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Australian Demand and Pacific Supply**

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ABSTRACT

Labour Mobility with Vocational Skill: Australian Demand and Pacific Supply*

How many immigrants with less than university education, for a given immigration quota, maximise economic output? The answer is zero in the canonical model of the labour market, where the marginal product of a university-educated immigrant is always higher. We build an alternative model in which national production occurs through a set of Leontief production functions that shift over time with technological change. This model is used to estimate that the Australian economy growing at historical rates through the year 2050 will demand approximately two million migrant TVET workers, many of which could be supplied from the Pacific Islands.

JEL Classification: F22, J11, J24

Keywords: immigration, labor, low skill, TVET, training, human capital, growth

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1 Introduction

Suppose an official is charged with setting quotas on the number of visas for foreigners to work in Australia. She would face pressure to admit only workers that the economy “needs”. Workers with university education are often considered to be needed. But how would the official place a number on the economic “need” for workers with less than tertiary education, such as those with vocational training?

A common stance in immigration policy is that the economic need for such workers is close to zero. The United States and United Kingdom, for example, have explicitly barred almost all employment-based settler immigration for workers without tertiary education.¹ Australia has largely lacked an official policy toward labour migration for vocationally-skilled work work (Wright and Clibborn 2017), despite a growing mismatch between focus on high educational qualifications and the needs of the labour market (Wright et al. 2016).

In this paper, we build a simple model of the Australian economy in which the output-maximising quantity of vocationally-skilled immigration is positive. This is because the substitution of university-educated workers for vocationally-educated workers is 1) limited by the speed of technological change, as in the seminal model of Jones (2005), and 2) inherently limited for some tasks. We use the model to build rough estimates of the demand for less-educated workers in the Australian economy over the next three decades, and the likely supply of those workers among natives of Australia and of the Pacific region. Our contribution is to distinguish between falling relative demand for some tasks that do not require a university education—those that are being substantially automated or offshored—and other occupations with stable relative demand that

¹Under Prime Minister Theresa May, the United Kingdom restricted its General Work Visa (with minor exceptions) to migrants earning over £30,000 per year; the median worker even with the highest level of secondary education earns £18,450. A UK government review of the evidence concluded that “a policy on work migration that provided greater access for higher-skilled migration while restricting access for lower-skilled workers to enter the UK would be consistent with the available evidence.” (Manning et al. 2018, 111). In the United States, the influential Jordan Commission created by Congress recommended “the elimination of the admission of unskilled workers”—that is, those with no college degree. Today the United States offers only 0.1% of its settler visas for newly-arrived immigrants on the basis of employment that does not require university education. It offers no temporary visa for nonseasonal work that does not require university education. UK data source in Appendix. Jordan Commission report is USCIR (1995, 102). In fiscal year 2018, the United States admitted newly-arrived 528,727 permanent immigrants, of which 468 (0.086%) were for work requiring less than a college degree (EB-3 “needed unskilled workers”, *Yearbook of Immigration Statistics 2018*, “Table 7: Persons Obtaining Lawful Permanent Resident Status by Type and Detailed Class of Admission: Fiscal Year 2018”).

we call *fundamental workers*. We find a large gap between projected demand and native supply, reaching roughly two million by the year 2050 (stock, not flow).

Broadly, this gap can be reduced in three ways: accepting lower university-educated employment and economic growth, occupational downgrading by highly educated native workers, or immigration by vocationally educated foreign workers (temporary or permanent). We explore the case for this last option and in particular the case for recruiting vocationally educated workers from the Pacific region.

The paper begins by presenting the new model in [section 2](#) and discussing its implications in [section 3](#). [Section 4](#) discusses how the model is more consistent with recent Australian data than the canonical model used to study immigration, and [section 5](#) explores the implications for future scenarios of demand and supply of vocationally-skilled workers in Australia. The potential for managed migration focused on Pacific-region labour supply is considered in [section 6](#), and [section 7](#) concludes.

2 Demand for workers with less than university education

The effect of labour on national production can be modelled in various ways. The canonical model admits two types of workers: one with high education and high marginal product, another with low education and low marginal product. In this framework, national output is always strictly higher if a worker with vocational education is replaced by a worker with university education.

These assumptions yield a strong implication for immigration policy. In such an economy, admitting any given immigrant worker with vocational education imposes an economic cost relative to admitting a university-educated worker—a cost that could only be compensated by non-economic policy objectives such as humanitarian protection or family reunification. It implies that for any given quota of immigrants, the output-maximising number of vocationally-educated immigrants is zero.

Here we set out a simple theoretical framework in which the output-maximising number of

immigrants with vocational skill is nonzero. Prior literature has focused on the impact of foreign workers in Australia on the distribution of income, generally finding little to no effect (Breunig et al. 2017; Crown et al. 2020). We focus instead on macroeconomic impact: estimating the demand for immigrants with vocational education that would maximise productivity and fiscal revenue.

2.1 Labour demand: The canonical model

Studies of the economic effects of immigration focus on the “canonical” model of the relative demand for labour by education level (Tinbergen 1974; Katz and Murphy 1992; Acemoglu and Autor 2011; Dustmann et al. 2016). In the essence of that model, national output Y is created by a long-run neoclassical production technology with two types of labour, constant returns to scale, and constant elasticity of substitution σ :

$$Y = A \left(\alpha L_h^{\frac{\sigma-1}{\sigma}} + (1-\alpha) L_v^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \quad (1)$$

L_h is workers who have completed higher education (diploma, associate degree, university degree), L_v is workers who have completed vocational education (secondary or Certificate I–IV), aggregate labour is $L \equiv L_h + L_v$, $\alpha < 1$ captures their relative productivity, and constant A is an overall labour productivity parameter capturing both capital and technology.

An official setting immigration quotas would want to know: When a growing economy employs more workers with college education (L_h), how many more workers with vocational education (L_v) does it employ? Assuming perfect competition in factor markets, output is maximised when the wage ratio for the two types of labour equals the marginal rate of technical substitution:

$$\frac{w_h}{w_v} = \frac{1-\alpha}{\alpha} \cdot \left(\frac{L_h}{L_v} \right)^{1/\sigma}, \quad (2)$$

Isocost curves are defined by a constant labour cost share $s_h \equiv \frac{w_h L_h}{w_h L_h + w_v L_v} = 1 - s_v$, requiring

$$\frac{w_h}{w_v} = \frac{1-s_h}{s_h} \cdot \frac{L_h}{L_v}. \quad (3)$$

Taking the total differential of (1),

$$d \ln L_v = d \ln Y - d \ln A - s_h (d \ln L_h - d \ln L_v), \quad (4)$$

we can use (2) and then (3) to arrive at a version of the Slutsky equation, in quantities employed:²

$$\frac{d \ln L_v}{d \ln L_h} = 1 - s_h \sigma. \quad (5)$$

The first term in (5) is the pure scale effect of unity: In the short run—with a Leontief production technology, and thus fixed factor proportions—a percentage rise in employment with college education (and thus output) would require the same percentage rise in employment with vocational education. That is, it reflects the short-run elasticity of substitution $\sigma = 0$. The second term captures the negative substitution effect in the long run: If the technology is not Leontief ($\sigma > 0$) then rising employment of workers with college education can cause an even larger rise in output if a technology can be developed that is relatively more intensive in workers with college education, with an offsetting negative effect on demand for workers with vocational education.

The sign of the net effect is ambiguous if the two types of workers are relative substitutes, that is, if the Hicks-Allen direct elasticity of substitution σ exceeds unity (Stern 2011). Empirically, it does: In a group of advanced economies including Australia, σ is estimated at 1.8–2.6 (Jerzmanowski and Tamura 2020). Thus it is possible that workers with college education, in this model, can displace workers with vocational education even as they cause the economy to grow.

2.2 Limitations of the canonical model

Two key assumptions above limit the policy relevance of the canonical model. First, the relative labour demand equation (5) applies to the ambiguously-timed “long run” (Hamermesh 1986), but immigration quotas must be set in the short run. Second, it assumes the same possibilities of substitution between workers with college education and all types of workers with vocational education, regardless of the tasks they perform. Intuitively, new ideas from college-educated workers to substitute for vocationally-educated workers might arrive at very different rates for, say, telephone operators than for childcare workers. Here we discuss relaxing those assumptions.

²Without factor substitution, trivially $\frac{d \ln Y}{d \ln L_h} = \frac{\partial \ln Y}{\partial \ln L_h} + \frac{\partial \ln Y}{\partial \ln L_v} \cdot \frac{d \ln L_v}{d \ln L_h} = s_h + s_v = 1$.

Rather than the ambiguous “long run”, the immigration official might be interested in the demand for each type of labour at a moment in finite time. We can estimate that using [Jones’s \(2005\)](#) interpretation of the national production function (1): It is a reduced form capturing not a single production technology, but the long-run substitution possibilities *between different (Leontief) short-run production techniques*. Combining the two types of labour in a new way, at a substantially different ratio, requires new ideas—and ideas arrive over time at a certain rate.

That feasible rate of change in the organisation of national production is captured by σ . From (5) the instantaneous rate of change $\frac{d \ln(L_v/L_h)}{dt} = -s_h \sigma \frac{d \ln L_h}{dt}$, so that for any finite interval t ,

$$\Delta \left(\ln \frac{L_v}{L_h} \right) = -t s_h \sigma \cdot \Delta (\ln L_h) \quad (6)$$

If ideas capable of reorganising national production arrive very slowly ($\sigma \approx 0$), the labour ratio remains constant during growth as the economy expands along Leontief isoclines. The shift in the labour ratio over a finite time period characterises the degree of substitution between production techniques made feasible by the arrival of new ideas during that period.

This points to a second important limitation of the canonical model. The ideas needed to reorganise production might not arrive at the same rate for all types of workers with vocational education: They might arrive relatively quickly for telephone operators and very slowly for child care workers. Thus in the medium run the employment of college educated workers might reduce the demand for telephone operators even as it raises demand for child care workers ([Cortés and Tessada 2011](#); [Cortés and Pan 2013](#)). The labour literature has recently focused on this concern, as the canonical model has proven unable to adequately explain the heterogeneity of changing education premia across the education spectrum in many advanced economies over the last half century ([Bárány and Siegel 2018](#)), often called labour market polarisation ([Autor and Dorn 2013](#); [Goos et al. 2014](#)). This new literature reconsiders the national production function as combining not workers directly but *tasks* that are in turn produced by workers. It explores how substitutability can vary across tasks performed by workers even within the same education level.

Such polarisation of labour demand by task has been evident in Australia as well ([Coelli and Borland 2016](#)) though it is less marked than in other countries, possibly due to wage regulations limiting employment growth in the lowest-wage jobs ([Wilkins and Wooden 2014](#), 424). This new

literature offers tools to consider the relationship between labour demand at different education levels in a way that accounts for Australian particularities. This focus on tasks has only begun to shape the study of immigration (e.g [Foged and Peri 2016](#); [Basso et al. 2017](#)).

2.3 A task-based alternative

Consider a national long-run technology that directly combines types of labour as *tasks*, not people ([Autor et al. 2003](#); [Autor and Dorn 2013](#)). This conception of labour as tasks is distinguished with the script \mathcal{L} . Some of these tasks are “complex” or abstract and require formal higher education (\mathcal{L}_h), such as the services of a surgeon. Other, “basic” tasks can be performed by a person with formal education to the vocational level only (\mathcal{L}_v). Some of these are *replaceable* ($\mathcal{L}_{v,r}$)—that is, can be automated or offshored—such as the services of a medical transcriptionist. Other tasks that can be performed by low-education worker are *not replaceable* ($\mathcal{L}_{v,f}$)—thus “fixed” or “fundamental”—such as the services of a nurse’s aide.³

National output is produced by combining these tasks in the nested, constant elasticity of substitution production function

$$Y = A \left(\alpha \left(\beta \mathcal{L}_h^{\frac{\delta-1}{\delta}} + (1-\beta) \mathcal{L}_{v,r}^{\frac{\delta-1}{\delta}} \right)^{\frac{\delta}{\delta-1} \frac{\sigma-1}{\sigma}} + (1-\alpha) \mathcal{L}_{v,f}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \quad (7)$$

Automatable and/or offshorable tasks $\mathcal{L}_{v,r}$ can be substituted by greater use of abstract, complex tasks \mathcal{L}_h more easily than fixed or fundamental tasks $\mathcal{L}_{v,f}$. This difference is captured by the Hicks direct elasticities as $\sigma \ll \delta$.

In this model, the creation of complex employment \mathcal{L}_h again affects demand for the other tasks $\mathcal{L}_{v,r}$, $\mathcal{L}_{v,f}$, through a short-run scale effect and a long-run substitution effect. In the short run, before new ideas to rearrange production arrive, production is Leontief and additional complex employment causes an equal percentage rise in demand for the other two employment types.

³Here, “automatable” means a task sufficiently routine that it can in principle be performed by machines ([Acemoglu and Autor 2011](#)). “Offshorable” means a task that can be done in a foreign country while still supplying the good or service to the home country ([Blinder and Krueger 2013](#)). The task of medical transcription, for example, can be replaced by complex tasks such as programming an artificial intelligence system or setting up an overseas transcription service. Neither are feasible for what we call “fixed” or “fundamental” tasks, also called “hard-core nontradable” tasks by [Pritchett \(2006\)](#).

In the long run, the rise in demand for the other two employment types is mitigated by technological change to use complex employment more intensively. It might be tempting to characterise that substitution using the Hicks direct elasticities of substitution in (7) and use them to write a separate version of the Slutsky equation (5) for each labour type. But the response of demand for $\mathcal{L}_{v,f}$ to a rise in employment of \mathcal{L}_h depends on the substitutability of \mathcal{L}_h and $\mathcal{L}_{v,r}$. The labour demand relationship analogous to (5) for ‘fundamental’ tasks thus requires the [Morishima \(1967\)](#) elasticity of substitution between nests, which in this case is a weighted average of the Hicks direct elasticities ([Anderson and Moroney 1993](#); [Frieling and Madlener 2016](#)). This gives the long-run gross elasticities

$$\frac{d \ln \mathcal{L}_{v,r}}{d \ln \mathcal{L}_h} = 1 - s_h \delta \quad \text{and} \quad \frac{d \ln \mathcal{L}_{v,f}}{d \ln \mathcal{L}_h} = 1 - s_h (\beta \sigma + (1 - \beta) \delta) \equiv 1 - s_h \mu, \quad (8)$$

where μ is the (one-way) Morishima elasticity of demand for fundamental tasks to the marginal product of complex tasks. By definition, $0 < \mu < \delta$. As above, these correspond to the finite-time relationships

$$\Delta \left(\ln \frac{\mathcal{L}_{v,r}}{\mathcal{L}_h} \right) = -t \delta \cdot s_h \Delta(\ln \mathcal{L}_h) \quad \text{and} \quad \Delta \left(\ln \frac{\mathcal{L}_{v,f}}{\mathcal{L}_h} \right) = -t \mu \cdot s_h \Delta(\ln \mathcal{L}_h) \quad (9)$$

That is, over any finite period, the change in the ratio of ‘fundamental’ employment to complex employment is slower than the change in the ratio of ‘replaceable’ employment to complex employment.

The last step is to introduce workers. Every task must be produced by a worker, so that $\mathcal{L}_h + \mathcal{L}_{v,r} + \mathcal{L}_{v,f} = L_h + L_v$. Some workers with only vocational education can manage to acquire the skills and experience to be as productive in complex jobs as those with higher education (*upskilling*: L_v^h), provided they do not face a licensing barrier. Others have higher education but nevertheless perform tasks that do not require it (*downskilling*: L_h^v). Still others work at the level for which they are educated: L_v^v, L_h^h . Thus,

$$\mathcal{L}_h = L_h^h + L_v^h \quad (10)$$

$$\mathcal{L}_{v,r} + \mathcal{L}_{v,f} = L_v^v + L_h^v. \quad (11)$$

Either type of worker (h, v) can be native (n) or immigrant (i), and these are perfect substitutes

within education groups:

$$L_h = L_h^n + L_h^i \quad (12)$$

$$L_v = L_v^n + L_v^i \quad (13)$$

This assumption is for simplicity in the baseline analysis, despite evidence that otherwise observably identical natives and immigrants are not perfect substitutes (Peri and Sparber 2009). We will discuss relaxing this assumption below. Finally, the whole population N includes non-working elderly or juvenile dependants L_d alongside workers, so that $N = L_h + L_v + L_d$.

3 Economic and fiscal implications of skill-selective immigration policy

The model has an important implication for the economically efficient regulation of immigration. Often, as discussed above, admitting a vocationally-educated immigrant worker is seen as necessarily reducing national productivity at the margin, relative to admitting a university-educated worker. Indeed, countries with greater increases in the average education of the labour force experience greater economic growth (e.g. Cohen and Soto 2007).

But this reasoning implicitly assumes an infinite elasticity of substitution between the tasks performed by high- and low-education workers. The optimal labour demand equations (9) are derived from the output-maximisation condition (2). So when there is a rise in employment that requires high education, relative employment requiring low education must change to the degree shown, or output would be lower than if it had. If the right sides of either of the equations (9) is positive, employment requiring low education must rise as well.

For example, if an immigrant engineer can only produce engineering work (\mathcal{L}_h) by consuming the services of a child care worker (low substitutability μ), then maximizing output requires raising employment in child care ($\mathcal{L}_{v,f}$). If the supply of natives with low education is rising, that demand can be filled domestically. If not, then maximising output requires admitting a low-education immigrant (L_v^i) or native downskilling (L_h produces $\mathcal{L}_{v,f}$).

The model also has an important implication for the fiscal effect of low-education immigration. This effect is typically analysed with individual-level accounting exercises: summing the lifetime taxes paid directly by such immigrants, net of benefits they receive. This too would suggest a rule always preferring high-education immigrants, who on average pay higher taxes.

Again this implicitly assumes perfect substitution between the work performed by immigrants and natives. But if they are not perfect substitutes, and if low-education immigrants raise the productivity of other workers, they generate tax revenue indirectly (Colas and Sachs 2020). This shortcoming is recognised by influential studies of the fiscal impact of immigration, which nevertheless proceed to carry out individual-level fiscal accounting (Blau and Mackie, eds e.g. 2017, 324; Manning et al. 2018, 71). because the indirect effects are difficult to measure.

But suppose that net tax revenue, and thus the long-run size of government, is a constant share of national product.⁴ This implies that net tax revenue is maximised by maximising output. So again, the addition of new high-education employment requires the changes in low-education employment described in the labour demand relations (9), or net fiscal revenue is lower than it could have been. In the example above, the tax revenue from the engineer's employment is foregone, indirectly, without the employment of the child care worker. It is the overall effect of the addition of both workers to the labour force that determines the fiscal effect of low-education immigration, not a simple account of the taxes paid by the child care worker.

4 Trends in the tasks and education of the Australian workforce

Immigration to Australia raises GDP and reduces unemployment (AboElsoud et al. 2020), today as it has for the prior century (Pope and Withers 1993).⁵ The Australian economy has been shifting to use complex tasks relatively more than basic tasks over time. But sizeable employment in some basic tasks has remained essential for employment in complex tasks. Consistent with the task-based production function (7), the demand for fundamental tasks relative to complex tasks has remained remarkably constant over time, while the relative demand for replaceable tasks has

⁴This is true in Australia, where total government spending has been roughly 35% of GDP for decades according to the OECD.

⁵Freebairn (1998, 117–125) reviews work on aggregate labour demand function in Australia.

fallen. This suggests a hard limit on the substitutability of complex workers for basic workers, one that is not present in standard models of the labour market with two types of worker skill.

Seeing this in the data requires an empirical definition of the types of tasks in the model. For now, we define ‘complex’ occupations as requiring a university degree or equivalent experience. ‘Fundamental’ occupations are those that are neither offshorable nor automatable. We define an ‘offshorable’ occupation as one that is not rated as strictly ‘not offshorable’ by [Blinder and Krueger \(2013\)](#). We define an ‘automatable’ occupation as one placed in the top third ([Autor and Dorn 2013](#), 1571) of the Routine Task Index proposed by [Acemoglu and Autor \(2011\)](#). [Table 1](#) lists examples of the some of the highest-employment occupations separated by these metrics in the 2016 census of Australia. ‘Fundamental’ workers are in the upper left; all others are ‘replaceable’.

Table 1: Typical occupations by task category

	<i>Not offshorable</i>	<i>Offshorable</i>
<i>Not routine</i>	Sales assistant	Metal fitters and machinists
	Aged or disabled carer	Cabinet maker
	Carpenter and joiner	Seafood process worker
	Chef	Concrete machine operator
	Hairdresser	Musical instrument maker
<i>Routine</i>	Receptionist	Bookkeeper
	Commercial cleaner	Architectural draftsman
	Waiter	Welder
	Baker	Dairy products maker
	Crop farm workers	Product assembler

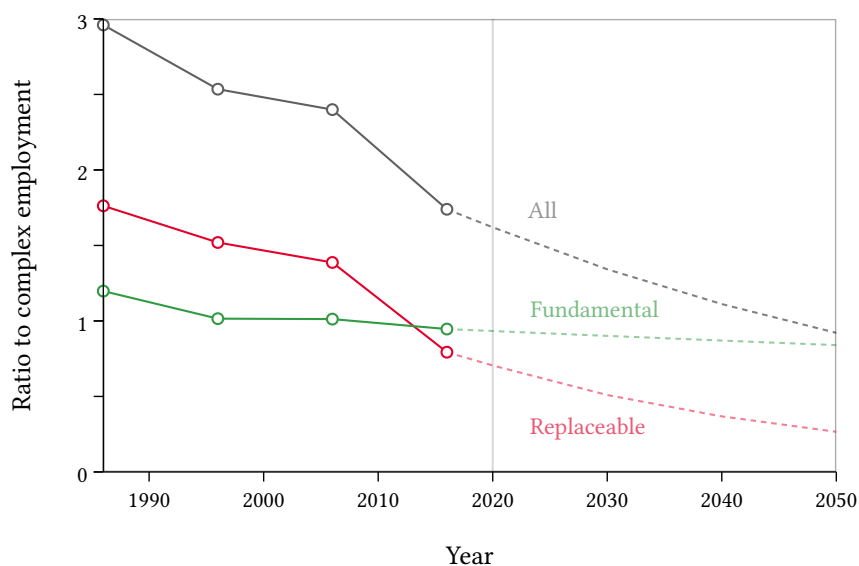
Selected occupations from the top 20 occupations in each category with the most employment in the 2016 census, excluding professional occupations typically requiring a university degree or equivalent experience. ‘Fundamental’ tasks are at the top left, shaded red.

The trends in relative demand for these task types is shown in [Figure 1](#). The solid black line shows the ratio of employment in all basic tasks relative to employment in complex tasks, in each census year. The open circles on the left side of the graph show real full-count census data from each year. The dashed line extends forward a geometric extrapolation of the 20-year trend leading up to 2016. The green and red lines then separate basic tasks by fundamental and

replaceable tasks, respectively.

The demand for fundamental workers relative to complex workers has changed little in the past two decades, even while relative demand for replaceable workers has collapsed. Since the late 1990s the number of replaceable workers employed for each complex worker has fallen by more than half. But the number of fundamental workers employed per complex worker—roughly one—did not change over the same period.

Figure 1: Trends in the relative demand for fundamental and replaceable tasks



‘Complex’ occupations are defined as those requiring a university degree or equivalent. Among all other occupations, ‘fundamental’ occupations are nonroutine and not offshoreable; ‘replaceable’ tasks are all others.

By equation (9), this implies an elasticity of substitution between complex employment and replaceable employment (δ) that is large in absolute value, but an elasticity of substitution between fundamental employment and complex employment (μ) that is very small. This in turn suggests that demand for many tasks not requiring university education—those classified as fundamental—will remain strong decades into the future as a necessary complement to projected advances in the demand for complex tasks.

Figure 2 compares evolving Australian demand for tasks at different skill levels to the supply of workers at each level. In Figure 2a, the orange line shows the fraction of all employment that is in occupations requiring a bachelor's degree or higher—or equivalent knowledge—according to the Australian Bureau of Statistics. Again the dashed line shows a geometric extrapolation of the 20-year trend prior to 2016. The blue line shows the fraction of all workers who have university education or higher, and of these, the purple line shows Australian natives. The gap between 'tasks' and 'education' shows workers with no university degree filling occupations that require knowledge at that level but require no degree-based license, such as business managers.

Figure 2b shows the same relationships for employment at the lower tertiary level (diploma/associate degree), with one difference. Here, the 'education' line excludes workers who are working at tasks that are above their education level. (For such workers to supply labour to tasks at the lower tertiary level would require occupational downgrading.) At both the upper tertiary and lower tertiary level, employment has been rising as a fraction of overall employment, and native workers have been keeping pace.

The same is not true for employment at the vocational level, in Figure 2c. Tasks requiring only vocational education have been a declining share of overall employment, as seen earlier (Figure 1). Here again, the 'education' line includes all workers with secondary education only, *except* those working at tasks above their education level. Thus the gap between 'tasks' and 'education' comprises workers with education at the tertiary level working in occupations that only require secondary education. The figure shows that native workers with training appropriate to vocational tasks have been a declining share of the vocational workforce.

This trend is highlighted in Figure 3. It presents the ratio between the 'Education, native' line and the 'Tasks' line for each task level from Figure 2. While natives with task-appropriate education (or less) have made up a historically rising and recently steady share of employment at the tertiary level, natives are a declining share of those with task-appropriate education at the vocational level. The trends imply that within a few years, more than half of all vocational-level work in Australia will be filled either by immigrant workers or by native workers with more education than is needed to perform their jobs.

Figure 2: Fraction of Australian workers by task and education

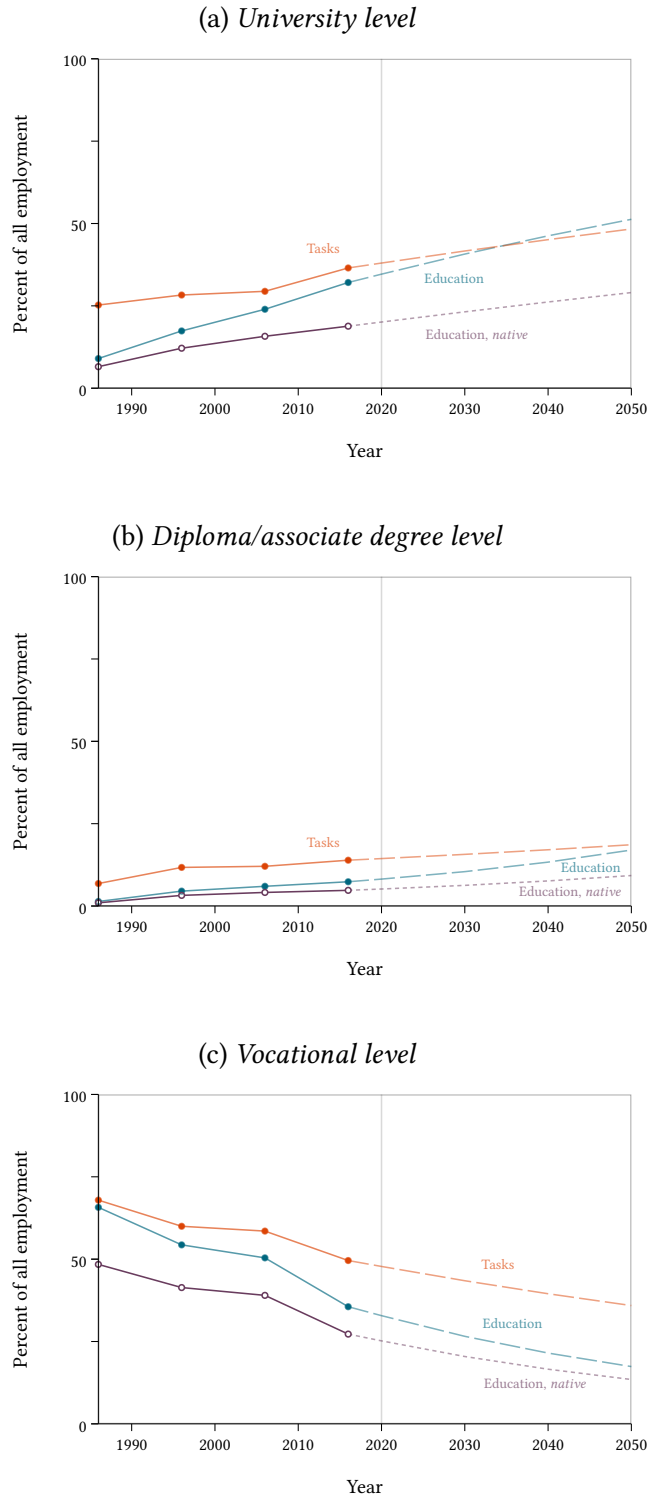
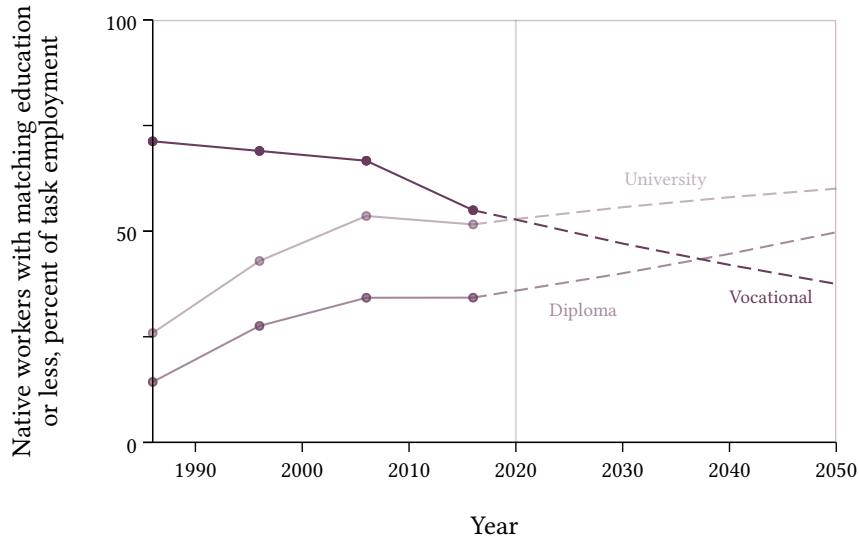


Figure 3: Changing supply of native workers by task group



Two important trends are clear in these graphs. First, demand for some basic occupations will remain strong into the future and will go hand-in-hand with rising demand for more complex occupations. Second, that demand is being increasingly met by immigrants or by native downskilling (working at tasks below one’s education level). This suggests that, if native downskilling is considered undesirable, rising demand for complex workers might require a certain degree of immigration for work in vocational-level tasks. In the next section we estimate this relationship between complex employment and the degree of immigration for basic tasks, given trends in native labour supply to those tasks.

5 Economic growth and the demand for basic tasks

Under the model’s assumptions, we can create scenarios for the evolution of demand for vocational tasks as the economy grows and demands more complex tasks. We begin by estimating a relationship between growth and complex tasks, under different assumptions about techno-

logical change. The model above then implies a given change in demand for basic tasks. That change in demand will be compared, in the following section, to the evolving supply of native workers and Pacific immigrant workers.

5.1 From growth to demand for tasks, with demographic change

First, the model implies that a given rise in income per capita (Y/N) requires a certain change in complex tasks. Start with a simplified version of the task-based production function (7) that lumps together the basic tasks: $Y = A \left(\alpha \mathcal{L}_h^{\frac{\sigma-1}{\sigma}} + (1-\alpha) \mathcal{L}_v^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$. Dividing by N , taking the total derivative with respect to \mathcal{L}_h , and rearranging gives

$$\frac{d \ln(Y/N)}{d \ln \mathcal{L}_h} = \left(\frac{d \ln A}{d \ln \mathcal{L}_h} + \frac{d \ln N}{d \ln \mathcal{L}_h} + s_h \right) + (1 - s_h) \left(\frac{d \ln \mathcal{L}_v}{d \ln \mathcal{L}_h} \right). \quad (14)$$

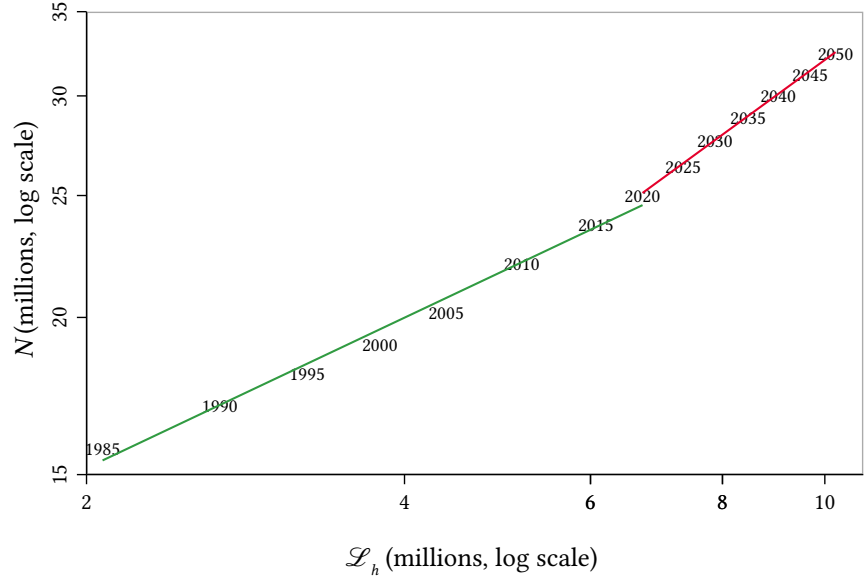
The first term on the right side (hereafter γ) includes the co-movement of complex employment and overall productivity A as well as change in the demographic structure $\frac{N}{\mathcal{L}_h}$. The second term (hereafter θ) accounts for technological change that uses complex tasks relatively more intensively than basic tasks.

The equation (14) can be easily estimated from the data for 1986–2016. In the estimation, Y is national output in each year at constant prices, N is the entire resident population of Australia. \mathcal{L}_h is total employment in occupations requiring tertiary education or commensurate knowledge and experience, as rated by the Australian Bureau of Statistics,⁶ and \mathcal{L}_v is all other employment. The best fit to the data gives $\hat{\gamma} = 0.366$ and $\hat{\theta} = 1.10$.

This allows us to create scenarios of the future demand for complex tasks given any scenario for the growth of GDP per capita *given past rates of demographic change* as shown in the regression equation (14). If future years bring a faster percentage change in the overall population (including elderly dependants) relative to the number of workers in complex tasks, additional workers are required to achieve the same GDP per capita growth for all residents including those not working. The demand for complex tasks must rise by that additional amount (the increase in growth of $\frac{d \ln N}{d \ln \mathcal{L}_h}$ in future years relative to past years).

⁶The method for classifying occupations in the census data is described in the Appendix.

Figure 4: Acceleration of demographic change in Australia



Computed from demographic projections by [Lutz et al. \(2018\)](#).

We begin this estimation in the first row of [Table 2](#). The first row shows the assumed annual rate of growth in real GDP per capita up to each year shown, beginning in the last census year of 2016. The 1.8% annual growth rate represents a continuation of the trend from 1986 to 2016.

Note that this growth rate assumes *past* rates of demographic change, as in equation (14). But the demographic change term $\frac{d \ln N}{d \ln \mathcal{L}_h}$ is not forecast to be the same in coming years. [Figure 4](#) shows estimates of the total Australian population relative to the stock of tertiary-educated workers since the mid-1980s (green) and projected over the next three decades (red). The ageing of the Australian population means that each increment in complex workers will be met with a larger rise than before in the total population: the difference in the two slopes is 0.003. In other words, the size of the complex labour force will need to rise 0.3% faster each year to achieve the same historical rise in GDP per person due to this acceleration of demographic change. Thus the assumed growth rate of GDP per capita in the fourth through sixth columns of [Table 2](#) is 2.1% per year.

We choose the an age range for “working age” that stops at 65 because Australian labour force

Table 2: Demand and supply scenarios for vocationally-skilled workers in Australia

Year	Without demographic acceleration			With demographic acceleration		
	2030	2040	2050	2030	2040	2050
<i>Growth</i>						
ln Y/N growth, annual	0.018	0.018	0.018	0.021	0.021	0.021
ln Y/N cumulative rise	0.284	0.534	0.834	0.338	0.647	1.027
<i>Demand</i>						
ln \mathcal{L}_h cumulative rise	0.104	0.196	0.305	0.124	0.237	0.376
\mathcal{L}_h cumulative rise	560,034	1,106,404	1,822,275	674,572	1,366,565	2,332,344
\mathcal{L}_v cumulative rise	412,345	659,918	880,481	496,677	815,091	1,126,934
<i>Supply</i>						
ln Native working-age pop., cumul. rise	1.010	1.005	0.965	1.010	1.005	0.965
L_v^n cumul. change	-371,968	-648,559	-989,080	-371,968	-648,559	-989,080
Demand-native supply gap, $\Delta (\mathcal{L}_v - L_v^n)$	784,313	1,308,477	1,869,560	868,645	1,463,650	2,116,014

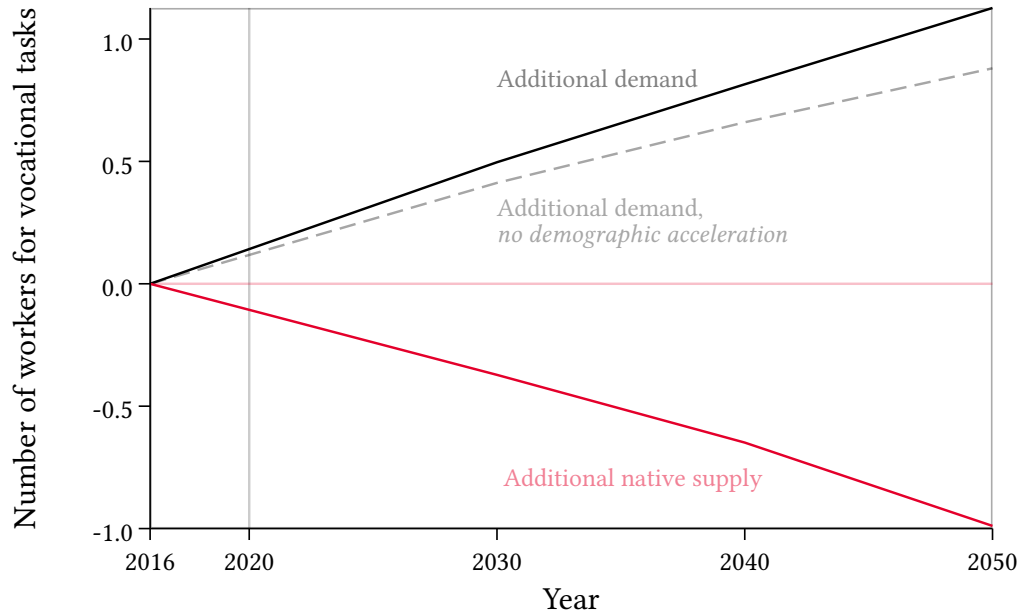
Changes are relative to 2016.

participation by those over 65 is projected to remain low—around 17%—during the decades up to 2050 ([Commonwealth of Australia 2015](#), 19).

The *Demand* section of [Table 2](#) uses this growth rate to estimate the necessary rise in complex employment. Because the estimation of \hat{y} above already accounted for the shifting composition of employment across tasks, the rise in complex employment associated with the assumed economic growth is simply the cumulative economic growth from the second row times the estimate \hat{y} from equation (14). Starting from the size of complex employment in 2016, this cumulative growth rate in complex employment gives the new, additional complex employment needed to achieve the assumed growth rate (row 4).

Given the projected ratio of tertiary-level task employment to vocational-level task employment in [Figure 2c](#), this implies the associated amount of new, additional vocational-level employment (row 5). These estimates do not assume current technology, but rather a continuation of the past rate of technological change shifting relative demand for the two types of workers, as in equations (6) and (9).

Figure 5: Rising demand and falling native supply for vocational tasks in Australia



Source: [Table 2](#).

5.2 Native supply

The next rows of [Table 2](#) estimate the change in supply of *native* workers to fill those additional vocational-level jobs in each year. The sixth row of the table shows the cumulative rise (starting in 2016) of Australia’s native working-age population.⁷ In the next row, this growth is applied to the base amount of native vocational-task employment in 2016, and scaled in each future year by a geometric extrapolation of the 1996–2016 trend in the fraction of vocational tasks performed by native workers.

Because the number of working-age natives will not substantially rise over the forecast period, and because natives are a falling share of vocational-task work, the number of native workers in vocational-level tasks is projected to fall over this period. The native decline in this estimation reaches almost 1 million by the year 2050.

⁷From the United Nations *World Population Prospects 2019* forecast, zero-migration variant in order to capture natives only.

The final row of [Table 2](#) simply takes the difference between the additional demand for vocational tasks (row 5) and the additional native supply of vocational tasks (row 7). With accelerated demographic change, the gap between new demand and native supply reaches about 870,000 by 2030, 1.5 million by 2040, and over 2 million by 2050. [Figure 5](#) shows the same data graphically.

5.3 The potential for managed migration

The quantitative exercise reported in [Table 2](#) and [Figure 5](#) is informative about policy options for the future. Under the assumptions of the model, there are only three ways to narrow the estimated skill gap. First, economic growth and thus the demand for highly-skilled workers could fall, making Australians collectively worse off. Second, a large number of Australians could downskill, performing less productive and less remunerative occupations than their education qualified them for. Finally, managed migration could create more opportunities for vocationally-skilled migration to Australia, either on temporary or settler visas, particularly in fundamental occupations.

An important role for managed migration for targeted sectors is the subject of some degree of political consensus. The last *Intergenerational Report* by the Australian Commonwealth Treasury notes, “Migrants are expected to continue to be the largest source of population growth. Migration contributes to economic growth and can help offset population ageing. However, migration needs to be managed well to ensure it supports higher living standards” ([Commonwealth of Australia 2021](#), vii). The report places priority on “improving the skills of workers” (p. xiii), noting that permanent migrants arrive younger and better skilled thus make “a higher economic and fiscal contribution during their time in Australia” (p. 22).

We use three examples from the care industry to explain how matching the supply of TVET-trained migrants for existing and emerging employment in Australia can make a significant contribution to the economy and welfare of natives.

Aged care and the National Disability Insurance Schemes (NDIS) are two of the largest service industries, and those projected to create the most employment until the middle of this century. Both these sectors require skilled workers, the majority of whom provide personalised and es-

sential care to a vulnerable segment of society that is neither routine nor offshoreable. Aged care as of 2016 employed 366,000 workers, 68,000 volunteers, and another 28,000 unpaid helpers (Pagone et al. 2021, 63). The sector is estimated to account for 3 percent of the Australian workforce, with the challenge of the future being able to “attract and retain a skilled workforce from a relatively smaller working population” (p. 24). The projections are that aged care will need an additional 80,000 workers by 2030 and 180,000 by 2050 (p. 42). Similarly, the NDIS was anticipated to create 162,000 full-time equivalent positions by 2019–2020 when the scheme was to come into full operation (NDIS 2015, 19). While the implementation of the NDIS has been delayed, the growth in workforce requirement is projected to accelerate until 2030 before stabilising at the rate of population growth (Pagone et al. 2021, 107).

Further, the participation of women in the workforce rests on access to affordable childcare, another non-offshoreable and non-routine service in which appropriately skilled migrants can make a significant contribution. The demand for vocationally-skilled workers within the care sector as a whole is likely to increase in line with the ageing of the population, the expansion of access to the NDIS, and increases in participation of women in the workforce. The costs within the care sector are largely driven by wage costs, which in turn are dependent on supply of appropriately skilled workers.

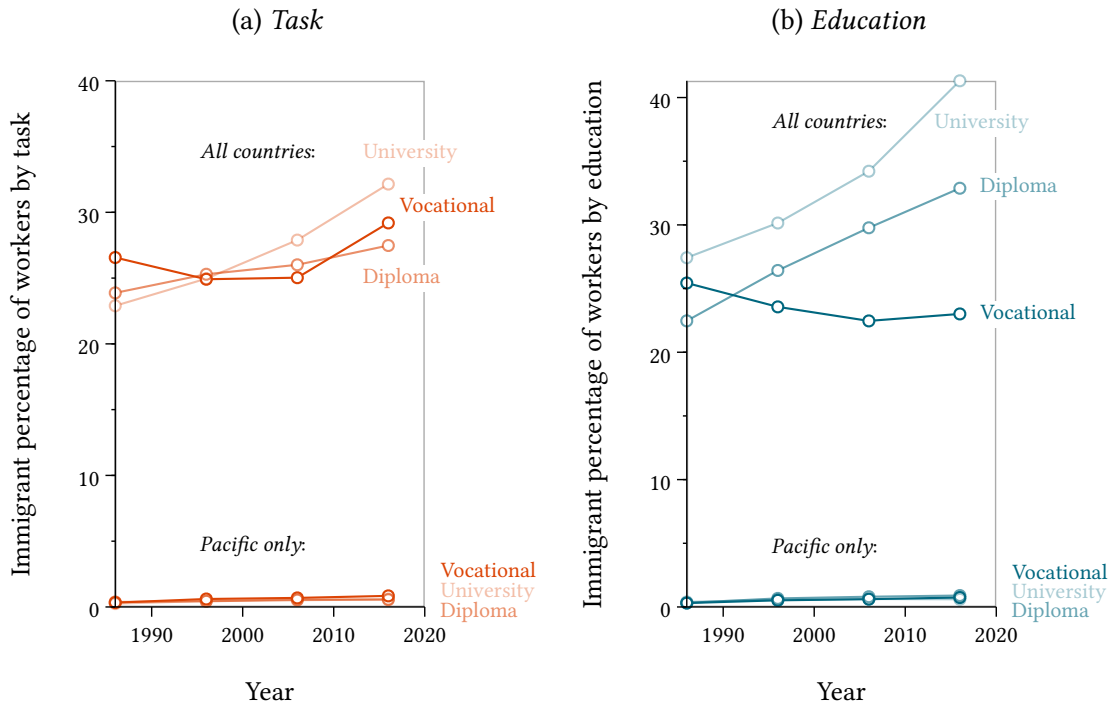
It is unlikely that the supply of a sustainable skilled workforce for aged care and the NDIS will be satisfied locally. Permanent migrants have traditionally filled long-term needs of the economy (Ongley and Pearson 1995) while temporary migrants have met transient need for skills such as those for seasonal agricultural workers (Fels et al. 2019).

6 Supply of vocationally skilled labour in the Pacific

Managed migration to fill these gaps could, in the abstract, come from anywhere. But perhaps the largest opportunity for mutually beneficial managed migration in the decades to come exists in the Pacific Islands. This region has provided agricultural workers to meet seasonal demand, and the same could apply for vocationally-skilled workers more broadly.

To date, however, employment immigration from the Pacific to Australia has been extremely

Figure 6: Immigrant fractions by task and education



Source: Tabulations from full-count census data provided by Australian Bureau of Statistics. “Pacific island countries” are all island member states of the Pacific Island Forum.

low. Figure 6a shows the fraction of the Australian workforce by task composed of immigrants from all countries, comparing it with the fraction from Pacific Island countries. Figure 6b shows the same breakdown by level of education. Broadly speaking, almost none of the work-based immigration to Australia has come from the Pacific, at any level of work. And even the scant work-based immigration from the region has been heavily dominated by workers from Polynesia rather than Melanesia, where the great supply will exist.

A similarly sharp skew against the Pacific region exists in temporary work visas. The microstate visa and Pacific Labour Scheme remain small, and the Seasonal Worker Program is not focused on building vocational skills (Brickenstein 2015). As of June 2020 the Pacific Labour Scheme listed just 984 workers present in Australia.

This highlights a major opportunity. Demand for vocational occupations will rise greatly in

Australia in the decades to come, particularly in ‘fundamental’ occupations. At the same time, the supply of natives with training appropriate for those jobs will shrink. The Pacific has sharply rising stocks of workers who are at or near the appropriate level of training, human capital that has gone largely untapped by Australia’s skill-focused immigration policy to date. A strategy of focusing on the Pacific to prepare and hire many of those workers could spur economic growth and the creation of additional higher-order employment in Australia, help offset the effects of demographic change, and serve Australia’s foreign policy goals in the region.

Regional preferences go against the political pressure for nondiscriminatory immigration policy that has sought to place all foreign countries on equal footing as a reaction to the legacy of the White Australia Policy (Rivett 1988, 276). That reaction to the burdens of history is understandable. But we note several reasons why the active facilitation of vocationally-skilled labour mobility *from the Pacific region* could serve Australia’s interests.

6.1 Why the Pacific?

The Pacific Islands are particularly suited to meet Australian demand for workers with vocational skills for five reasons that we detail below: (i) their physical and cultural proximity to Australia; (ii) the rising supply of skill in the Islands’ workforce; (iii) the opportunities for Australia to further upskill the requisite workforce at source; (iv) the potential for circulation of skilled workers between Australia and the islands; and (v) the potential for regional labour mobility to complement Australia’s foreign policy, commercial policy, and geopolitical objectives in the region.

Physical and cultural proximity: The suspension of international travel during the COVID-19 pandemic saw a sharp decline in labour supply to Australian agriculture, with Working Holiday Maker visas collapsing by an order of magnitude from 2019 to 2020 (ABARES 2021). Some of the worker shortages were filled from the Pacific Islands, due to their physical proximity to Australia and the ready pool of workers available there. This was a period when Australian farmers resorted to the use of chartered flights with specialised quarantine facilities to bring in workers from the neighbouring Pacific islands to harvest and tender crops, securing supplies of food for the public (see ABC News). Cultural connectedness to Australia is just as important, with Pacific

Figure 7: Projected supply of workers by education level, Australia and Pacific



Source: Forecasts by [Lutz et al. \(2018\)](#). “Pacific island countries” are: Papua New Guinea, Solomon Islands, Fiji, French Polynesia, Kiribati, Guam, New Caledonia, Vanuatu, Micronesia, Tonga, and Samoa.

islanders having close trading and sporting links that extend for more than a century.

The shortage of workers during COVID lockdowns has highlighted the need for a reliable supply and a sustainable source for workers for the Australian economy rather than heavy reliance on working holiday makers from outside the Pacific ([Howe et al. 2019](#)). Access to a stable workforce, as evidenced by the regional Recognised Seasonal Employer (RSE) scheme of New Zealand, boosts labour productivity and raises income ([Gibson and Bailey 2021](#)) and in times of crisis becomes a safeguard of national security ([Cicccone 2020](#)). The circulation of workers between rural and remote regions, and in healthcare and social assistance where most jobs are projected to be created ([LMIP 2020](#)), could be critical to the survival of regional communities and services.

Rising skill prevalence in the region: As large as the worker shortages in [Table 2](#) may seem, the human capital to meet that demand will exist in the Pacific. [Figure 7](#) shows forecasts of the working-age population with secondary education in Australia and the Pacific region. The num-

ber of working-age people with secondary education in the Pacific island countries will rise by over four million by 2050. Workers with completed secondary education would either already have the skills needed to perform many of the new vocational tasks that will be demanded in Australia, or could acquire those skills in a relatively short training program such as the Certificate III programs offered by the Australia-Pacific Training Coalition.

The overall supply of workers from the Pacific islands and Timor-Leste is projected to increase by 88 percent, or to a total of 12.2 million workers, by 2050 (Gibson and Bailey 2021); and Papua New Guinea alone is estimated to contribute an additional 4.4 million people of working age by then (ibid; 25). The potential gains to the Pacific islands are just as significant: in employment, and development more generally. Youth unemployment is high and rising within the Pacific islands that lack access to foreign employment (Duncan et al. 2006), while evidence regarding potential gains to welfare from participation in temporary migration schemes in the Pacific is well established (Gibson and McKenzie 2014).

Opportunities for upskilling: Australia has institutions in place within the Pacific islands to up-skill workers for local employment. The Australia Pacific Training College (APTC) which has campuses in six island nations was created specifically with the objective of providing Australian qualifications for foreign employment. The APTC subsequently formed a Coalition with local (i.e. Pacific island) TVET providers to offer Australian qualifications, with a view to expanding access to the qualifications on offer while reducing costs of delivery. The APTC operationalises the concept of the Global Skills Partnership (Clemens, 2015), providing the opportunity to deliver the triple gains foreshadowed within the GSP. The proximity of the Pacific islands to Australia together with the close economic and cultural links provide the opportunity to harness a ready source of a transient workforce for the future.

Opportunities for circular migration: Finally, the Pacific islands offer an opportunity for circulation of workers between Australia, New Zealand, and the neighbouring islands. The large wage gaps between the Pacific islands and Australia provide the economic incentives for international mobility (Howe et al. 2019), with the potential for work experience abroad sufficient to secure long-term employment at home and income for retirement. Workers from the Pacific have experience in subsistence agriculture and hospitality, thus are familiar with the seasonal

nature and manual demands of both these industries. They can also pick up skills from being formally employed in a commercial operation requiring accredited qualifications—those that may be gained through a combination of TVET and on-the-job experience. Many of the islands lack the scale to offer the requisite work experience for TVET graduates, a void that could be filled through temporary work experience abroad. Proximity to Australia together with family links at home means that Pacific islanders are likely to return home. Indeed, [Gibson and McKenzie \(2011\)](#) provide evidence of the ‘best and the brightest’ from the islands having a high propensity to return home after having worked for short periods abroad—a fact largely attributed to the cultural connectedness to the kin left behind.

Complementing Australia’s other regional objectives: Greater and more beneficial regional labour mobility is consistent with the Australian Government’s policy of a ‘Pacific Step-up’ that aims to strengthen the people-to-people links with the aim of greater strategic security, economic stability, and political sovereignty for regional governments. The Australian government has acknowledged the long-standing and enduring nature of its relationship with the Pacific islands, and has set the goal of “promoting economic cooperation and greater integration within the Pacific and also with the Australian and New Zealand economies, including through labour mobility” ([DFAT 2017](#), 99).

In other words, labour mobility within the region serves Australia’s development, foreign policy, public diplomacy, and trade objectives (*cf.* [Barker 2010](#)). It is a high-impact form of overseas assistance. “The A\$99.4 million in net income that Tonga has gained through the [Seasonal Worker] programme since its inception,” notes the [World Bank \(2018, xi\)](#), “is more than double the annual bilateral aid budget from the Australian Government”. Migration for vocationally-skilled work generates important knowledge transfer to Pacific countries of origin, such as technologies to improve horticultural yields ([Dun et al. 2018](#)). Beyond creating overall employment in the region, labour mobility especially creates formal employment where it is extremely scarce. Just 16 percent of the labour force of Papua New Guinea holds a formal sector job ([ILO 2017, 4](#)).

Finally, regional labour mobility strengthens Australia’s geopolitical interests in the Pacific in a historical era of growing influence by China ([White 2011](#); [Beeson 2017](#)). Enhanced labour mobility has long been a priority for regional governments (e.g. [PIF 2006, 2](#)), but de-facto expan-

sion of access to the Australian labour market remains highly limited, especially for Melanesia. The Australia-Pacific Training Coalition, for example, though created expressly to extend labour market access to the region, according to the [World Bank \(2017, 37\)](#) “has failed to deliver on its labor-mobility mandate”. All of the motives underlying Australia’s New Comprehensive Strategic and Economic Partnership with Papua New Guinea, announced in 2019, are well served by enhanced labour market access.

7 Conclusion

The evidence we have discussed yields two broad lessons. The first is that a policy to actively recruit workers with less than college education is in the medium-term economic interest of native Australian workers. The exact level of that migration cannot be forecast with precision. But there is strong evidence that roughly half of the Australian employment share for less-than-college workers will be *fundamental workers*, resistant to ongoing trends of automation and offshoring.

For Australian native workers, the likely alternative to a national policy for recruiting vocationally-skilled labour will be either reduced economic welfare or occupational downgrading. Australia’s increased focus on the admission of highly trained immigrants in the 1990s did not affect indicators of the usage of their training in the Longitudinal Survey of Immigrants to Australia ([Tani 2020](#)). A shift in immigration policy toward actively seeking vocationally-skilled labour is needed as the economy recovers from the 2020 contraction and will be more acutely needed in the decades to follow.

In principle the labour to supply the rising demand for vocationally-skilled workers could come from anywhere on earth. But the second lesson of this analysis is that a substantial portion of it could and should come from the Pacific region. Education levels in the region have been rising sharply and the supply of high-school-educated workers in the region is far more than sufficient to supply any realistic share of Australia’s demand for foreign vocationally-skilled workers. Beyond this, developing pathways for those workers from the Pacific will serve Australia’s self-interested development policy, trade policy, public diplomacy, and geopolitical interests in

the region. Current initiatives such as the Pacific Labour Facility and Australia-Pacific Training Coalition, while precisely the seed of such pathways that is needed, remain extremely limited in magnitude. [Chand et al. \(2021\)](#) propose one regional mobility scheme—the ‘Pacific Skills Visa’—that could contribute to realising these gains.

References

- ABARES**, *Snapshot of Australian Agriculture 2021*, Canberra: Dept. of Agriculture, Water, and the Environment, 2021.
- AboElsoud, Mostafa E, Anas AlQudah, and Eman Elish**, “Does a change in immigration affect the unemployment rate in host countries? Evidence from Australia,” *Journal of Applied Economics*, 2020, 23 (1), 21–43.
- Acemoglu, Daron and David H Autor**, “Skills, tasks and technologies: Implications for employment and earnings,” in Orley C. Ashenfelter and David Card, eds., *Handbook of Labor Economics*, Vol. 4B, Amsterdam: Elsevier, 2011, pp. 1043–1171.
- Allen, R G D**, *Mathematical Analysis for Economists*, London: Macmillan and Co., 1938.
- Anderson, Richard K and John R Moroney**, “Morishima elasticities of substitution with nested production functions,” *Economics Letters*, 1993, 42 (2-3), 159–166.
- Autor, David H. and David Dorn**, “The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market,” *American Economic Review*, August 2013, 103 (5), 1553–97.
- Autor, David H, Frank Levy, and Richard J Murnane**, “The skill content of recent technological change: An empirical exploration,” *Quarterly Journal of Economics*, 2003, 118 (4), 1279–1333.
- Bárány, Zsófia L and Christian Siegel**, “Job polarization and structural change,” *American Economic Journal: Macroeconomics*, 2018, 10 (1), 57–89.
- Barker, Fiona**, “Maximizing the migration policy buck: Uniting temporary labor, development and foreign policy goals in New Zealand,” *Policy and Society*, 2010, 29 (4), 321–331.
- Basso, Gaetano, Giovanni Peri, and Ahmed Rahman**, “Computerization and Immigration: Theory and Evidence from the United States,” Working Paper 23935, National Bureau of Economic Research October 2017.
- Beeson, Mark**, “Alternative realities: Explaining security in the Asia-Pacific,” *Review of International Studies*, 2017, 43 (3), 516–533.
- Blau, Francine D and Christopher Mackie, eds.** *The Economic and Fiscal Consequences of Immigration*, Washington, DC: National Academies Press, 2017.
- Blinder, Alan S and Alan B Krueger**, “Alternative Measures of Offshorability: A Survey Approach,” *Journal of Labor Economics*, 2013, 31 (S1), S97–S128.
- Breunig, Robert, Nathan Deutscher, and Hang Thi To**, “The Relationship between Immigration to Australia and the Labour Market Outcomes of Australian-Born Workers,” *Economic Record*, 2017, 93 (301), 255–276.
- Brickenstein, Christine**, “Impact assessment of seasonal labor migration in Australia and New Zealand:

- [A win-win situation?](#),” *Asian and Pacific Migration Journal*, 2015, 24 (1), 107–129.
- Chand, Satish, Michael A. Clemens, and Helen Dempster**, “A Pacific Skills Visa: Improving Opportunities for Skilled Migration Throughout the Pacific Region,” CGD Policy Paper. Washington, DC: Center for Global Development 2021.
- Cicccone, Raff**, “[Agriculture: the new national security frontier](#),” in Genevieve Feely and Peter Jennings, eds., *After Covid-19: Voices from Federal Parliament*, Vol. 3, Canberra: Australian Strategic Policy Institute, 2020, p. 59.
- Coelli, Michael and Jeff Borland**, “[Job polarisation and earnings inequality in Australia](#),” *Economic Record*, 2016, 92 (296), 1–27.
- Cohen, Daniel and Marcelo Soto**, “[Growth and human capital: good data, good results](#),” *Journal of economic growth*, 2007, 12 (1), 51–76.
- Colas, Mark and Dominik Sachs**, “[The Indirect Fiscal Benefits of Low-Skilled Immigration](#),” CEPR Discussion Paper 15325. London: Centre for Economic Policy Research 2020.
- Commonwealth of Australia**, *2015 Intergenerational Report: Australia in 2055*, Canberra: Commonwealth of Australia, 2015.
- , *2021 Intergenerational Report*, Canberra: Commonwealth of Australia, 2021.
- Cortés, Patricia and Jessica Pan**, “[Outsourcing household production: Foreign domestic workers and native labor supply in Hong Kong](#),” *Journal of Labor Economics*, 2013, 31 (2), 327–371.
- and **José Tessada**, “[Low-skilled immigration and the labor supply of highly skilled women](#),” *American Economic Journal: Applied Economics*, 2011, 3 (3), 88–123.
- Crown, Daniel, Alessandra Faggian, and Jonathan Corcoran**, “[High skilled immigration and the occupational choices of native workers: the case of Australia](#),” *Oxford Economic Papers*, 05 2020, 72 (3), 585–605.
- DFAT**, “[2017 Foreign Policy White Paper](#),” Dept. of Foreign Affairs and Trade. Canberra: Australian Government 2017.
- Dun, Olivia, Natascha Klocker, and Lesley Head**, “[Recognising knowledge transfers in ‘unskilled’ and ‘low-skilled’ international migration: Insights from Pacific Island seasonal workers in rural Australia](#),” *Asia Pacific Viewpoint*, 2018, 59 (3), 276–292.
- Duncan, Ron, Heather Booth, Guangyu Zhang, Maheshwar Rao, Fakavae Taomia et al.**, “The Young and the Restless: Population Pressures in the Pacific,” in “Pacific Islands At Home and Away: Expanding Job Opportunities for Pacific Islanders Through Labour Mobility,” The World Bank, 2006.
- Dustmann, Christian, Uta Schönberg, and Jan Stuhler**, “[The impact of immigration: Why do studies reach such different results?](#),” *Journal of Economic Perspectives*, 2016, 30 (4), 31–56.
- Fels, Allan et al.**, *Report of the Migrant Workers Task Force*, Canberra: Government of Australia, 2019.
- Foged, Mette and Giovanni Peri**, “[Immigrants’ effect on native workers: New analysis on longitudinal data](#),” *American Economic Journal: Applied Economics*, 2016, 8 (2), 1–34.
- Freebairn, John W**, “[Microeconomics of the Australian labour market](#),” in Guy Debelle and Jeff Borland, eds., *Unemployment and the Australian Labour Market*, Canberra: Reserve Bank of Australia and Australian National University, 1998, pp. 110–133.
- Frieling, Julius and Reinhard Madlener**, “[Estimation of substitution elasticities in three-factor production functions: Identifying the role of energy](#),” FCN Working Paper, Institute for Future Energy Consumer Needs and Behavior, Aachen University 2016.

- Gibson, John and David McKenzie**, “The microeconomic determinants of emigration and return migration of the best and brightest: Evidence from the Pacific,” *Journal of Development Economics*, 2011, 95 (1), 18–29.
- **and —**, “The development impact of a best practice seasonal worker policy,” *Review of Economics and Statistics*, 2014, 96 (2), 229–243.
- **and Rochelle-Lee Bailey**, “[Seasonal Labor Mobility in the Pacific: Past Impacts, Future Prospects](#),” *Asian Development Review*, 2021, 38 (1), 1–31.
- Goos, Maarten, Alan Manning, and Anna Salomons**, “[Explaining Job Polarization: Routine-Biased Technological Change and Offshoring](#),” *American Economic Review*, August 2014, 104 (8), 2509–26.
- Hamermesh, Daniel S**, “[The demand for labor in the long run](#),” *Handbook of Labor Economics*, 1986, 1, 429–471.
- Hardy, Wojciech, Roma Keister, and Piotr Lewandowski**, “[Educational upgrading, structural change and the task composition of jobs in Europe](#),” *Economics of Transition*, 2018, 26 (2), 201–231.
- Hicks, J R**, *The Theory of Wages*, London: Macmillan and Co., 1932.
- Howe, Joanna, Stephen Clibborn, Alexander Reilly, Diane van den Broek, and Chris F Wright**, “Towards a durable future: Tackling labour challenges in the Australian horticulture industry,” *University of Adelaide and University of Sydney*, 2019.
- ILO**, *A study on the future of work in the Pacific*, Suva: International Labour Organization Office for Pacific Island Countries, 2017.
- Jerzmanowski, Michal and Robert Tamura**, “[Aggregate Elasticity of Substitution between Skills: Estimates from a Macroeconomic Approach](#),” MPRA Paper No. 100768 2020.
- Jones, Charles I**, “[The shape of production functions and the direction of technical change](#),” *Quarterly Journal of Economics*, 2005, 120 (2), 517–549.
- Katz, Lawrence F. and Kevin M. Murphy**, “[Changes in Relative Wages, 1963-1987: Supply and Demand Factors](#),” *The Quarterly Journal of Economics*, 1992, 107 (1), 35–78.
- LMIP**, “[2020 Employment Projections: for the five years to November 2025](#),” Labour Market Information Portal, Government of Australia 2020.
- Lutz, Wolfgang, Anne Goujon, Samir Kc, Marcin Stonawski, and Nikolaos Stilianakis**, *Demographic and human capital scenarios for the 21st century: 2018 assessment for 201 countries*, Publications Office of the European Union, 2018.
- Manning, Alan et al.**, *EEA migration in the UK: Final report*, London: Migration Advisory Committee, 2018.
- Morishima, Michio**, “A few suggestions on the theory of elasticity,” *Keizai Hyoron (Economic Review)*, 1967, 16, 144–150.
- NDIS**, *Integrated Market, Sector and Workforce Strategy*, Canberra: Australian Government Dept. of Social Services, National Disability Insurance Scheme, 2015.
- Ongley, Patrick and David Pearson**, “[Post-1945 International Migration: New Zealand, Australia and Canada Compared](#),” *International Migration Review*, 1995, 29 (3), 765–793.
- Pagone, GT et al.**, *Final Report: Care, Dignity, and Respect*, Vol. 1, Canberra: Royal Commission into Aged Care Quality and Safety, 2021.
- Peri, Giovanni and Chad Sparber**, “[Task specialization, immigration, and wages](#),” *American Economic*

- Journal: Applied Economics*, 2009, 1 (3), 135–69.
- PIF**, *Thirty Seventh Pacific Islands Forum Communiqué, 24–25 October 2006*, Nadi, Fiji: PIF Secretariat, 2006.
- Pope, David and Glenn Withers**, “Do migrants rob jobs? Lessons of Australian history, 1861-1991,” *Journal of Economic History*, 1993, pp. 719–742.
- Pritchett, Lant**, *Let their people come: Breaking the gridlock on global labor mobility*, Washington, DC: Brookings Institution Press, 2006.
- Rivett, Kenneth**, “The New Case for Immigration,” *The Australian Quarterly*, 1988, 60 (3), 275–284.
- Stern, David I**, “Elasticities of substitution and complementarity,” *Journal of Productivity Analysis*, 2011, 36 (1), 79–89.
- Tani, Massimiliano**, “Migration Policy and Immigrants? Labor Market Performance,” *International Migration Review*, 2020, 54 (1), 35–57.
- Tinbergen, Jan**, “Substitution of Graduate by Other Labour,” *Kyklos*, 1974, 27 (2), 217–226.
- USCIR**, *Legal Immigration: Setting Priorities*, U.S. Commission on Immigration Reform, 1995.
- White, Hugh**, “Power shift: rethinking Australia’s place in the Asian century,” *Australian Journal of International Affairs*, 2011, 65 (1), 81–93.
- Wilkins, Roger and Mark Wooden**, “Two decades of change: the Australian labour market, 1993–2013,” *Australian Economic Review*, 2014, 47 (4), 417–431.
- World Bank**, *Pacific Possible: Long-term Economic Opportunities and Challenges for Pacific Island Countries*, Washington, DC: International Bank for Reconstruction and Development, 2017.
- , *Maximizing the development impacts from temporary migration: Recommendations for Australia’s seasonal worker program*, Washington, DC: International Bank for Reconstruction and Development, 2018.
- Wright, Chris F and Stephen Clibborn**, “Back door, side door, or front door: An emerging de-factor low-skilled immigration policy in Australia,” *Comparative Labor Law and Policy Journal*, 2017, 39, 165–188.
- , —, **Nicola Piper, and Nicole Cini**, *Economic migration and Australia in the 21st century*, Sydney: Lowy Institute, 2016.

Appendix: Data sources

Raw full-count census data from the Australian Bureau of Statistics (ABS) were provided as tabulations of the entire resident population by education, occupation, and country of birth. In the raw 2016 census data, occupations are coded using ANZSCO 1.3. These were translated into ISCO-08 using the official correspondence of the ABS. In the raw 2006 and 1996 census data, occupations are coded using ASCO 2nd edition. These were translated first into ANZSCO 1.0 and then into ANZSCO 1.3 using the official correspondences of the ABS. In the raw 1986 census data, occupations are coded in ASCO 1st edition. These were translated into ASCO 2nd edition using the official correspondence of the ABS, before proceeding as above to translate into ISCO-08 codes. In the few cases for each census year where an ASCO or ANZSCO occupation code in the raw census data corresponds to more than one ISCO-08 code, the individual's ISCO code is set to the one whose textual description string most closely matches the textual description string of his or her original ASCO/ANZSCO code.

The ISCO-08 code for each occupation is then assigned a value of the Routine Task Index ([Açemoğlu and Autor 2011](#); [Autor and Dorn 2013](#)) using the crosswalk coded by [Hardy et al. \(2018\)](#) and assigned a value of the offshorability index (survey based) by [Blinder and Krueger \(2013, S107\)](#). (The raw [Blinder and Krueger](#) index is reported as SOC codes, which are translated into ISCO codes using the correspondences of [Hardy et al. 2018](#)). An occupation is classified as 'complex' if the ASCO or ANZSCO classification system determines it to require a bachelor's degree or equivalent (first digit 1 or 2), as 'Diploma' level with first digit 3, and 'vocational' level with first digit 4–9, as recommended by ABS. Among all other occupations, those are classified as 'fundamental' that receive a score of 1 (not offshorable) in the survey-based indicator of [Blinder and Krueger \(2013\)](#) and fall below the 66.666th percentile of scores on the Routine Task Index (following [Autor and Dorn 2013](#)). An occupation is classified as 'replaceable' if it is neither complex nor fundamental.

Australian GDP is from: Organization for Economic Co-operation and Development, Constant Price Gross Domestic Product in Australia [AUSGDPRQDSMEI], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/AUSGDPRQDSMEI>, June 15, 2020. Annual mean of quarterly series. Australian population in 1986, 1996, 2006, and 2016 is from: Australian Bureau of Statistics, series A2133251W, "Total resident population of Australia at midyear".

United Kingdom wages by qualification level: From public Freedom of Information request Reference number 008042: "[The mean and median gross weekly and gross hourly earnings measured by highest education qualification](#)", Release date February 6, 2018, data from Annual Population Survey covering October 2016 to September 2017, weekly gross earnings converted to annual assuming 50 work-weeks per year.