grade 6 learners (see full set of results in Appendix Tables A3 and A4). Results for six models are presented. Initially, only the school's provincial location and LE ratio are included as controls (models 1a and 1b). Then models 2-5 control individually for school resources, school composition and structural indicators, teacher utilisation or efficiency factors and teacher characteristics. Model 6a and 6b includes all sets of controls together. Models 1b and 6b only include the LE ratio in linear form (i.e. no quadratic).

Figure 12: Association between class sizes and LE ratio (including SGB educators), local polynomial regression



Source: SMS 2017/18 linked to 2018 EMIS Masterlist.
Learner weighted. LE ratio truncated at 55 where 99th percentile is 52.

Results

A relatively consistent result across models 1a to 6b in Table 4 and 5, is a positive and significant association between LE ratios (including SGB educators) and class sizes. If the LE ratio is included in a linear form only, the size of the coefficient in estimating grade 3 class sizes is almost one (0.95) in a very simple model (model 1b) but reduces to 0.70 when all controls are included (model 6b). In estimating largest class sizes, the coefficient on LE ratio is 1.45 in model 1b (without additional controls) reducing to 0.85 when all controls are included (model 6b). The coefficient on the quadratic of the LE ratio is negative but insignificant in estimating both grade 3 class sizes and largest class size taught by a grade 6 educator.

Other than the strong provincial effects identified and the positive coefficient on total school enrolment, a striking result in the full set of results (Appendix Table A3 and A4) is just how few other controls consistently explain class sizes. With the exception of LE ratios, the only other consistent positive predictor of class size is total school enrolment. At best, between 24% and 29% of the variation in grade 3 class sizes can be explained by LE ratios, province, Quintile and the four sets of factor controls. There are, however, strong unobserved provincial processes or inefficiencies at work reflected in provincial fixed effects in the fully controlled modelled. Figure 13, by illustration, shows the predicted class sizes (for Grade 3 and largest class taught by a grade 6 educator) in each province controlling for LE ratios only, and then including the full set of controls. The high grade 3 class sizes and the extremely large classes taught by grade 6 educators in Limpopo, KwaZulu-Natal and Mpumalanga are not explained away by observed differences in characteristics. Rather the provincial contrasts in class size become even more stark in a multivariate regression. The Western Cape and Northern Cape's relative capacity to manage very large class sizes, even after accounting for observed provincial differences in schooling, is clearly evident. This may be attributed to teacher management being easier in smaller provinces. Nevertheless, even in the Western Cape (and Northern Cape) predicted grade 3 class sizes are above a suggested maximum ideal of 35 (but less than 40).

Table 4: Estimating grade 3 class size (all school Quintiles)

	LE ratio + province	LE ratio + province	Add: Resources	Add: Composition + Structure	Add: Utilization	Add: Teacher	All controls	All controls
	(1a)	(1b)	(2)	(3)	(4)	(5)	(6a)	(6b)
LE ratio (incl. SGB)	1.641***	0.952***	1.766***	1.629***	1.605***	1.657***	1.573***	0.704***
LE ratio (incl. SGB) squared	-0.011		-0.013	-0.015*	-0.011	-0.011	-0.014	
R-squared	0.230	0.228	0.236	0.287	0.233	0.231	0.290	0.286
N (educators)	1503	1503	1503	1503	1503	1503	1503	1503
N (schools)	903	903	903	903	903	903	903	903
School resources			X				X	X
School composition				X			X	X
School structure				X			X	X
Utilisation factors					X		X	X
Teacher characteristics						X	X	X
Source data: SMS 2017/18 linked to the Masterlist 2018. Teacher reports clustered at school level. Learner weighted. Significant at *10%, **5% and ***1% level.								

Table 5: Estimating largest class size taught by a grade 6 educator (all school Quintiles)

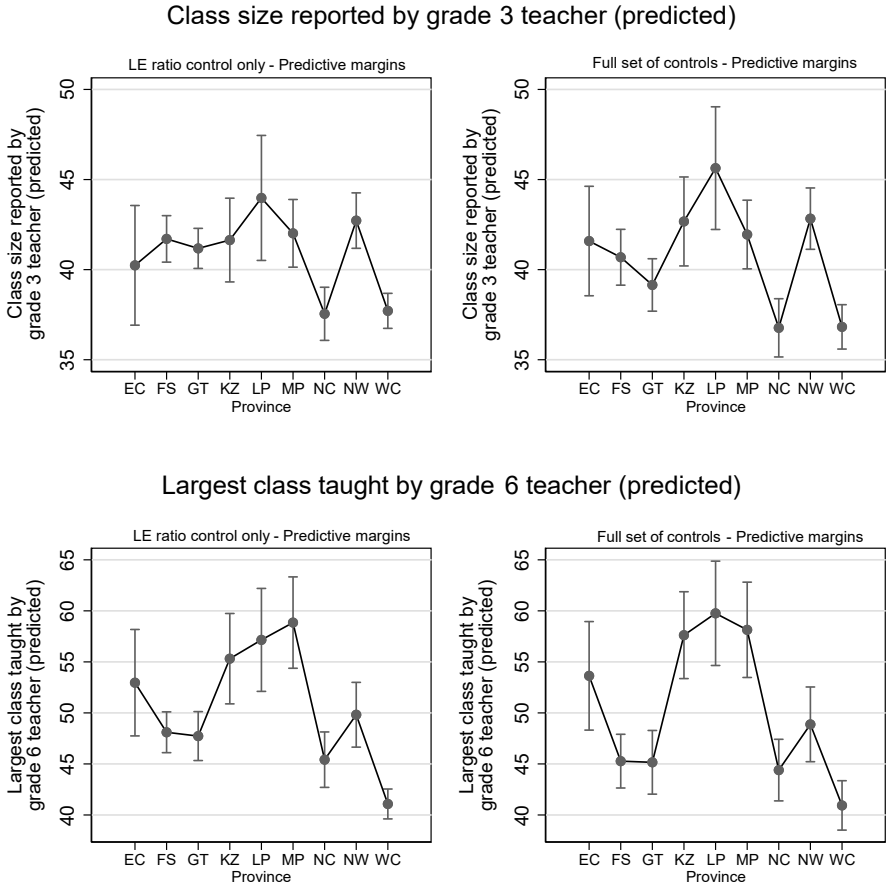
	LE ratio + province	LE ratio + province	Add: Resources	Add: Composition + Structure	Add: Utilization	Add: Teacher	All controls	All controls
	(1a)	(1b)	(2)	(3)	(4)	(5)	(6a)	(6b)
LE ratio (incl. SGB)	2.607**	1.458***	2.205**	2.529**	2.483**	2.640**	1.814*	0.850***
LE ratio (incl. SGB) squared	-0.019		-0.014	-0.023	-0.017	-0.019	-0.015	
R-squared	0.178	0.176	0.182	0.226	0.180	0.183	0.239	0.238
N (educators)	2155	2155	2155	2155	2155	2155	2155	2155
N (schools)	950	950	950	950	950	950	950	950
School resources			X				X	X
School composition				X			X	X
School structure				X			X	X
Utilisation factors					X		X	X
Teacher characteristics						X	X	X
Source data: SMS 2017/18 linked to the Masterlist 2018. Teacher reports clustered at school level. Learner weighted. Significant at *10%, **5% and ***1% level.								

The results in Table 4 and 5 imply that a one unit decrease in the LE ratio will lead to a reduction in class size of around 70-85 percent of the LE ratio decrease. However, the descriptive results imply that the class size to LE ratio association may differ across provinces and by school Quintile. To allow for this, Province and Quintile are interacted with the LE ratio. The results are presented in Appendix Table A5 but shown pictorially in Figure 14.

Indeed, the class size to LE ratio association differs by province after controlling for observed differences across schools. For a given rise in the LE ratio, class size increases are better contained in the Northern Cape and Western Cape and somewhat in Gauteng and the Free State as reflected

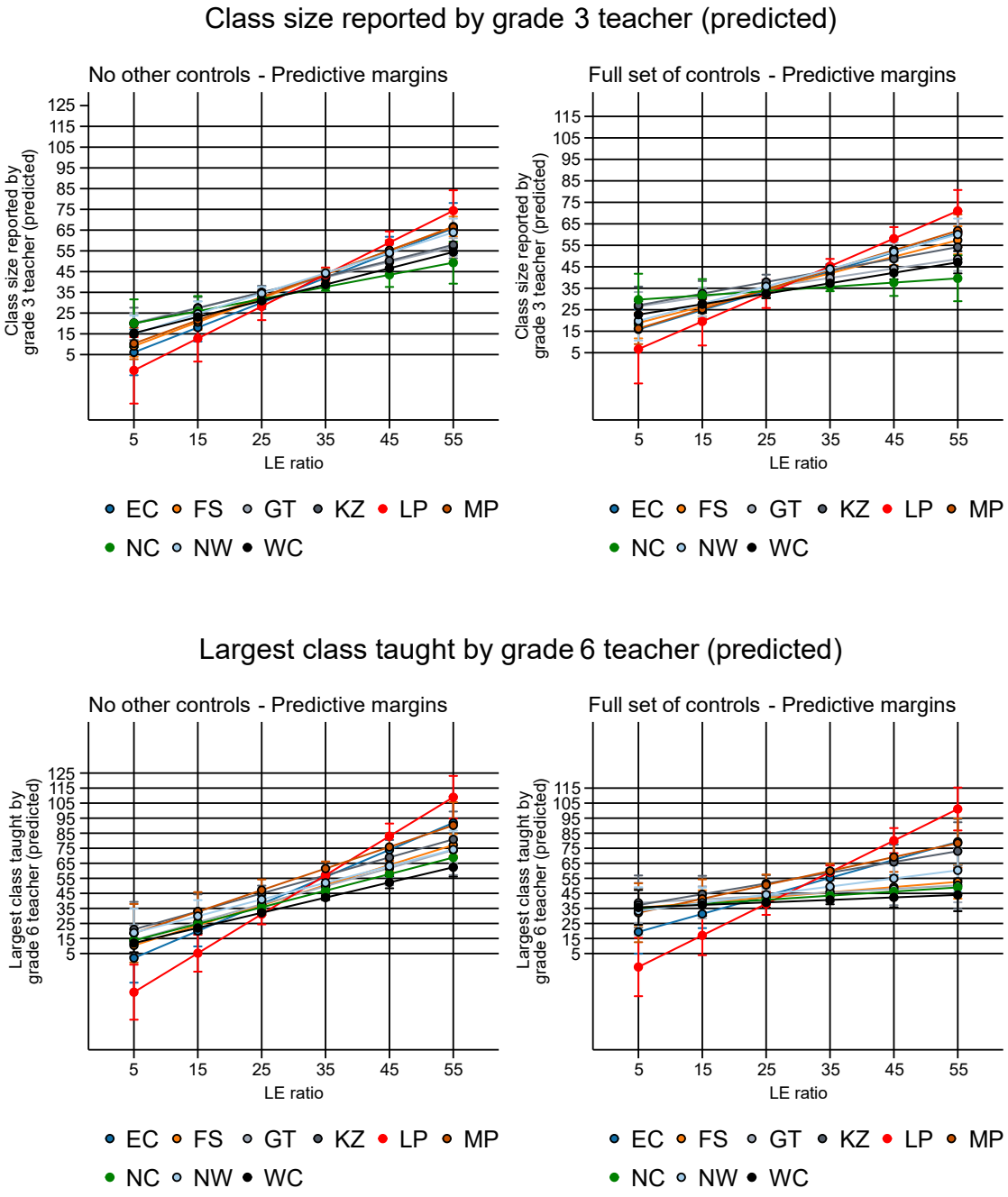
in flatter slopes. In Limpopo province, a very steep slope is identified. While this implies that class sizes are not well contained as LE ratios climb above 30-35, it also suggests that reducing high LE ratios by a certain amount in Limpopo province could potentially lead to class size reductions of a larger amount relative to other provinces. Longitudinal data on LE ratios and class sizes, however, would be needed to confirm this. An important implication of these patterns is that leveraging LE ratios as a tool to manage class sizes would yield differing results across provincial administrations.

Figure 13: Predicted class sizes (all school Quintiles), provincial effects



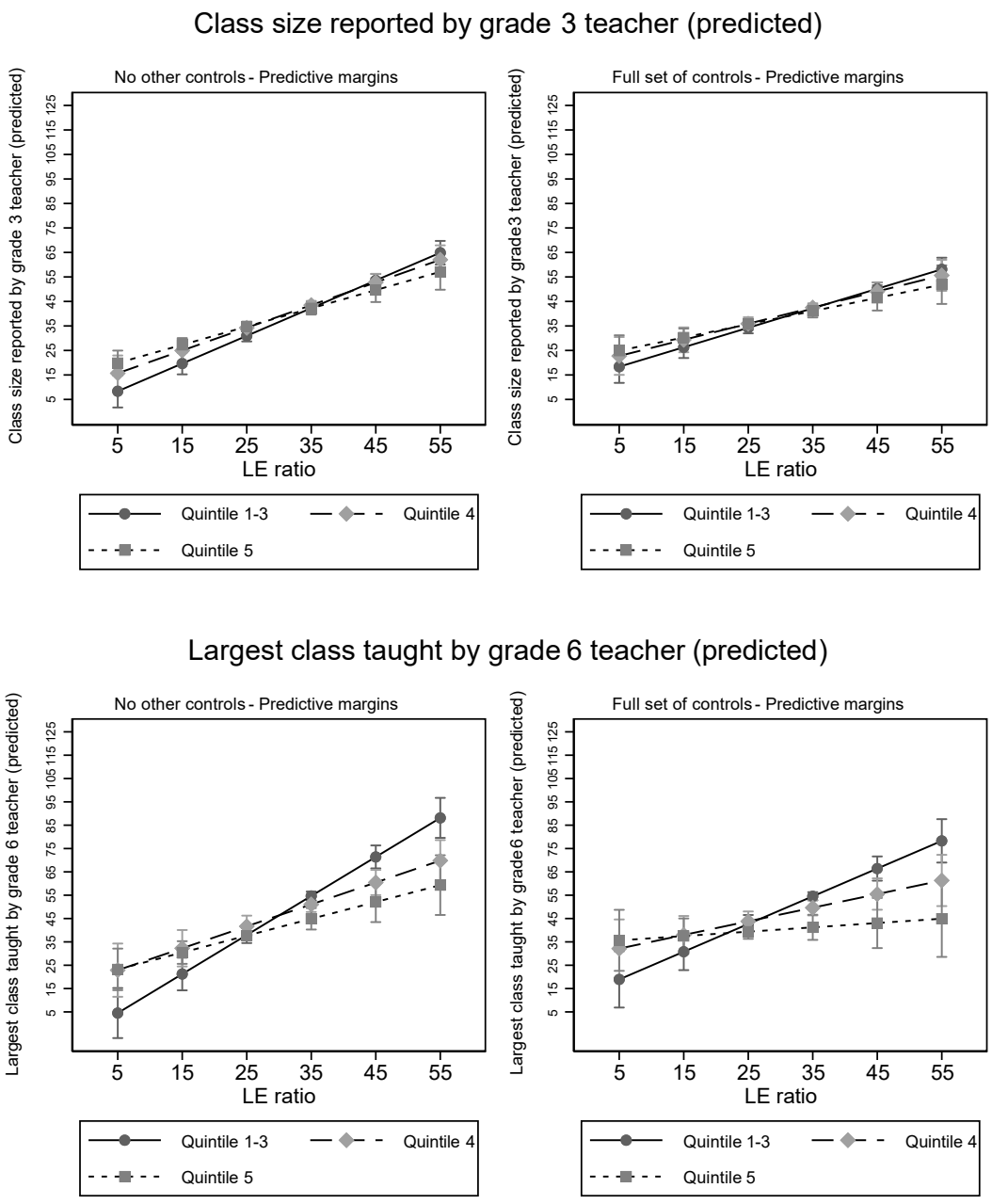
A flatter association between class sizes and the LE ratio is observed in both controlled and uncontrolled models in Quintile 4 and particularly Quintile 5 schools, when compared with Quintile 1-3 schools as seen in Figure 16. The coefficient on the interaction terms is only significant in estimating largest class size taught by a grade 6 educator in the fully controlled model (see Table A5). This is in keeping with earlier findings that Quintile 5 schools are better able to contain large class sizes as LE ratios rise.

Figure 14: Class size simulations after interacting province with LE ratios, all school Quintiles



Notes: In the left figures, only the LE ratio (linear inclusion) and Province are controlled for .
In the right figure, all controls as in Model 6b are included (LE ratio, province, resourcing factors, structural factors , efficiency factors and teacher characteristics)

Figure 15: Class size simulations after interacting school Quintile with LE ratios



Notes: In the left figure, only the LE ratio (linear inclusion) and Quintile are controlled for.
In the right figure, all controls as in Model 6b are included (LE ratio, province, resourcing factors, structural factors, efficiency factors and teacher characteristics)

6. Conclusion

Rising learner-educator (LE) ratios in South Africa from 2012 to 2021 (Gustafsson 2022b) present a concern for worsening class sizes which were already high by developing country standards over a decade ago. Against this context, this paper aimed to provide more specificity on primary grade class sizes in South Africa and explored their relationship to learner-educator ratios. This inquiry was guided by a conceptual framework that may explain deviances across the two measures and is situated within a global analysis of class sizes and LE ratio linkages.

An analysis of a public school sample representative of grade 6 learners identified an average (learner-weighted) national learner-to-public-educator ratio of 35 in 2017/18 in South Africa. This reduces to 33 with the private hiring of school governing body (SGB) educators. By comparison, the learner-weighted average grade 3 class size in this school sample was 41 learners. Taking the ratio of grade 3 class size to LE ratio, a crude metric of teacher utilisation, a national alignment ratio is 1.2. This is roughly in line with that calculated using median grade 6 class sizes and LE ratios from SACMEQ 2007.

Although LE ratios in South Africa are high relative to OECD countries (averaging 15 at the primary level), they are much lower relative to other low-income African countries (Walter 2020). South African primary class sizes on average are also better aligned to LE ratios compared with OECD countries with an average alignment ratio in primary public institutions of 1.5. The relatively higher alignment in South Africa compared to the OECD country average is consistent with a global finding that countries with more teaching resource constraints, reflected in higher LE ratios, better align their class sizes to LE ratios to limit excessively large class sizes. However, a within-country school analysis in South Africa revealed little evidence overall for increased class size containment as LE ratios rise, except in wealthier school contexts and in two provinces.

South Africa's alignment ratio is in line with regional expectations when compared to other Southern and Eastern African countries with similar primary level LE ratios. Yet there is room for improvement. Comparatively, some other middle-income countries (Brazil, the Russian Federation and Mexico), achieve lower alignment ratios, close to one, aided by multi-shift schooling which is not implemented in South Africa. Furthermore, a few Southern or East African countries with higher average LE ratios than South Africa do somewhat better at containing class sizes for a given LE ratio in the absence of a multi-shift system.

Possibilities for class size reductions in South Africa given existing teacher allocations become even more evident in lieu of large provincial differentials in class size. By example, in 2017/18 the largest class sizes experienced by grade 6 educators in the Western Cape average 39 learners, compared to an average of 61 in Limpopo, 59 in Mpumalanga and 54 in KwaZulu-Natal. The

regression results identified stark differences in the association between class sizes and LE ratios across provinces even after controlling for four sets of factors: school resources, school composition including total enrolment, pedagogical structures and observed teacher utilisation indicators. Except for LE ratios, total school enrolment and province, other indicators controlled for do little consistently to explain class sizes. On provincial interactions, Limpopo province specifically struggles to contain class sizes at LE ratios over 30. By contrast, the Western Cape and Northern Cape's relative capacity to manage very large class sizes as LE ratios is evident. Wealthier Quintile 5 schools, after controlling for other observed school differences, better contain class sizes at higher LE ratios.

Leveraging LE ratios as a tool to manage primary class sizes will yield differing results across provincial administrations. Further longitudinal analysis is needed to interrogate this finding, but so far results suggest that the significant costs of reducing LE ratios may not result in desired reductions in primary class sizes in some provinces. Furthermore, where class size impacts on learning outcomes are mixed, including in developing countries with very large class sizes (Duflo et al. 2015; Datta & Kingdon 2021), more cost-effective approaches to reducing class sizes than hiring additional teachers should be implemented. Echoing earlier findings on post-provisioning (DoE 2006), improving teacher utilisation should be prioritised, and this should occur alongside contextually targeted approaches to address large class sizes through reduced learner-educator ratios.

In a fiscally constrained environment, it is incumbent upon provincial administrations to tackle difficult issues of teacher utilisation within schools, and to monitor how teachers are allocated across classrooms. This will also require efforts from school management. As Miles & Darling-Hammond (1998, p27) reflect in relation to improving teacher utilisation "changing school organizations to better fit an instructional vision will require schools to confront tradition and a host of state, district, and union policies and practices."

Where class size variation across grades is attributed to demographic factors (especially the temporary rise in births in the mid-2000s), these demographic shocks should be accommodated through improved planning and reallocations of teachers and classrooms in relation to relative grade enrolments. Proactive steps to improve within school allocations of teachers would be preferred over policy mandates that set class size 'ceilings'. Incorporating into a post provisioning distribution model grade-specific class size thresholds that should not be exceeded is likely not only to be financially infeasible, but directly could lead to "undue year-on-year instability" with respect to teachers movements between schools, undesired class size variation in schools (Miles

& Darling-Hammond) and perverse incentives for higher grade repetition (DoE 2006, p58).[17] For this reason, an approach focused on maintaining the learner-educator ratio at the school level was preferred in South Africa's current post provisioning model. However, there could be room for an equity-focused approach to this problem, first to 'eliminate all class sizes in excess of 60, then in excess of 50 and so on' rather than applying an overall class size ceiling limit (Spaull et al. 2022). To do this, monitoring of class sizes is critical. Nationally, and at a provincial education department level, South Africa has not systematically measured and monitored class sizes. It is not sufficient to track class sizes at just one or two grade levels - the range of class sizes across grades in a school should be monitored. As seen in this paper, focusing on grade 3 average class sizes alone hides the high incidence of very large classes taught by grade 6 educators (nationally averaging 51 learners in the SMS 2017/18 sample).

Finally, efforts to reduce class sizes should be weighed against further empirical work that interrogates class size effects on learning. Additional quantitative research, that extends this analysis to secondary school grades with added subject provisioning complexities will also add important nuance. Furthermore, qualitative research is needed to interrogate reasons for very large class sizes that cannot be explained by observed differences across schools. This will require inquiry into school level timetabling practices, within-school teacher allocation dynamics and the actual time educator's spend teaching.

[17] It creates an incentive to distribute learners across grades in such a way that the total staff complement of the school is maximised. For example, by holding back one learner in a grade, a school could alter its staff complement by one teacher.

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Appendix

Table A 1: Source data or questions used to construct class size and LE ratios from principal or educator questionnaires in SMS 2017/18

LE ratio, calculated including SGB-paid educators (Denominator)	Main question on educators	Principal Q8: How many EDUCATORS were employed at your school as at the end of September 2017? Note: Educators include both SGB and state-employed educators and includes the following: principal, SMT members and educator/practitioners (including Grade R educators). It does not include administrative staff/clerks, cleaners, caretakers, security, student teachers on practical, etc.
LE ratio, calculated excluding SGB-paid educators (Denominator)	*Subtract*	Principal Q: How many SGB posts has the school established for the following categories?
		Q46: Deputy principal posts established by the SGB?
		Q47: HoD posts established by the SGB?
		Q48: Educator posts established by the SGB?
LE ratio (Numerator)		Principal Q7: How many LEARNERS were enrolled in your school as at the end of September.
Class size (grade 3 self-reported)		Grade 3 educator Q18: How large is your class this year? (Number of learners)
Class size (grade 3 headcount)		Q129: Count and record the number of learners present in this Foundation Phase class
Class size (grade 6 self-reported)		Grade 6 educator Q17: What is the largest class that you teach this year (i.e. 2017) (number of Learners)

Table A 2: SGB-paid educators, class sizes, LE-ratios and alignment ratios across schools offering Grade 6, by school Quintile and by province, SMS 2017/18

	Any SGB educators in school		Number of SGB employed educators					Average Class sizes						Average LE ratios						Average Alignment ratios			
	School weighted	Learner weighted	School weighted		Learner weighted			Grade 3 class size			Largest class taught by grade 6 teacher			LE ratio (incl SGB educators, masterlist)			LE ratio (excl. SGB educators, self-report)			Grade 3 class size		Largest class taught by grade 6 teacher	
	%	%	Mean	p50	Mean	p50	N	Mean	95% CI		Mean	95% CI		Mean	95% CI		Mean	95% CI		Incl. SGB	Excl. SGB	Incl. SGB	Excl. SGB
Quintile																							
Quintile 1	28.6	23.3	0.6	0	0.5	0	264	41.0	38.9	43.1	52.0	49.0	55.1	33.5	32.6	34.3	34.4	33.5	35.2	1.22	1.21	1.55	1.56
Quintile 2	17.3	19.8	0.3	0	0.4	0	247	41.1	38.9	43.3	56.4	52.4	60.3	34.6	33.8	35.4	34.8	34.0	35.6	1.18	1.19	1.61	1.61
Quintile 3	20.0	25.3	0.4	0	0.6	0	246	42.9	40.6	45.2	54.7	51.0	58.4	34.8	34.0	35.5	35.7	34.9	36.4	1.24	1.21	1.57	1.56
Quintile 4	55.5	55.8	2.6	1	2.6	1	108	40.3	38.4	42.3	46.8	43.5	50.1	32.4	31.3	33.5	34.9	33.8	36.1	1.26	1.17	1.45	1.35
Quintile 5	78.4	81.7	6.7	5	8.3	6	120	36.1	34.7	37.5	37.6	35.3	39.9	27.7	26.2	29.3	35.6	34.5	36.7	1.34	1.04	1.40	1.07
Total	**29.1**	**33.7**	**1.0**	**0**	**1.7**	**0**	**985**	**40.8**	**39.8**	**41.8**	**51.4**	**49.7**	**53.1**	**33.2**	**32.8**	**33.7**	**35.0**	**34.6**	**35.4**	**1.23**	**1.18**	**1.54**	**1.49**
Province																							
EC	41.9	44.7	0.9	0	1.4	0	114	38.5	34.8	42.3	50.7	45.2	56.2	32.4	31.1	33.8	35.1	33.5	36.6	1.18	1.11	1.52	1.43
FS	28.3	34.0	1.0	0	1.2	0	106	40.8	39.1	42.6	48.3	45.8	50.8	32.6	31.6	33.6	33.9	32.5	35.2	1.26	1.25	1.47	1.47
GT	40.5	44.9	2.8	0	3.3	0	107	40.9	39.5	42.2	47.6	44.8	50.4	33.0	31.9	34.1	36.4	35.5	37.4	1.26	1.14	1.44	1.32
KZ	9.6	16.2	0.5	0	1.0	0	117	41.1	38.4	43.9	54.0	49.5	58.6	33.1	31.9	34.3	33.4	32.5	34.3	1.26	1.25	1.67	1.66
LP	14.5	16.7	0.4	0	0.6	0	114	46.5	43.2	49.8	61.2	55.8	66.6	37.2	36.2	38.2	36.3	35.4	37.2	1.24	1.29	1.63	1.71
MP	35.7	31.8	0.9	0	1.2	0	110	41.6	39.7	43.6	59.0	54.5	63.5	32.6	31.7	33.5	34.6	33.8	35.5	1.28	1.21	1.79	1.71
NC	16.9	24.5	0.6	0	1.2	0	98	34.8	33.3	36.3	42.2	39.5	45.0	30.3	29.3	31.2	32.5	31.4	33.5	1.16	1.08	1.38	1.27
NW	24.6	23.1	0.8	0	1.0	0	108	42.6	40.7	44.5	50.0	46.5	53.5	33.6	32.7	34.5	34.5	33.8	35.2	1.27	1.24	1.49	1.45
WC	69.3	68.5	3.1	2	4.1	2	111	36.3	35.0	37.6	38.9	37.2	40.5	31.9	30.9	32.9	36.9	36.0	37.8	1.15	1.00	1.23	1.07
Total	**29.1**	**33.7**	**1.0**	**0**	**1.7**	**0**	**985**	**40.8**	**39.8**	**41.8**	**51.4**	**49.7**	**53.1**	**33.2**	**32.8**	**33.7**	**35.0**	**34.6**	**35.4**	**1.23**	**1.18**	**1.54**	**1.49**
Total number of schools with SGB educators							**333**																

Data source: SMS 2017/18 linked to 2018 Masterlist. Information on whether school privately hires SGB educators (including School Management SGB paid) from school principal reports. SGB = school governing body. Class sizes, average LE ratios and alignment ratios are all learner-weighted.

Table A 3: Estimating grade 3 class size (all school Quintiles)

	LE ratio + province	LE ratio + province	Add: Resources	Add: Composition + Structure	Add: Utilization	Add: Teacher	All controls	All controls
	(1a)	(1b)	(2)	(3)	(4)	(5)	(6a)	(6b)
LE ratio (incl. SGB)	1.641***	0.952***	1.766***	1.629***	1.605***	1.657***	1.573***	0.704***
LE ratio (incl. SGB) squared	-0.011		-0.013	-0.015*	-0.011	-0.011	-0.014	
FS	1.467	1.737	0.459	-0.785	1.632	1.092	-1.315	-0.900
GT	0.940	1.097	-0.250	-2.254	1.045	0.499	-2.745	-2.438
KZ	1.403	1.431	1.252	1.035	1.452	1.085	0.910	1.086
LP	3.741	3.598	3.347	4.628*	3.815	3.485	4.146	4.045
MP	1.776	2.088	1.159	0.425	1.906	1.587	-0.058	0.361
NC	-2.691	-2.316	-3.561*	-4.656**	-2.803	-2.852	-5.281**	-4.818**
NW	2.483	2.736	2.049	1.042	2.512	2.287	0.924	1.243
WC	-2.526	-2.254	-3.804*	-5.066**	-2.490	-2.645	-5.290**	-4.764**
Learner to classroom ratio			0.005				0.002	0.002
School Quintile 2			-0.450				-0.644	-0.618
School Quintile 3			-0.010				-1.402	-1.326
School Quintile 4			0.854				-0.422	-0.329
School Quintile 5			1.483				-0.378	-0.787
School has internet			1.724				0.865	0.904
Maintenance: Moderate signs of disrepair			1.841				1.414	1.429
Maintenance: Minor signs of disrepair			1.721				0.927	0.829
Maintenance: Well-maintained			0.740				-0.016	-0.218
Maintenance: Missing			0.985				1.440	1.388
Total enrolment grade 1-12				0.008***			0.008***	0.008***
Ratio: Grade 3 to grade 1-12 enrolment				-11.789			-11.664	-10.462
Highest grade offered at school				0.651			0.519	0.465
Multi-grade teaching at the school				-2.238			-2.115	-2.380
HOD visits to teacher: One				0.672			0.878	0.789
HOD visits to teacher: Two				0.370			0.446	0.536
HOD visits to teacher: Three				1.810			1.974	1.986
HOD visits to teacher: Four				0.440			0.406	0.331
HOD visits to teacher: More than four				1.765			1.946	1.825
Ratio: all educators (1-12) to all SMT				0.039			0.045	0.044
Total home languages offered				-0.352			-0.353	-0.373
Proportion of educators who did not sign the register					-3.275		2.603**	2.605**
Percent of allocated public educator posts that are vacant					-0.762		-0.502	-0.624
Classroom not used: 1					-0.331		0.016	0.016
Classroom not used: 2					-1.149		-2.109	-1.954
Classroom not used: 3 or more					-0.773		-0.552	0.026
Number of financial management functions transferred to school					-0.088		0.438	0.461
Educator is SMT member						1.859	-0.490	-0.595
Took mathematics for Matric						-0.225	-0.863	-0.899
Years teaching in this phase / subject						0.032	-0.011	-0.085
Constant	-1.933	8.218***	-6.364	-6.681	-1.410	-2.088	-5.537	7.921
R-squared	0.230	0.228	0.236	0.287	0.231	0.233	0.290	0.286
N (educators)	1503	1503	1503	1503	1503	1503	1503	1503
N (schools)	903	903	903	903	903	903	903	903

Source data: SMS 2017/18 linked to the Masterlist 2018. Teacher reports clustered at school level. Learner weighted. Notes: Reference categories are the Eastern Cape, Quintile 1, Major signs of disrepair, No HOD visits to teacher, No unused classrooms.

Table A 4: Estimating the largest class taught by a grade 6 educator (all school Quintiles)

	LE ratio + province	LE ratio + province	Add: Resources	Add: Composition + Structure	Add: Utilization	Add: Teacher	All controls	All controls
	(1a)	(1b)	(2)	(3)	(4)	(5)	(6a)	(6b)
LE ratio (incl. SGB)	2.607**	1.458***	2.205**	2.529**	2.483**	2.640**	1.814*	0.850***
LE ratio (incl. SGB) squared	-0.019		-0.014	-0.023	-0.017	-0.019	-0.015	
FS	-4.857	-4.563	-5.928*	-8.226**	-4.697	-5.895	-8.573**	-8.359**
GT	-5.231	-5.095	-4.819	-10.230**	-4.691	-5.959	-8.543*	-8.473*
KZ	2.353	2.177	3.324	2.486	2.401	2.038	4.104	3.984
LP	4.193	3.828	3.602	7.317*	3.872	3.297	6.381	6.126
MP	5.890	6.317	4.947	4.359	6.010	5.716	4.252	4.509
NC	-7.544*	-6.964*	-7.901**	-9.992**	-7.310*	-8.143*	-9.522**	-9.235**
NW	-3.141	-2.794	-3.784	-5.004	-3.059	-3.396	-4.841	-4.754
WC	-11.883***	-11.562***	-11.024***	-15.744***	-11.437***	-12.543***	-13.003***	-12.697***
Learner to classroom ratio			0.004				-0.003	-0.003
School Quintile 2			2.030				1.737	1.851
School Quintile 3			0.717				-1.067	-0.867
School Quintile 4			-2.092				-4.015	-3.806
School Quintile 5			-4.599				-8.169***	-8.616**
School has internet			2.763				0.925	1.087
Maintenance: Moderate signs of disrepair			1.832				0.853	0.876
Maintenance: Minor signs of disrepair			3.085				1.112	0.942
Maintenance: Well-maintained			0.674				-1.070	-1.296
Maintenance: Missing			0.474				1.149	1.161
Total enrolment grade 1-12				0.013***			0.014***	0.014***
Ratio: Grade 6 to grade 1-12 enrolment				21.817			20.361	17.255
Highest grade offered at school				2.640*			2.669**	2.527*
Multi-grade teaching at the school				-3.834*			-4.802*	-5.425**
HOD visits to teacher: One				0.925			1.243	1.360
HOD visits to teacher: Two				0.263			-0.224	-0.108
HOD visits to teacher: Three				2.229			1.196	1.278
HOD visits to teacher: Four				2.929			2.334	2.409
HOD visits to teacher: More than four				1.668			0.956	0.947
Ratio: all educators (1-12) to all SMT				-0.025			0.064	0.054
Total home languages offered				-0.645*			-0.619*	-0.647*
Proportion of educators who did not sign the register					-5.442		-2.822	-2.930
Percent of allocated public educator posts that are vacant					-0.964		-0.758	-0.871
Classroom not used: 1					0.383		0.102	0.103
Classroom not used: 2					1.404		-2.827	-2.596
Classroom not used: 3 or more					1.462		5.936	6.655
Number of financial management functions transferred to school					-1.556		0.898	0.910
Educator is SMT member						-3.755*	2.148	1.911
Took mathematics for Matric						-1.482	1.880	1.816
Years teaching in this phase / subject						0.123	-1.648	-1.702
Constant	-12.668	4.234	-7.355	-36.068**	-11.831	-10.932	-22.126	-5.935
R-squared	0.178	0.176	0.182	0.226	0.180	0.183	0.239	0.238
N (educators)	2155	2155	2155	2155	2155	2155	2155	2155
N (schools)	950	950	950	950	950	950	950	950

Source data: SMS 2017/18 linked to the Masterlist 2018. Teacher reports clustered at school level. Learner weighted. Notes: Reference categories are the Eastern Cape, Quintile 1, Major signs of disrepair, No HOD visits to teacher, No unused classrooms.

Table A 5: Estimating class size. Interactions between LE ratio and province or school Quintile

	Grade 3 class size				Largest class size reported by Grade 6 educator			
	Interact LE ratio and Province		Interact LE ratio & school Quintile		Interact LE ratio and Province		Interact LE ratio & school Quintile	
	LE ratio + province (1b)	All controls (6b)	LE ratio + province (1b)	All controls (6b)	LE ratio + province (1b)	All controls (6b)	LE ratio + province (1b)	All controls (6b)
LE ratio	1.539***	1.286***	1.131***	0.795***	2.593***	2.101***	1.672***	1.187***
EC	10.382	11.146	-3.070	-4.196	26.719	27.845*	-3.384	-6.363
FS	13.627	14.763	-1.538	-4.699*	37.413**	48.151***	-7.746**	-13.845***
GT	26.895**	24.141*	-2.733	-6.283**	41.537***	51.970***	-7.232*	-14.042***
KZ	26.247*	24.111*	-1.861	-2.860	48.746**	48.135***	0.205	-1.155
MP	15.015	11.470	-0.958	-3.306	45.003**	41.957*	3.025	-0.603
NC	27.430*	28.492*	-5.293**	-8.462***	41.823**	48.343***	-9.058**	-14.065***
NW	20.251	15.536	-0.436	-2.705	46.979**	45.094**	-6.481*	-10.692***
WC	21.712*	20.042*	-5.981**	-8.521***	40.578***	49.284***	-12.633***	-17.619***
EC # LE ratio	-0.342	-0.390			-0.795	-0.903*		
FS # LE ratio	-0.388	-0.516			-1.258***	-1.756***		
GT # LE ratio	-0.807**	-0.846**			-1.395***	-1.868***		
KZ # LE ratio	-0.777**	-0.744*			-1.396**	-1.385**		
MP # LE ratio	-0.417	-0.376			-1.159*	-1.175*		
NC # LE ratio	-0.954**	-1.088**			-1.489***	-1.827***		
NW # LE ratio	-0.558	-0.482			-1.486***	-1.561***		
WC # LE ratio	-0.758**	-0.799**			-1.584***	-1.935***		
Quintile 4		0.463	8.371	5.074		-4.378*	22.043*	16.241
Quintile 5		-0.469	13.428**	7.835		-10.617***	23.465**	21.755*
Quintile 4 # LE ratio			-0.204	-0.137			-0.734**	-0.604
Quintile 5 # LE ratio			-0.386*	-0.256			-0.950**	-1.002**
Constant	-10.278	-11.081	4.995	7.062	-33.679**	-46.077**	0.395	-14.530
Adjust R2	0.237	0.295	0.234	0.287	0.185	0.251	0.188	0.244
N (educators)	1503	1503	1503	1503	2155	2155	2155	2155
N (schools)	903	903	903	903	950	950	950	950
School resources		X		X		X		X
School structure + composition		X		X		X		X
Utilization factors		X		X		X		X
Teacher characteristics		X		X		X		X

Source data: SMS 2017/18 linked to the Masterlist 2018, own calculations. Teacher reports clustered at school level. Learner weighted.
Notes: Reference categories are Limpopo and Quintile 1-3 schools. Signficant at *10%, **5% and 1% level. LE ratio includes SGB (from Masterlist 2018).

Figure A 1: Cumulative distribution of LE ratios (including SGB educators) in public primary schools in 2018, EMIS Masterlist

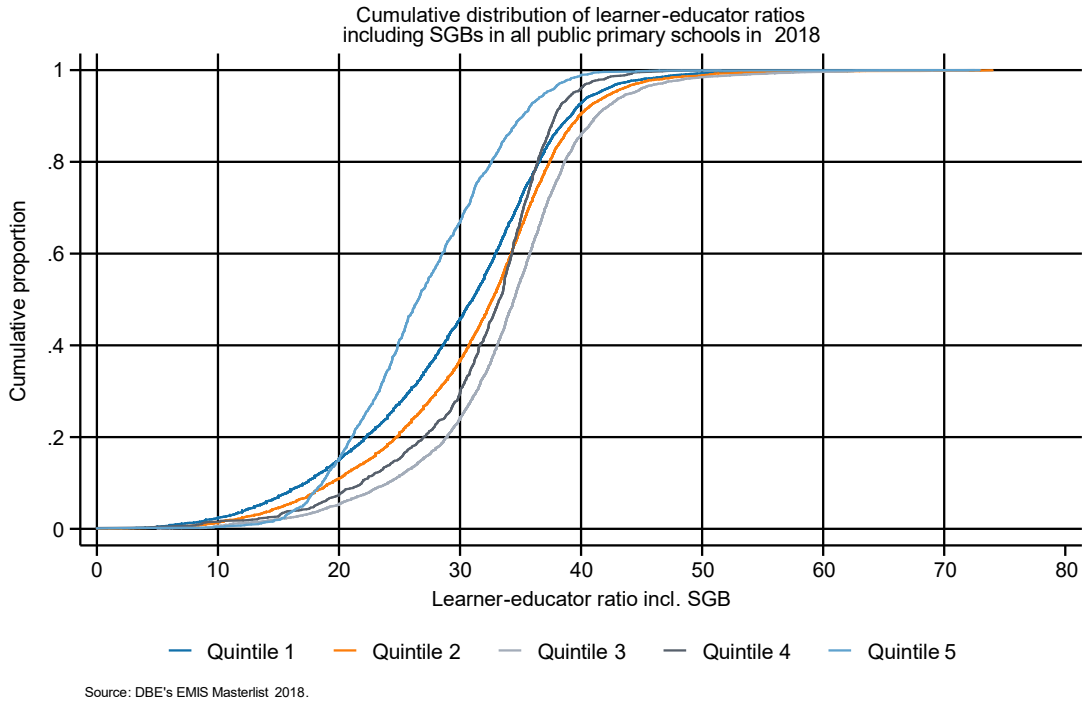

Table A 6: LE ratios (including SGB educators) from 2018 EMIS Masterlist

	Mean	P10	P25	P50	P75	P90	N (schools)
Public primary	30.9	19.3	26.0	32.3	36.3	39.6	14606
Private primary	17.4	7.5	10.3	15.7	22.5	28.4	651
Public secondary	27.1	18.4	22.9	27.8	31.3	34.6	5559
Primary: Eastern Cape	28.5	15.8	21.3	28.4	35.1	40.3	3079
Primary: Free State	27.2	12.0	20.0	30.3	35.1	37.2	664
Primary: Gauteng	32.7	24.0	29.4	33.9	36.7	38.7	1391
Primary: KwaZulu-Natal	30.7	20.0	26.0	31.5	35.8	39.2	3739
Primary: Limpopo	35.4	27.0	32.1	36.0	39.2	42.6	2359
Primary: Mpumalanga	31.1	22.9	28.0	32.1	35.0	37.7	1099
Primary: Northern Cape	27.2	17.3	22.0	29.0	32.5	34.6	313
Primary: North West	31.5	21.5	28.3	33.4	36.2	38.5	982
Primary: Western Cape	29.4	19.3	24.3	31.3	34.7	36.5	980
Primary: Quintile 1	29.7	17.3	24.2	31.0	35.5	39.2	4761
Primary: Quintile 2	31.3	19.4	26.5	32.7	36.5	39.8	4022
Primary: Quintile 3	33.7	24.0	30.2	34.5	37.9	41.3	3378
Primary: Quintile 4	31.5	21.9	29.0	33.3	35.8	37.9	1146
Primary: Quintile 5	26.8	18.6	22.2	26.5	31.3	35.2	1267

Source: EMIS Masterlist 2018. Data to derive LE ratios is missing for 964 schools in the 2018 Masterlist, roughly 3.7% of all schools in the 2018 list. Estimates are *not* learner-weighted.