

Digitalisation and Women's Workforce Participation in the Indo-Pacific

Timothy Watson, Acting Director, Women's Economic Security, Office for Women, Department of the Prime Minister and Cabinet; Crawford School of Public Policy, Australian National University

Michael Corliss, Research Associate, Centre for Labour Market Research

Michelle Le, Research School of Economics, Australian National University

Abstract

Between 2000 and 2016 the gap between women and men's workforce participation in the Indo-Pacific has narrowed, while indicators of digital connectivity and Internet use have grown rapidly. We find a robust and statistically significant correlation between Internet use and women's workforce participation controlling for country fixed effects, a time trend, and numerous other controls. The most conservative estimate suggests that, on average, growth in Internet use has been associated with around four-fifths of the increase in women's participation in the Indo-Pacific between 2000 and 2016. Instrumental variables estimation finds a stronger positive association between women's workforce participation and exogenously determined Internet use. Despite finding a positive association between Internet use and women's participation, a number of barriers exist that are preventing women from fully sharing in the benefits of the digital economy. Based on findings from the G20 Taskforce on Digitalisation, we consider a range of measures that policymakers in the Indo-Pacific can pursue to address these barriers.

Keywords: labour economics; gender; technological change

Corresponding author

Timothy Watson, timothy.watson@anu.edu.au, Acting Director, Women's Economic Security, Office for Women, Department of the Prime Minister and Cabinet; Crawford School of Public Policy, Australian National University

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1. Introduction

The digital economy is expanding rapidly in the Indo-Pacific, helping boost growth and expand economic opportunities at a time of otherwise disappointing global productivity growth. In low and middle-income countries digital platforms are helping micro-businesses access new, in some cases global, markets and supplement traditional sources of income (Vial and Hanoteau, 2015). The rapid increase in mobile phone availability and use in the region has helped reduce the costs of obtaining information and other transaction costs, lowered the costs of money transfer and financial services, improved access to credit, and helped women to coordinate their work and family lives (Jacobsen, 2011). In both developed and developing economies, automation and skill-biased technological change have increased the demand for 'brains' relative to 'brawn' which has helped women close participation and pay gaps (see World Bank, 2012; and Black and Spitz-Oener, 2010). While in developed economies the Internet has increased women's workforce participation through supporting teleworking and flexible work arrangements, and reduced the time spent undertaking household labour (Dettling, 2017).

Despite this potential, concerns have been raised that the benefits of digitalisation are not being shared equally by women; that women face higher barriers to participation in the digital economy compared to men; and that digitisation may see a reduction in job quality for women. For instance, Martinez and Nguyen (2014) observe that a lack of digital skills; lower access to finance and purchasing power; and a range of cultural and normative barriers are preventing women in Asia from gaining the full benefits of the digital revolution.

This paper seeks to address two questions. First, what is the relationship between women's workforce participation and the digital economy in the Indo-Pacific since the turn of the century focusing on Internet usage as an indicator of digital activity? Second, based on early insights gained from the work of the G20 Taskforce on Digitalisation on bridging the digital gender divide, what policies can countries in the Indo-Pacific prioritise to ensure that women can fully share in all the benefits the digital economy has to offer?

For the purposes of our analysis the Indo-Pacific countries include all countries in Asia, Oceania and the Pacific coast of the Americas where relevant data is available. Without providing an exhaustive list, these cover a diverse range of countries including: The United States and Canada in North America; Mexico in Central America; Chile and Nicaragua in South America; Saudi Arabia, Turkey and Jordan in the Middle-East; countries such as Russia, Georgia and Azerbaijan in Central and West Asia; China and Japan in East Asia; India, Pakistan and Sri Lanka in South Asia; Southeast Asian countries such as Indonesia, Cambodia and Myanmar; and Australia, Papua New Guinea and New Zealand in Oceania.

We find a robust and statistically significant correlation between Internet use and women's workforce participation in the Indo-Pacific controlling for country and time fixed effects, and numerous other controls identified in the literature. The most conservative estimate suggests that growth in Internet use has been associated with around four-fifths of the increase in women's workforce participation in the Indo-Pacific between 2000 and 2016. Instrumental variables estimation finds support

for a stronger positive association between exogenously determined Internet use and women's participation for the 2008-2014 period, and indirectly points to the importance of the free flow of information online for women's workforce participation in the region. Although we find a positive and significant relationship between Internet use and women's workforce participation, there remain a number of barriers, both globally and in the region, that are preventing women from fully sharing in the benefits of the digital economy. Drawing on work of the G20 Taskforce on Digitalisation, we discuss a range of measures that policy makers in the Indo-Pacific can consider to address these barriers.

2. Literature review

Despite the rapid and ubiquitous digital transformation of the global economy over the past generation, surprisingly few studies have assessed the consequences of digitalisation for labour market outcomes, and especially for women and in developing economies. This is perhaps especially surprising given the predictions of Frey and Osborne (2017) that 'computerisation' will result in significant job losses. Results concerning the impact of digitalisation on job search have been somewhat mixed with Stevenson (2009) and Kuhn and Mansour (2014) finding that Internet job search reduces unemployment duration; Kuhn and Skuterad (2004) finding the opposite result; and Kroft and Pope (2014) finding no relationship. Atasoy (2013) has found a positive relationship between broadband penetration and employment rates in the United States.

Over the past generation digital technologies have had a transformative impact on the organisation of economic activity, increasing the demand and returns for cognitive and non-routine skills relative to manual and routine skills (World Bank, 2012). There is some evidence that this has been more beneficial to women relative to men. For example, Black and Spitz-Oener (2010) found that women had experienced an increase in non-routine analytical and interactive tasks relative to men as a consequence of digitisation and automation in West Germany between 1979 and 1999. These tasks were associated with higher skill levels, and therefore higher remuneration levels, which helped to reduce the gender pay gap.

Dettling (2017) has found high-speed Internet use contributed to a 4.1 percentage point increase in workforce participation for married women in the United States between 2000 and 2009, with no benefits for single women or men.¹ Among married women, college educated women with children experienced the greatest benefits. Using the Internet to telework and saving time in home production were the two key drivers of increased participation.

From a methodological perspective, Dettling (2017) estimates a reduced form labour supply relationship with women's workforce participation as the dependent variable; high-speed Internet connections as the key explanatory variable which is also instrumented for using the proportion of multi-dimensional dwellings in the state; time and state fixed effects; and a range of control variables including state

1 High-speed Internet use was also found to cause married women to work an additional four hours per week, and increase full-time employment by 3.7 percentage points for married women relative to single women and men. High-speed Internet use is also found to increase married women's employment by 3 percentage points.

level income per capita, wages, population density, housing prices, unemployment and various measures of Internet-intensive business activity.

This paper is also related to studies that have focused on the implications of technological change, and improvements in labour saving household technologies in particular, for women's workforce participation (see Greenwood, Seshadri, and Yorukoglu, 2005; and Cavalcanti and Tavares, 2008). Cavalcanti and Tavares (2008) for instance argue that the decline in relative prices of home appliances in the United Kingdom between 1975 and 1999 accounted for about 10 to 15 per cent of the increase in women's workforce participation over this period using ordinary least squares estimation, increasing to 33 to 55 per cent under instrumental variables estimation. They estimate a panel model of women's workforce participation for OECD countries regressing women's workforce participation on an index of relative price change of household appliances with respect to the consumer price index; country dummies; a common time trend; government spending as a proportion of GDP; the urban population; GDP growth; and a measure of GDP per head of male population. Following Blau (1998), urban population is used as an instrument for fertility rates. To test for exogeneity the authors use the manufacturing price index and the terms of trade as instruments for the relative price decline in household appliances, and find evidence of a causal relationship between the relative decline in prices of labour saving household technologies and women's workforce participation.

This paper is also situated in a broader literature concerning the determinants of women's workforce participation. Goldin (1995) showed that women's workforce participation tends to fall as countries move from low to middle-income status, however tends to rise again as countries move from middle to high-income status as the opportunity costs of women remaining out of the labour force rise. When country income levels are low and the agricultural share of production is high, poverty and necessity are the primary drivers of high female workforce participation rates.

As countries transition to middle-income status, greater economic prosperity provides women with more choices concerning work, and some may choose to withdraw due to the income and status effect (ILO, 2014). The transition from subsistence agriculture into manufacturing activity is also typically associated with increased use of capital-intensive technologies, which are often more complementary to male rather than female labour (Olivetti, 2013).

Moving from middle to high-income status, women's workforce participation tends to rise again when women's education levels improve, and the opportunity cost of women's time in market sector employment rises. Some countries within the Indo-Pacific display within-country U-shaped relationships between incomes and women's participation. For example, women's workforce participation has remained relatively flat in Indonesia between 2000 and 2016. Schaner and Das (2016) attribute this to rising educational attainment and wage employment in urban Indonesia offsetting declines in workforce participation in rural Indonesia as women opt out of unpaid, informal employment.

Looking at the OECD economies, Jaumotte (2003) finds that cultural beliefs and attitudes, education, labour market conditions, and tax and transfer policies can all influence the level of women's workforce participation. More recently Thevenon

(2013) again highlights the contribution of educational attainment, declining fertility rates, cyclical labour market conditions, growth in services employment, and increases in part-time employment as key contributors to the increase in women's workforce participation in OECD countries, with no relationship found between government employment and women's participation. Tax, transfer, parenting leave and childcare policies are all found to have a positive relationship with women's participation. This analysis is based on a panel model of labour force participation in OECD countries featuring a range of policy measures, country and time dummies, and a range of control variables that are likely to influence women's participation including fertility rates, average years of educational attainment, services and government employment shares, unemployment, incidence of part-time employment, and GDP growth.

ADB (2015) highlight the importance of increasing educational attainment, declining fertility rates, and changing cultural norms for recent increases in women's workforce participation in the Asia-Pacific. They observe that women's workforce participation tends to be higher in countries with larger agricultural and services sectors, and women's ability to participate in the labour market can be impaired by unequal access to technology, credit and land. Dasgupta *et al.* (2015) find that women in China are more likely to be employed in the agricultural and services sector, and that declining women's workforce participation in recent years has been driven by young women spending longer in education, and more women withdrawing from the labour force during child-bearing age.

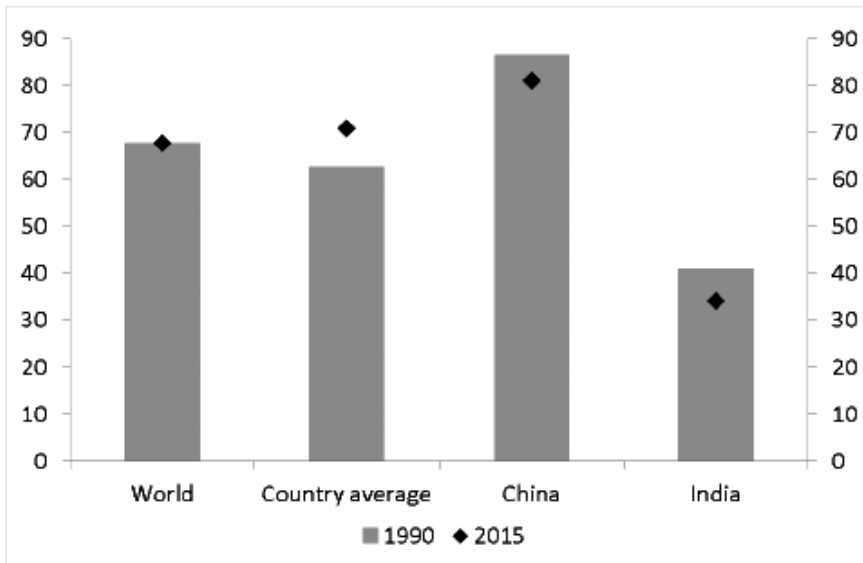
Contreras and Plaza (2010) find cultural factors and education are key determinants of women's workforce participation in Chile, while Srivastava and Srivastava (2010) suggest similar drivers of women's workforce participation in rural India. Klasen and Pieters (2013) suggest rising household incomes, husbands' educational attainment and demand-side factors were responsible for declining women's workforce participation in urban India between 1987 and 2009. Blau (1998) attributes the 23 percentage point increase in women's workforce participation in the United States between 1970 and 1995 to the positive substitution effect generated by increasing wives' real wages exceeding the income effect of rising husbands' real wages; increasing educational attainment and divorce rates; and declining fertility and marriage rates. Evans and Kelley (2004) identify rising educational attainment and declining fertility rates as key drivers of women's workforce participation in Australia in the 1980s and 1990s. Dayioğlu and Kirdar (2010) argue that urbanisation was a key factor behind the decline in women's workforce participation in Turkey between 1988 and 2010, with some offsetting gains attributable to rising educational attainment in urban areas and declining fertility rates.

However, it also remains the case that a substantial amount of the increase in women's workforce participation recently observed in many countries has not been explained by variables conventionally used in econometric analysis. Standard concerns about model uncertainty, omitted variables and endogeneity in undertaking cross-country empirical analysis using aggregate time-series data (see Durlauf, 2009; and Sims, 1980) suggest that results should be interpreted as indicative in nature. Indeed, this paper endeavors to undertake cross-country empirical analysis in the spirit of Durlauf (2009), as a 'tool for pattern recognition and construction of stylized facts.'

3. Women's workforce participation and digitisation in the Indo-Pacific: What does the data show?

The global female-male participation ratio has remained effectively steady for a quarter-of-a-century between 1990 and 2015 at just under 68 per cent (Chart 1). However, the average participation ratio across all countries actually increased by 8.4 percentage points over the same period. The main reason for this divergence is that the world's two most populace economies, India and China, both experienced declines in the participation ratio over this period. This reflects the fact that economic development is the primary driver of women's labour force participation, with women's participation following a U-shaped trajectory as countries move from low to high-income status (Goldin, 1995).

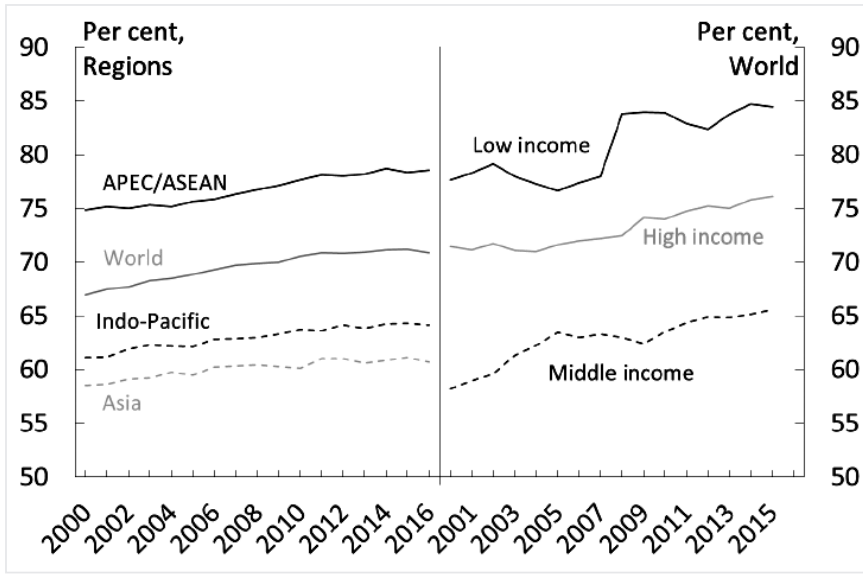
Chart 1: Female-male participation ratio, per cent



Source: World Bank

Between 2000 and 2015 most countries in the Indo-Pacific experienced an improvement in women's labour force participation relative to men (Chart 2). However, it remains the case that many countries in the Indo-Pacific region have very low levels of women's participation, and some experienced declining women's representation in the labour force relative to men. In most cases the decline in female-male participation ratios most likely reflects the development process; however, in the case of Syria, conflict and emigration clearly played a significant role.

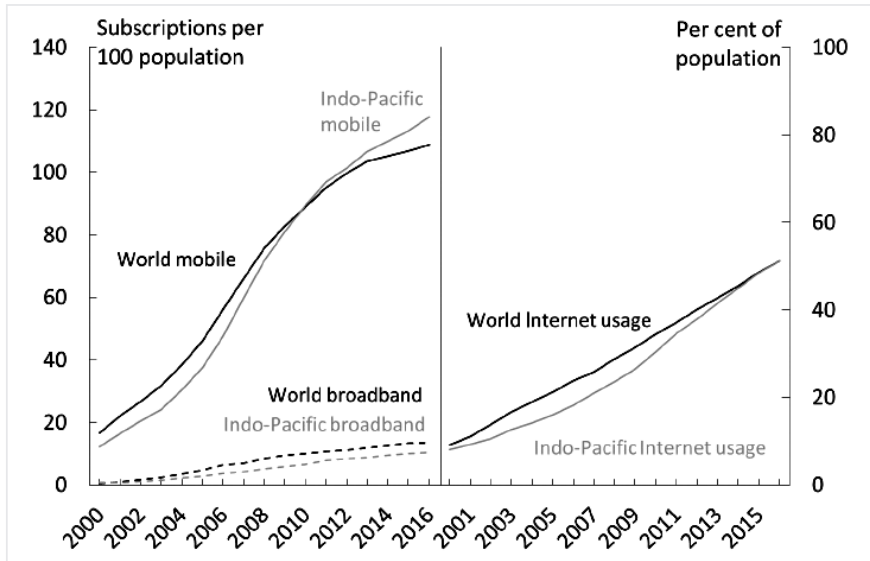
Chart 3: Female-male participation ratio by region and income, per cent



Source: World Bank

Chart 4 demonstrates that indicators of digital activity have also increased significantly between 2000 and 2016, both globally and in the Indo-Pacific. In recent years growth in mobile penetration in the Indo-Pacific has actually outpaced the global average, while broadband penetration rates have grown at a rate below the global average. In recent years the average level of Internet usage in the Indo-Pacific has caught up with the global average driven by the rapid growth in mobile penetration.

Chart 4: ICT connectivity by region



Source: International Telecommunications Union

4. Modelling framework

To obtain a more formal sense of the relationship between digitalisation and women's workforce participation in the Indo-Pacific, a reduced form labour supply relationship along the lines of that estimated in Dettling (2017) and Cavalcanti and Tavares (2008) was estimated for the region using panel regression techniques controlling for time and country fixed effects, and a selection of other correlates with women's workforce participation identified in the literature. The basic modelling specification is as follows:

$$WPR_{it} = \alpha + \beta_0 \cdot INTERNET_{it} + \beta_1 \cdot Z_{it} + \gamma_i + \delta_t + \varepsilon_{it} \quad (1)$$

WPR_{it} is the workforce participation rate for women aged over 15 years in country i in period t . $INTERNET_{it}$ is Internet use as a proportion of the population which acts as our indicator of digital activity. Z_{it} is a vector of additional control variables including GDP per capita; the urban population as an instrument for fertility rates; government spending as a proportion of GDP; and the agricultural share of the economy. The model specification also includes time and country dummy variables δ_t and γ_i to control for time and country specific fixed effects. The use of country dummies to model country specific fixed effects assumes that sources of time invariant heterogeneity between countries related to factors such as cultural norms, religious beliefs or legal systems may be correlated with explanatory variables used in the regression. All data used in estimation was sourced from the World Bank Development Indicators Database with the exception of Internet use data which is sourced from the International Telecommunications Union (Table 1).

Table 1: Descriptive statistics

<i>Description</i>	<i>Obs.</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Minimum</i>	<i>Maximum</i>
Women's workforce participation rate (per cent women's population 15+)	1,207	48.08	16.66	10.96	82.27
Internet usage (per cent of population)	1,100	26.70	25.79	0.00	98.00
GDP per capita (PPP, constant international dollars)	1,190	15,934.83	20,492.06	875.52	129,349.90
Urban population (per cent total population)	1,309	58.04	24.43	12.98	100.00
Government expenditure (per cent of GDP)	720	23.25	12.12	3.89	134.77
Agriculture share (per cent of GDP)	1,023	13.61	10.55	0.04	57.24

Sources: World Bank Development Indicators Database, International Telecommunications Union

Following Goldin (1995) GDP per capita in purchasing power parity terms is included in estimation to control for the influence of the general level of economic development between countries, and to reflect the fact that labour supply is expected to increase in response to rising income levels. Given that GDP can be decomposed into cyclical and structural components, including GDP per capita also helps control for cyclical factors that may influence women's workforce participation. Annual real GDP growth was also trialed as a potential control for business cycle dynamics; however, it was found to be insignificant in all model specifications, and was hence excluded from reported results. Unlike some previous studies we have not included unemployment as an explanatory variable because unemployed women are included in the women's workforce participation rate.

Following Blau (1998) and Cavalcanti and Tavares (2008) we include the urban population as an instrument for women's fertility. These studies argue that the prevalence of use of birth control and lower fertility rates are exogenously predicted by the proportion of the population living in urban areas. An instrument for fertility rates is included to control for the fact that lower fertility rates and dependency ratios are likely to be associated with higher levels of women's labour supply. The fertility rate is instrumented for because family planning decisions may be driven by a desire to work, and therefore there is potentially some reverse causality.

Government spending as a share of GDP was included as an additional control variable as suggested by Cavalcanti and Tavares (2008, 2016). Unfortunately detailed data concerning specific tax, transfer and social policies that might be expected to be positively associated with women's workforce participation (see Thévenon, 2013) are not broadly available for the Indo-Pacific region. However, higher government spending as a share of GDP may be used as an indicator of the presence of government policies that support women's education, child rearing and childcare, which are expected to be positively associated with increasing levels of women's workforce participation.

Agriculture's share of GDP is included as a control variable following the suggestion from Goldin (1995) and ADB (2015) that the least developed countries with high levels of subsistence agricultural activity are also expected to have high levels of women's workforce participation. Also following ADB (2015), models were estimated including the service sectors share of GDP as an additional control. A higher services share is also commonly associated with higher levels of women's participation because services industries can be viewed as more culturally appropriate for women in some societies, and are typically more conducive to part-time and flexible work arrangements that tend to enable higher levels of participation for people with caring responsibilities who are disproportionately female. However, the services share was insignificant in all model specifications, and therefore it has been excluded from reported results.²

The model was estimated using the Prais-Winsten technique with panel corrected standard errors (PCSEs). PCSEs are robust to contemporaneous correlation and heteroscedasticity between panels, and first order serial autocorrelation within panels making them ideal for estimation with a panel including aggregate time-series data.

5. Results

Table 1 reports regression results for all model specifications revealing a statistically significant and positive association between Internet use and women's workforce participation that is relatively stable between model specifications. Based on the range of parameter estimates reported in Table 1, the average 43.1 percentage point increase in Internet use in the Indo-Pacific between 2000 and 2016 is associated with between a 1.5 and 2.5 percentage point increase in the women's participation rate over the corresponding period. That is equivalent to between approximately 80 and 130 per cent of the increase in the women's participation rate between 2000 and 2016. While these estimates are large and highly significant, they sit comfortably within the estimate of the impact of broadband Internet on married women's workforce participation in the United States from Dettling (2017). Consistent with the findings of Cavalcanti and Tavares (2008), technological change, this time represented by increasing Internet usage, has the largest impact on women's workforce participation relative to the other control variables.

It is also important to note that there have been divergent influences on women's workforce participation over the period. The average decline in agriculture's share of production has been associated with reductions in women's workforce participation in the Indo-Pacific during the period. For example, the average decline in agriculture's share of production is associated with a decline in women's workforce participation of around 1.1 percentage points in the Indo-Pacific region between 2000 and 2016 based on equation 5 in Table 2.

² We did find a positive relationship between services' share of GDP and women's workforce participation using global data, and for high income countries in particular (not reported).

Table 2: Determinants of women's labour force participation in the Indo-Pacific (PCSE)

<i>Dependent variable: Women's workforce participation rate, 2000-2016</i>					
<i>Equation</i>	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>
Internet use	0.05*** (5.91)	0.06*** (5.96)	0.06*** (6.13)	0.04** (2.69)	0.04** (3.12)
GDP per capita		0.09*** (4.80)	0.09*** (4.92)	0.14*** (4.69)	0.18*** (5.17)
Urban population			0.11*** (3.18)	0.26** (2.73)	0.22*** (3.71)
Gov. exp. share				0.02** (2.35)	0.02** (2.61)
Ag. share					0.18*** (4.18)
Country dummies (p>F)	0.00	0.00	0.00	0.00	0.00
Time dummies (p>F)	0.00	0.00	0.00	0.01	0.00
N	1053	995	995	632	548
R ²	0.99	0.99	0.99	0.99	0.99
Wald test (p> χ^2)	0.00	0.00	0.00	0.00	0.00

Notes: * p<0.05; ** p<0.01; *** p<0.001. Constants are omitted from reported results. z statistics are in brackets. Wald tests are on the null of all parameters being equal to zero. GDP per capita enters the equation in thousands of constant international dollars. Dividing parameter estimates by a factor of 1,000 returns the relationship between GDP per capita in constant international dollar terms and women's workforce participation.

We find stronger empirical support for a linear relationship between GDP per capita and the women's workforce participation rate in the Indo-Pacific, rather than the U-shaped relationship predicted in the literature (see Goldin (1995) for instance).³ This is mostly driven by the fact that there is a lack of data availability for low-income countries in the region, and therefore the results largely reflect the relationship between GDP per capita and women's participation in middle and high-income countries in the region. That is, from the bottom to the top right hand corner of the U. We also include agriculture's share of GDP in some of our model specifications which may help explain some of the decline in women's workforce participation when countries move from low to middle-income status.

³ In results not reported we found evidence in favour of the quadratic relationship in models estimated using global data, including for high, middle and low-income sub samples.

A positive statistically and economically significant relationship is found between the urban population and women's workforce participation as anticipated. Depending on model specification, increasing urbanisation accounts for up to 60 per cent of the increase in women's workforce participation in the region between 2000 and 2016. Interpreting urbanisation as an instrument for fertility rates, this indicates an economically and statistically significant negative relationship between fertility rates and women's workforce participation as well.

A positive and statistically significant relationship was also found between government expenditure as a proportion of GDP and women's workforce participation. However, in economic terms the average contribution of government spending contributes less than one per cent of the increase in women's workforce participation in the region between 2000 and 2016.

6. Causality

So why might higher levels of Internet usage be positively associated with women's workforce participation? Since the turn of the century the Internet has enabled an increase in the pace of knowledge and technology transfer across borders, helping to drive increases in productivity. For example, the World Bank (2009) estimated that a 10 percentage point increase in Internet use is associated with a 0.77 percentage point increase in GDP growth in high income countries and a 1.12 percentage point increase in growth in low and middle-income countries. Between 2000 and 2016 Internet use increased by 43.1 percentage points on average in the Indo-Pacific. There is also some evidence suggesting that the productivity benefits of digitalisation and the Internet may be under-measured in national accounts. For example, Coyle and Mitra-Kahn (2017) find that mismeasurement of GDP growth related to fixed and mobile broadband data use could add up to 1.5 percentage points per annum to UK real GDP growth between 2010 and 2015. Increased output and productivity related to the Internet and digitisation, combined with changing social attitudes towards women in the workforce as reflected in our time fixed effects, should translate into increased demand for female workers, and higher women's workforce participation.

In developing countries digitalisation has helped expand the provision of financial services to under-served communities, helping to support women's entrepreneurship. Digital platforms such as Alibaba are helping small and medium-sized businesses access global markets, while others such as Go-Jek help support the many small household-based businesses that account for the bulk of businesses, employment and GDP in countries such as Indonesia. The digital economy may also support greater services employment, and part-time and flexible work arrangements, which have traditionally benefitted women's workforce participation. As Dettling (2017) finds, the Internet and digital technologies can support teleworking arrangements and reduce time spent on home production activities which may help men and women better balance work and family responsibilities. Digital technologies may also help generate efficiencies in labour market search and home production which could support higher levels of women's workforce participation.

However, a statistically significant association between Internet usage and increasing women's workforce participation does not imply that Internet use causes increases in women's workforce participation. Some of the increase in Internet use in the region has potentially been driven by increased levels of women's workforce participation (demand directed technical change). However, it should be noted that it is practically unlikely that much of the 43.1 percentage point average increase in Internet usage between 2000 and 2016 could be attributed to a 1.9 percentage point average increase in women's participation over the same period. The great majority of the increase in Internet use is likely to have been driven by rapid innovation in ICT products and services, and the related rapid decline in the relative price of ICT products and services over the period.

To formally assess the association between exogenously determined Internet use and women's workforce participation, we need to find instrumental variables that are strongly related to increases in Internet use, and unlikely to directly affect women's participation. We anticipate that variables representing the absence of state control over Internet access will be strongly positively related to Internet use, and not directly related to women's workforce participation. State control of Internet access in particular is also of interest from a policy perspective because it provides an insight into how important the free flow of information online is to Internet usage, and broader economic outcomes such as women's workforce participation.

It is theoretically possible that the degree of Internet freedom or state control of Internet access could be directly related to women's workforce participation to the extent that the nature of these controls directly prevented women from engaging in e-commerce, conducting job search, or advertising their availability to work online for example. This would invalidate the use of state control of Internet access as an instrumental variable. However, in practice we find no empirical support for a direct relationship between state control of Internet access and women's workforce participation in the Indo-Pacific countries used in our empirical analysis. This could be because even governments in the region that seek to restrict access to the Internet are generally supportive of citizens using the Internet to conduct commercial activity, or look for work. It is typically other online activities that they seek to suppress, such as political communication or the publication of information critical of the government.

Further, it is anticipated that variables reflecting state control over traditional media sources, such as access to foreign newspapers and television channels, should be negatively correlated with Internet use, and not directly related to women's participation. State control over traditional media sources should be negatively correlated with Internet use because it is likely to encourage citizens to substitute towards different information sources, such as the Internet, that may be inherently more difficult for governments to control due to technologies such as Virtual Private Networks (VPNs). It is again theoretically possible that state control over traditional media sources could act as a direct impediment to women's workforce participation to the extent that women were banned from advertising their businesses in traditional media outlets for instance. However, in practice we find no evidence of a direct empirical relationship between state control over traditional media sources and

women's workforce participation in the Indo-Pacific countries used in our empirical analysis, suggesting that these variables are also suitable to use as instruments for Internet usage.

Helpfully for estimation purposes, the CATO Human Freedom Index includes subindexes representing 'state control over Internet access' reflecting the 'freedom of access, navigation, and publication on the Internet' (CATO Institute, 2017), 'laws and regulations that influence media content', 'political pressures and controls on the media', and 'access to foreign information' in the form of foreign newspapers and television channels. The CATO Human Freedom Index is described by CATO Institute (2017) as a broad measure of human freedom made up of 79 sub-indexes relating to economic and personal freedom in areas such as the rule of law; personal safety and security; freedom of movement and assembly; freedom of expression and access to information covering 159 countries. A score of 10 under each sub-index represents the highest degree of freedom, and zero the absence of freedom. This information is available for 2008 and the 2010-2014 period, with small sample sizes exacerbating the loss of estimation efficiency associated with two-stage least squares estimation.

In experimenting with different first stage regressions, state control over Internet access, combined with either laws influencing media content or political pressure on the media outlets appeared the most promising instruments. That is to say they had the most statistically significant relationships with Internet usage. However, somewhat paradoxically, in second stage regressions state control of the Internet and access to foreign information were the best performing instrumental variables. First stage regressions regressing Internet usage on state control of the Internet, access to foreign information and all the other right hand side variables used in estimation are reported in Table A1 of the Appendix. Wald tests also reject the null hypothesis that coefficients for the instrumental variables are jointly equal to zero in the first stage regressions for four equations at the 5 per cent significance level, and two equations at the 10 per cent level.

Table 3 reports second stage regressions for the women's workforce participation rate where we instrument for Internet use using state control of the Internet and access to foreign information. Consistent with Cavalcanti and Tavares (2008), all model specifications estimated using instrumental variables suggest a stronger relationship between exogenously determined Internet usage and women's workforce participation than under standard estimation. Indeed parameter estimates are on average around three times larger than under standard estimation techniques, which is again broadly consistent with Cavalcanti and Tavares (2008). Given the different sample periods used in estimation, it may have been that Internet use became a more important enabler of women's workforce participation in more recent years. However, models estimated without instrumenting for Internet usage for the post-2008 period indicate that this does not appear to be the case (see Appendix Table A2). Sargan-Hansen over-identification tests strongly support the null of instrument validity in each model specification. Less efficient parameter estimation under instrumental variables estimation is to be expected, which is exacerbated by relatively small sample sizes.

Table 3: Determinants of women's labour force participation in the Indo-Pacific - Instrumental variables (PCSE)

<i>Dependent variable: Women's workforce participation rate (2008, 2010-2014)</i>					
<i>Eq.</i>	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>
Internet use	0.16** (2.94)	0.15*** (3.52)	0.12** (3.44)	0.17** (3.11)	0.22** (3.26)
GDP per capita		0.11*** (3.72)	0.12*** (3.80)	0.11** (2.87)	0.16*** (4.00)
Urban population			0.27* (2.11)	0.48* (2.18)	0.68** (2.72)
Gov. share				-0.02 (-0.58)	-0.02 (-0.81)
Ag. share					0.06 (0.68)
Country dummies (p>F)	0.00	0.00	0.00	0.00	0.00
Time dummies (p>F)	0.00	0.00	0.00	0.00	0.00
N	300	300	300	238	223
R ²	0.99	0.99	0.99	0.99	0.99
Wald test (p> χ^2)	0.00	0.00	0.00	0.00	0.00
Overid. test (p> χ^2)	0.32	0.30	0.37	0.22	0.18

Notes: * p<0.05; ** p<0.01; *** p<0.001. Constants are omitted from reported results. z statistics are in brackets. Wald tests are on the null of all parameters being equal to zero. Over-identification test is the Sargan-Hansen test with null of valid instrumental variables. GDP per capita enters the equation in thousands of constant international dollars. Dividing parameter estimates by a factor of 1,000 returns the relationship between GDP per capita in constant international dollar terms and women's workforce participation.

In summary, our results suggest a positive and significant association between women's workforce participation and exogenously determined Internet use in the Indo-Pacific region, at least since 2008. The evidence in favour of a positive relationship between Internet use and women's workforce participation is robust to the introduction of a range of controls, including country and time dummies, and a range of factors associated with women's workforce participation identified in the literature. Indirectly, we also find evidence that freedom of the Internet from state interference and the free flow of information online are associated with higher levels of women's workforce participation in the Indo-Pacific.

7. Policies to bridge the gender divide in the Indo-Pacific

Conceptual framework

While we find a statistically significant and positive relationship between Internet use and women's workforce participation for countries in the Indo-Pacific region, there are still many barriers that are preventing women from fully sharing in the benefits of the digital economy. Policy actions to address these barriers can be roughly divided into four separate categories: Access, skills and entrepreneurship, norms, and data. Access relates to ensuring universal access to digital connectivity as an essential underpinning of active participation in the digital economy. Once access is enabled digital skills are critical to allow for the effective use of digital technologies. Norms refer to the stereotypical views about the suitability of women for digital careers, and other societal barriers often embedded in regulations and institutions that can hold women back from more actively participating in the digital economy. A final barrier to women's participation in the digital economy is the lack of gender-specific ICT data in national statistics which can make it difficult for policy makers to apply a gender lens in evidence-based policy development and evaluation.

Overarching issues

The first insight gleaned from the G20 Taskforce on Digitalisation's ongoing focus on bridging the digital gender divide is that national broadband, digital and entrepreneurship policies and strategies should incorporate a gender perspective that addresses women's needs, circumstances, capabilities and preferences.⁴ Governments should also consider incorporating gender equality targets for Internet and broadband access and use in these strategies as and where appropriate. Governments should apply formal gender impact analysis to all new policy proposals in these areas, and take into account gender equality and information and communications technology (ICT) linkages within sectoral strategies and innovation systems.

It goes without saying that digital development and innovation is proceeding at a more rapid pace in the private sector than the public sector. Businesses, governments and civil society all share a common interest in fostering digital inclusion, and this presents a range of opportunities for government to partner with the business and not-for-profit sector. Therefore, it may be valuable for policy makers in the Indo-Pacific region to consider leveraging existing private sector and civil society initiatives as a means to increase universal, equitable, safe, and affordable access to the Internet and other digital technologies, as well as increase women and girls' engagement in STEM, where these programs have proven to be effective.

4 In 2016 less than 50 per cent of countries globally incorporated relevant references, actions and goals to address gender equality in national broadband policies (Australian Government, 2017).

Access

Our empirical analysis provides some evidence of an economically significant and positive association between Internet usage and women's participation in the Indo-Pacific region, reinforcing the link between access to fast and reliable connectivity and participation in the digital economy. However, globally around 1.7 billion women in low and middle-income countries do not own a mobile phone (GSMA, 2015); nearly 60 per cent of the world's population have no access to the Internet; and there are 250 million fewer women online than men (ITU, 2016).

For many women in the region, access to digital connectivity is not just about access to digital or telecommunications infrastructure. In many low-income countries in particular, providing women with access to essential services that reduce the burden of household work, including ensuring access to potable water, sanitation, electricity, and cooking fuel (Gill *et al.*, 2010), is critical to enable women to allocate more time to participate in the workforce and digital economy. The digital economy also relies heavily on access to traditional transport, logistics and utility infrastructures, of which significant needs have been identified in the Asia-Pacific up to the year 2030 (see ADB, 2017).⁵

As with other forms of infrastructure, the maintenance of open and competitive markets for the provision of communications infrastructure should be the primary policy approach to providing affordable access to digital connectivity. Respect for the rule of law and the protection of property rights are also critical enablers of investment in digital infrastructure. Where there are market failures that result in a lack of access to connectivity in particular regions or communities, there may be a role for governments to step in and directly fund or deliver infrastructure. As an intermediate option, governments may consider introducing universal service obligations for private telecommunications providers. However, care needs to be taken to ensure that these regulatory interventions do not discourage private investment.

Encouraging investment in mobile networks in low-income countries in particular can be a powerful driver of digital financial inclusion, underpinning women's entrepreneurship and participation in the digital economy. It is also clear that governments need to be concerned not only with connecting the unconnected, but also with the quality and speed of network connectivity. More comprehensive high-speed Internet coverage supports higher levels of digital economic activity and women's workforce participation. For example in Australia, regions with access to the high-speed National Broadband Network (NBN) experienced 2.2 percentage points higher growth in women's entrepreneurship than areas without NBN (AlphaBeta, 2018).

Given how critical access to connectivity is to functioning in the information society of the 21st century, policy makers should view access to connectivity in a similar way as they view access to other essential services such as electricity and water when considering welfare adequacy and consumer protections such as financial hardship

⁵ The Asian Development Bank (ADB, 2017) forecast that between 2016 and 2030 developing Asia will require US\$14.7 trillion for power infrastructure, US\$8.4 billion for transport infrastructure, and US\$800 billion for water and sanitation. By comparison the ADB assess telecommunications infrastructure needs of US\$2.3 trillion. A huge increase in private sector financing will be required to augment public provision if these needs are to be accommodated.

provisions. The most efficient way to address affordability is via the tax and transfer system, and there may be merit in reviewing the adequacy of welfare arrangements to ensure that they are keeping pace with the costs of connectivity. Policy options that support low-income individuals, women and household secondary income earners to participate in the labour market, such as earned income tax credits or other wage subsidies, are also well adapted to supporting participation in the 'gig' economy and the future of work.

In some communities in the region it is still the case that prevailing norms and social practices combined with limited financial resources may restrict many women from accessing mobile phones, the Internet and other digital technologies. In these circumstances governments have a role to play in leading cultural change, which may include expanding anti-discrimination laws into areas of technological discrimination, as well as providing women in the most disadvantaged circumstances with direct access to technology. Initiatives to provide free wi-fi access at public buildings such as schools and libraries should be supported. Business incubators, accelerators, and maker or hacker spaces provide another avenue to provide access to connectivity and digital office space for women (World Bank, 2012).

Our results also indicate an important indirect relationship between maintaining a free and open Internet and women's workforce participation. The free flow of data online is a critical enabler of participation in global value chains, and opportunities for trade and employment in the future of work. Data flows are important not only because they underpin trading relationships, but also because they provide women with access to knowledge and skills to help improve their productivity and employment prospects. The free flow of information also allows people to access information that may challenge traditional ideas about the appropriate role of women in society and the economy. It can also facilitate access to information concerning positive role models for women in the technology sector for example, which may help encourage women to pursue digital careers. Respecting the free flow of data online in domestic regulation, and advocating for the benefits of the open Internet in international trade negotiations and diplomacy can be important drivers of reducing the gap in workforce participation between women and men in the Indo-Pacific region.

Skills and entrepreneurship

Women also face a skills gap, preventing them from fully participating as either consumers or producers of digital technologies and financial services. Globally, women make up fewer than 20 per cent of the ICT workforce; 9 per cent of ICT sector CEOs; and only 6 per cent of app developers (ITU, 2016). Given that 95 per cent of jobs now have a digital component (ITU, 2012), it is essential to equip young women with the digital skills and competencies necessary for them to succeed in the digital economy. Already there are reasons for optimism, with women beginning to thrive in the Indo-Pacific's rapidly expanding digital economy. For example, women-owned businesses account for 35 per cent of total revenue earned via Tokopedia, Indonesia's largest online marketplace; and 55 per cent of new digital businesses in China are founded by women (Tonby and Madgavkar, 2018).

In low to middle-income countries in the region, providing universal education to secondary school level is a necessary condition for improving women's representation in the digital economy; however, it will most likely not be a sufficient condition in the absence of other supporting interventions (Sudarshan, 2014). In India for example, recent research suggests that formal education alone has a limited impact on shifting entrenched gender norms (Manjrekar, 2013; Mukherjee, 2013; Santhya *et al.*, 2013).

Early exposure to digital technologies has been shown to be of particular benefit to girls, helping them build confidence and overcome cultural stereotypes (Powell and Chang, 2016). In this regard policymakers should consider expanding national primary and secondary curricula to incorporate coding, computational thinking and other digital skills. Consideration should also be given to including gender-appropriate teaching material in these curricula, and providing training and support to teachers to enable them to deliver a digital skills curriculum. Extra-curricular activities aimed at enhancing digital skills for young women and promoting digital careers should also be encouraged.⁶ Governments can also help facilitate partnerships between industry and secondary schools to improve STEM related vocational pathways for young women.⁷ Alongside a greater focus on STEM skills, curricula should also foster creativity, and the development of interpersonal and uniquely human skills that complement rather than compete with digital technologies (Future of Work Commission, 2018).

The Association of Academies and Societies of Science in Asia has found that only 18 per cent of Computer Science (CS) graduates in Asia are women (RMIT, 2017). However, evidence is emerging about a range of relatively simple interventions that can significantly increase female entry and graduation rates in CS and information technology (IT) degrees. For example, under the Building, Recruiting and Inclusion for Diversity (BRAID) initiative in the United States, each BRAID school commits to undertaking a range of evidence-based actions modelled on the example set by BRAID Beacon schools.⁸ Results from BRAID Beacon schools to date have been impressive (Table 4), with schools implementing BRAID commitments experiencing a 2.3 per cent increase in the representation of women in CS studies between 2014 and 2017.

⁶ For example, as part of its A\$13 million Women in STEM and Entrepreneurship grant program under the National Innovation and Science Agenda, the Australian Government is supporting initiatives such as Girl Geek Academy, which encourages early participation in STEM by teaching 5-8 years girls to code (National Innovation and Science Agenda, 2017).

⁷ For example, the Australian Government is investing A\$5.1 million to pilot two Pathways in Technology (P-TECH) sites to support the building of STEM capability and improving the quality of vocational pathways available for young people, including young women (Skilling Australia Foundation, 2017). The Australian Government has also committed to expanding the P-TECH pilot to 12 additional sites across Australia. P-TECH is an innovative approach to education-industry collaboration, which was adapted from the US Pathways in Technology Early College High School (P-TECH) model using existing qualifications and operating under current education system requirements. Key features of the program include: collaboration between education and industry sectors; innovative curriculum design; hands-on workplace experience for students; industry mentoring and support for students; and industry supported pathways for students to successfully transition to post-school study and/or work.

⁸ The Initiative is financially supported by Facebook, Google, Intel, Microsoft, the Computing Research Association and the National Science Foundation in partnership with participating institutions.

Table 4: BRAID Beacon schools improvements in female representation

<i>School</i>	<i>Years</i>	<i>Change in Representation</i>	<i>Unit of Measurement</i>
Cal Poly-SLO	2008-2016	8% to 27% (Computer Science) 9% to 29% (Software Engineering)	Women admitted to programs
Harvey Mudd College	2006-2016	12% to 47.5%	Women majoring in computing
University of British Columbia	1997-2016	16% to 32%	Women majoring in computing
University of Washington	2007-2015	19% to 33%	Women majoring in computing

Sources: Reproduced from <https://anitab.org/braid-building-recruiting-and-inclusion-for-diversity/>.

BRAID commitments to date have included: Making introductory CS more engaging for inexperienced students, with women typically overrepresented in this group; outreach programs to help develop digital and CS teaching skills; supporting events, camps and after school programs to encourage more girls to engage in CS; creating student societies and mentoring programs for women in computing; promoting positive female role models in computer science and STEM; offering interdisciplinary majors or double-degrees allowing CS to be combined with other fields of study based on evidence that women prefer to combine CS studies with other studies that address broader social betterment objectives; supporting summer STEM research opportunities for undergraduate students based on evidence this contributes to increasing graduation rates; hiring more female staff members; and introducing ‘flipped learning’ and other active learning and peer instruction methodologies (BRAID, 2017).

As the above list indicates, not all interventions to reduce the digital gender divide in CS studies are necessarily costly or out of reach for developing economies. They often involve simply changing the way existing classroom activities are structured or run. For example, Booth, Cardona Sosa and Nolen (2013) show that single-sex introductory classes for technical subjects, like STEM subjects, can significantly improve women's performance and university course completion rates, at no cost and with no adverse consequences for male students.⁹ Policymakers can also encourage national universities and research institutions to sign on to initiatives such as the Athena SWAN (Scientific Women's Academic

⁹ Booth, Cardona Sosa and Nolen (2013) suggest that enhanced female performance is attributed to a lowering of stereotype effects where women inhibited by culturally driven norms about the appropriate mode of female behaviour—avoiding risk—find it easier to make riskier choices once placed in an all-female environment. An all-female group may also facilitate the formation of friendships within a faculty environment that is disproportionately male. These friendships may enhance the confidence of these women and facilitate the formation of networks, leading them to feel more comfortable in making riskier choices than women in co-ed classes.

Network) Charter and support other national initiatives that promote gender equality and diversity in STEM fields.¹⁰

Lifelong learning is also critical, with Singapore's SkillsFuture platform providing an excellent model of how governments can equip people of all ages with the skills necessary to participate in a rapidly evolving digital economy. Under this initiative employers provide input on the skills they believe workers will require over the next three to five years. Individuals can then learn these skills in short, industry and digitally relevant courses, while they are working or undertaking study. The scheme provides a coherent framework for micro-skilling and lifelong learning, with course completion providing individuals with recognised qualifications in skills relevant to the digital economy. The initiative is heavily subsidised by employers, and the Singapore Government provides an opening credit of S\$500 and periodic top-ups into individual learning accounts to apply towards courses.

Policy-makers in the Indo-Pacific should also consider developing policies or strategies that support women who wish to become digital entrepreneurs. Programs, such as Australia's *New Enterprise Incentive Scheme* (Department of Employment, 2017), can encourage women to participate in digital careers by supporting job seekers to become small business owners. Programs such as these can help women participate in the digital economy, for example by starting a small business that trades online using digital platforms. The World Bank *Women Entrepreneurs Finance Initiative* (We-Fi), of which the Australian Government is a founding partner, will leverage more than US\$1 billion in financing to improve access to capital and technical assistance for female entrepreneurs, including those engaged in digital entrepreneurship.

In low to middle-income countries in particular, governments and other service providers should consider providing employment and training programs that help women develop their digital skills and direct them towards technology oriented careers. These programs can provide gateways into micro-business opportunities undertaking various services such as online sales, data monitoring, digitisation, cataloguing and transcription. For example, Wobe is a social enterprise that helps Indonesian women earn additional income from trading mobile data. The app works over 3G connections and on old smartphone operating systems, helping women earn additional income from the home. When used to augment household income earned from more traditional sources, these opportunities provide higher and more stable wages, and opportunities for further education and human capital development (Powell and Chang, 2016; Vial and Hanoteau, 2015).

10 The Athena SWAN Charter is an evaluation and accreditation program aimed at enhancing gender equity for STEM fields (Equality Challenge Unit, 2017). Through the accreditation process, the charter recognises excellence in employment practices that advance the careers of women and gender minorities in STEM fields. Currently, 137 institutions belong to the UK Athena SWAN Charter. Science in Australia Gender Equity (SAGE), the Australian pilot of the Athena SWAN Charter, has adapted the UK processes to the Australian context, running training workshops on gender equity and providing accreditation for universities, medical research centres and government research organisations who will participate in the SAGE Pilot.

Norms

Despite advances in educational attainment, women in the region remain subject to traditional attitudes and norms that prevent them from participating in fast-growing information technology and related sectors (Sudarshan, 2014; Tonby and Madgavkar, 2018). Our research points to the relevance of country specific heterogeneity reflecting time invariant cultural, religious and other value systems in determining women's workforce participation in the Indo-Pacific. This reinforces the fact that the challenge of bridging the digital gender divide is not simply a matter of providing equal access to digital technologies or digital skills; it is also about changing community attitudes and norms.

Women consistently report lower levels of self-confidence in their computing and STEM ability than men, despite high school level academic results revealing that women typically outperform men in these fields (Sax and Lehman, 2016). The stereotypical image of a person interested in studying or working in information technology as a 'geek', 'hacker' or 'gamer' can also be unappealing to many women. Therefore, policymakers should consider initiating national advocacy campaigns and events that promote positive female role models in the digital economy to help counteract these perceptions.¹¹

A further challenge to higher levels of female participation in the digital economy is that digital technologies can be used to harass and perpetrate violence against women and girls, creating an impression that the digital economy is not a safe space for women. Policymakers should consider supporting risk-based policy interventions that aim to lower the probability of cybercrime against women and girls taking place, as well as reducing the impact of these crimes on victims. This may include initiatives that enhance women and girls' resilience and ability to protect and defend themselves in a digital environment, such as digital literacy programs, and promoting awareness of support networks and counselling services for victims of cyber violence.¹²

Policy-makers should also consider introducing or reforming national legislation on violence against women to include technology-related forms of violence. Fundamentally, human rights and the rule of law should apply online as they do offline. This means enacting and enforcing laws that make it illegal to use the Internet to threaten, harass or offend women, and cooperating in international enforcement actions given the

11 For example, as part of the EQUALS initiative, a number of Girls in ICT Day events have been planned to promote ICT studies and careers to girls and young women before they make decisions related to tertiary education, including hands-on workshops that introduce girls and young women to coding, mobile apps development and programming robots (ITU, 2017). Girls in ICT Day organisers can also be leveraged to provide coding and mobile app training throughout the year to young women and girls.

12 Internationally, the American National Network to End Domestic Violence is a model of best practice. It undertakes research and provides instruction on how to recognise and address technology facilitated abuse, and provides training and support to frontline workers. The Australian Government also funds a range of initiatives to raise awareness about technology facilitated abuse and provide tools for community and front line services on how to identify it and provide victims with support such as 1800RESPECT, ThinkUKnow and eSafety Women.

global reach of the Internet.¹³ Governments should also continue to place pressure on social media and other digital platforms to immediately remove extremist and unlawful content, including that intended to threaten and intimidate women.

Social norms also influence policy settings that have a critical role to play in supporting women's participation in digital careers. At a basic level workplace relations policies should support flexible work practices, and promote a non-discriminatory workplace, including with respect to pay and career progression. Evidence from Thévenon (2013) suggests that reducing effective marginal tax rates on household secondary income earners, supporting access to childcare, and the provision of child and family benefit payments all support higher levels of women's workforce participation. However, care needs to be taken in the design of parenting leave arrangements to ensure these do not act as a labour market 'off ramp' for women. Transparency regimes for gender pay and participation gaps can also help shine a light on economically costly discrimination.

Governments also have a role to play in changing perceptions about women in technology leadership positions, and ensuring that women are more highly represented in executive positions and board appointments. Internationally, the EQUALS initiative founded by the International Telecommunications Union, UN Women, the International Trade Centre, GSMA and the United Nations University promotes leadership opportunities for women in the digital workforce and women's entrepreneurship, and aims to work with private sector and governmental partners to facilitate more women in leadership roles (Equals.org, 2017). In Australia, the Male Champions of Change in STEM Group drawn from male leaders of technology companies and research institutions seeks to use its individual and collective influence to achieve a significant increase in the representation of women in leadership positions in STEM industries and research.

Data

A final barrier to women's participation in the digital economy is the lack of gender-specific ICT data in national statistics which can make it difficult for policy makers to apply a gender lens in evidence-based policy development and evaluation. A better evidence base is urgently required to help inform the development and evaluation of policy actions to bridge the digital gender divide. A common feature of the digital economy and women's work is that a lot of productive activity takes place in the home without remuneration that is not recorded in official statistics. National macroeconomic statistics are in need of an upgrade to provide better visibility of the impact that the digital economy and home production are having on productivity and output. Better labour market data is also required to understand trends in contingent work arrangements and 'gig' employment.

¹³ Policy-makers should also consider comprehensive policy responses to prevent the nonconsensual sharing of images online and laws outlawing the use of the Internet to prepare or plan to cause harm to, procure, or engage in sexual activity with children.

Subject to capacity, countries in the Indo-Pacific region should consider collecting sex-disaggregated ICT statistics to better identify participation or usage gaps between the sexes. Developed economies in particular should consider running more frequent and comprehensive time-use surveys to fully measure women's contribution to national output and value created in the digital economy. Digital satellite accounts may be a useful vehicle to develop innovative approaches to measuring value created in the digital economy. Initiatives such as these will improve the evidence base for policies aiming to make digital development more inclusive. Countries in the region should also consider increasing their engagement with multilateral efforts already underway to improve the measurement of the digital economy in macroeconomic statistics.

8. Conclusions

On a country-by-country basis, the average labour force participation gap between men and women in the Indo-Pacific narrowed between the years 2000 and 2016 at a time of rapid growth in Internet usage and digital connectivity. Perhaps unsurprisingly, we find a positive and statistically significant association between Internet use and women's workforce participation in the Indo-Pacific, even after controlling for a number of variables commonly associated with women's workforce participation, time and country specific fixed effects. The magnitude of the association is economically significant, with the most conservative estimate suggesting that, on average, growth in Internet use has been associated with four-fifths of the increase in women's workforce participation between 2000 and 2016.

After 2008 we find evidence of an even stronger positive association between exogenously determined Internet usage and women's workforce participation using an instrumental variables approach. The use of state control of the Internet as an instrument for Internet use also points to the important role that the free flow of information online can play in supporting a thriving digital economy, and indirectly higher levels of women's workforce participation. Despite the positive association between digitisation and women's workforce participation, a number of barriers remain which are preventing women from fully participating in the digital economy. The G20 Taskforce on Digitalisation is focused on addressing the access, skills, normative and evidentiary barriers to higher levels of female participation in the digital economy, and better job quality for women in the future of work.

Appendix

A1: First stage regression

Dependent variable: Internet use (2008, 2010-2014)

<i>Eq.</i>	(1)	(2)	(3)	(4)	(5)
State control Internet	0.29 (1.87)	0.30* (1.96)	0.39* (2.35)	0.29* (2.13)	0.28* (2.03)
Access foreign info	-0.19** (-2.59)	-0.20** (-2.70)	-0.27** (-3.45)	-0.19* (-2.21)	-0.20* (-2.11)
GDP per capita		-0.23 (-1.46)	-0.38* (-2.44)	-0.61*** (-4.30)	-0.52* (-2.42)
Urban population			-3.54*** (-7.29)	-3.87*** (-9.29)	-3.57*** (-7.97)
Gov. share				0.44** (3.16)	0.42** (2.93)
Ag. share					0.56* (2.31)
Country dummies (p>F)	0.00	0.00	0.00	0.00	0.00
Time dummies (p>F)	0.00	0.00	0.00	0.00	0.00
N	300	300	300	238	223
R ²	0.97	0.97	0.98	0.98	0.98
Wald test all (p>χ ²)	0.00	0.00	0.00	0.00	0.00
Wald test IVs (p>χ ²)	0.03	0.02	0.00	0.06	0.07

Notes: * p<0.05; ** p<0.01; *** p<0.001. Constants are omitted from reported results. z statistics are in brackets. Wald tests are on the null of all parameters being equal to zero, and parameters on state control of the Internet and access to foreign information both equaling zero. GDP per capita enters the equation in thousands of constant international dollars. Dividing parameter estimates by a factor of 1,000 returns the relationship between GDP per capita in constant international dollar terms and Internet use.

A2: Determinants of women's workforce participation in the Indo-Pacific (PCSE)

<i>Dependent variable: Women's workforce participation rate (2008-16)</i>					
<i>Equation</i>	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>
Internet use	0.02* (2.59)	0.02** (3.03)	0.02** (2.68)	0.02* (2.18)	0.02 (1.59)
GDP per capita		0.07** (2.84)	0.07** (2.87)	0.16 (1.20)	0.07* (2.41)
Urban population			-0.08 (-1.31)	-0.10 (-1.21)	-0.07 (-0.75)
Gov. share				0.03 (1.70)	0.03 (1.74)
Ag. share					0.18* (2.09)
Country dummies (p>F)	0.00	0.00	0.00	0.00	0.00
Time dummies (p>F)	0.00	0.00	0.00	0.04	0.21
N	566	534	534	366	322
R ²	0.99	0.99	0.99	0.99	0.99
Wald test (p> χ^2)	0.00	0.00	0.00	0.00	0.00

Notes: * p<0.05; ** p<0.01; *** p<0.001. Constants are omitted from reported results. z statistics are in brackets. Wald tests are on the null of all parameters being equal to zero. GDP per capita enters the equation in thousands of constant international dollars. Dividing parameter estimates by a factor of 1,000 returns the relationship between GDP per capita in constant international dollar terms and women's workforce participation.

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