

*Despite the acceleration in population aging in almost all advanced economies over the past decade, aggregate labor force participation rates show divergent trajectories. Headline numbers also hide strikingly different shifts in the labor force attachment of different groups of workers: participation has increased among prime-age women and, more recently, older workers, but it has fallen among the young and among prime-age men. This chapter finds that aging and the drag from the global financial crisis can explain a significant share of the decline in the participation of men during the past decade. However, the rising participation of women underscores the importance of other factors in shaping participation decisions. The analysis suggests that labor market policies and institutions, together with structural changes and gains in educational attainment, account for the bulk of the dramatic increase in the labor force attachment of prime-age women and older workers in the past three decades. At the same time, technological advances such as automation, while beneficial for the economy as a whole, have weighed moderately on participation rates. These findings highlight the considerable scope for policies to counteract the forces of aging by enabling those who are willing to work to do so. Investing in education and training, reforming the tax system, and reducing incentives to retire early—along with stronger policies that improve the job-matching process and help workers combine family and work life—can encourage people to join and remain in the workforce. Ultimately, however, the dramatic shifts in demographic structure could overwhelm the ability of policies to mitigate the effects of aging on labor force participation, which underscores the need to rethink migration policies to boost labor supply in advanced economies.*

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## Introduction

Population growth in advanced economies is slowing, life expectancy is rising, and the number of elderly people is soaring. As these trends gather steam, the United Nations projects that by the middle of this century, total population will be shrinking in almost half of advanced economies (Figure 2.1). The burden will fall on those currently considered to be of working age, who in a few decades will support close to double the number of elderly people they do now. Unless more people participate in labor markets, aging could slow advanced economies' growth and, in many cases, undermine the sustainability of their social security systems (Clements and others 2015). Increases in labor supply accounted for a significant share of advanced economies' potential growth during 1985–2000, but their contribution has since fallen (Chapter 3 of the April 2015 *World Economic Outlook* [WEO]).

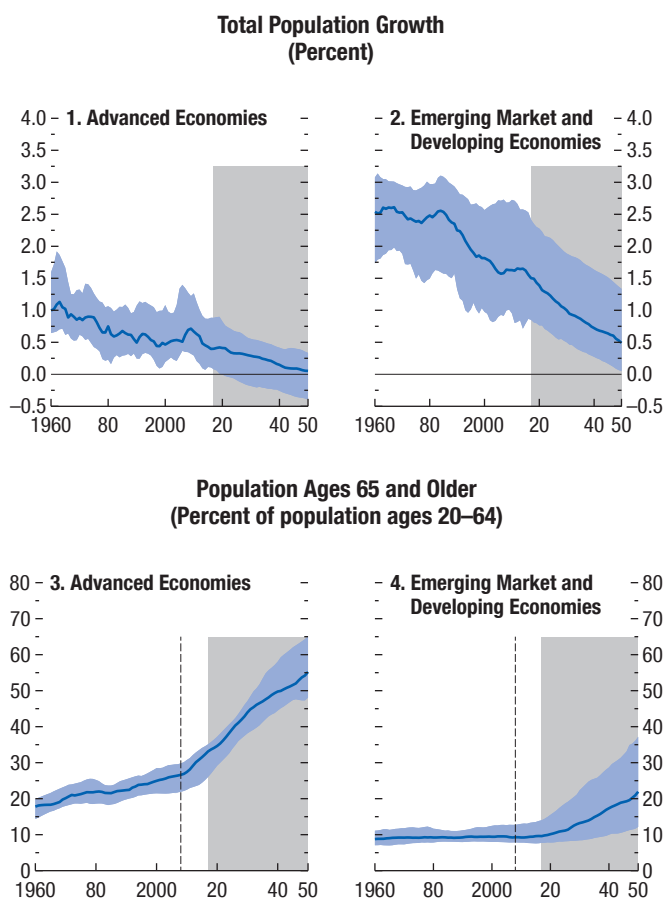
Even though population aging is already exerting pressure on labor supply, considerable differences in the evolution of overall labor force participation are evident throughout the world's advanced economies (Figure 2.2).<sup>1</sup> In half of those economies, the aggregate participation rate has actually increased since the global financial crisis of a decade ago, which coincided with an acceleration of the demographic transition. Headline numbers also hide stark differences in the participation rates of different groups of workers. For example, male participation has declined almost everywhere, while female participation has increased (see Box 1.1 of the October 2017 WEO).

What underlies these strikingly divergent trajectories across countries and for different workers? Various forces are likely at play. Differences in the exact timing and pace of the demographic transition may explain some of the divergence. However, the disparity in participation trends across specific groups of workers suggests a potentially important role for policies and institutions that influence people's decisions to join,

<sup>1</sup>The labor force participation rate is the fraction of the adult population (ages 15 and over) either working or looking for work. In this chapter, labor force participation and workforce attachment are used interchangeably.

**Figure 2.1. Demographic Transition: Recent Trends and Projections**

Population growth is slowing in both advanced and emerging market and developing economies. In advanced economies, the number of elderly is rising precipitously relative to the working-age population, a process that accelerated significantly after 2008.



Sources: United Nations; and IMF staff estimates.  
 Note: Solid lines show median; and blue shaded areas show interquartile range. Gray shaded areas indicate projections. Dashed vertical lines in panels 3–4 show year 2008.

remain in, or reenter the labor force. Differences in exposure and resilience to global forces such as technological advances and trade may have depressed long-term demand for workers with certain skill sets.<sup>2</sup> Identifying and ranking the key drivers of participation across population groups is necessary in designing policies that could enable those willing to work to do so and counteract the forces of aging. Indeed, the anal-

<sup>2</sup>See, for example, Acemoglu and Autor (2011); Autor and Dorn (2013); Goos, Manning, and Salomons (2014); Autor, Dorn, and Hanson (2016); Chapter 3 of the April 2016 WEO; and Chapter 2 of the October 2017 WEO.

ysis in this chapter suggests that strengthening specific groups of workers' attachment to the labor force has helped many countries defuse the effects of an aging population on aggregate labor force participation.

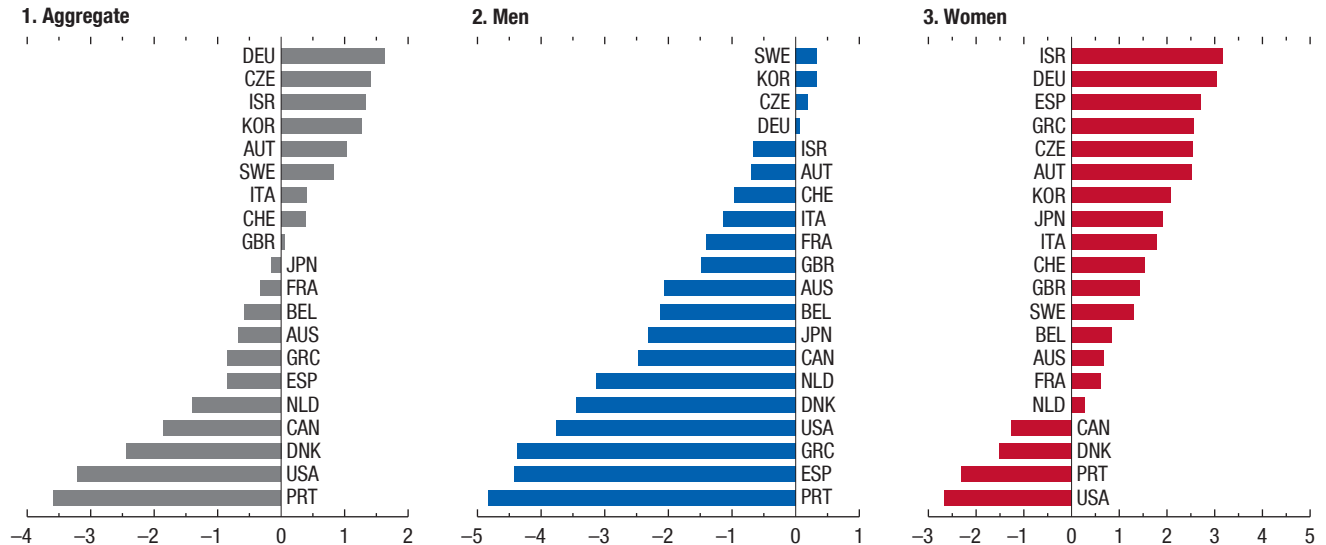
Accordingly, this chapter addresses the following questions:

- How have labor force participation rates evolved across advanced economies? Do the dynamics differ systematically by worker characteristics? Have trends in participation changed in the aftermath of the global financial crisis?
- What are the key drivers of changes in aggregate participation rates and the attachment of various groups of workers to the labor force? More specifically:
  - How much of the changes seen in aggregate rates in the past decade can be attributed to the acceleration in demographic shifts and cyclical effects, including the severe recessions associated with the global financial and European debt crises?
  - Historically, what has been the role of policies and institutions that shape individuals' decisions to work, compared with forces that may have shifted the demand for certain types of workers, such as automation and structural transformation?
- What are the prospects for labor force participation?

The chapter starts by taking stock of the changes in the labor force participation of different groups of workers in advanced economies over the past three decades. Several considerations justify the focus on participation. First, the availability of factors of production, including labor, is an important determinant of actual and potential growth in the long term. The participation rate, together with population growth, is the key determinant of labor supply. Second, labor force participation data have good coverage geographically and temporally, by gender and age group, and capture the pent-up supply of people who work part time but want to work full time and those currently unemployed but willing to work (Burniaux, Duval, and Jaumotte 2004). Finally, economic theory provides clear guidance for the evolution of people's labor force participation over the course of their lives. The chapter then uses complementary analytical approaches to assess the forces shaping participation trends. The first part quantifies the change in country-level participation rates that would be consistent with demographic shifts since the mid-2000s, when aging accelerated significantly in many advanced economies. The second part assesses

**Figure 2.2. Change in Labor Force Participation Rates, 2008–16**  
(Percentage points)

Changes in aggregate participation rates between 2008 and 2016 show considerable heterogeneity across advanced economies, with participation rates of men (women) generally decreasing (increasing).



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.  
Note: The panels show the 20 largest advanced economies by 2017 total population. Data labels in the figure use International Organization for Standardization (ISO) country codes.

in more detail the drivers of participation among specific groups of workers by examining differences in these trends across countries and over time. The third part hones in on the predictors of individuals' participation decisions, shedding light on the role of such characteristics as education, family composition, and exposure to technological advances. Finally, the long-term prospects for labor force participation are evaluated using a cohort-based model.

These are the chapter's main findings:

- Although aggregate labor force participation rates in advanced economies show divergent trajectories, surprisingly similar trends emerge across countries for specific groups of workers. The magnitude of change varies from country to country, but participation by women has increased dramatically since the mid-1980s. More recently, participation has picked up considerably among older workers and has fallen among the young. In almost all advanced economies, prime-age men (ages 25–54), particularly those with lower educational attainment, have become increasingly detached from the labor force over the past 35 years, although participation rates are still high and vary little across countries.

- Aging and the drag from the global financial crisis can explain a significant share of the decline in the aggregate participation rate of men during the past decade. However, the rise in the participation rate of women, even as women's average ages increased and despite unfavorable cyclical developments, underscores the important role of policies and other factors in shaping labor supply decisions and mitigating the effect of aging.
- The analysis suggests that policies and institutions, such as the tax-benefit system, public spending on active labor market programs, and policies targeted to encourage specific groups to participate, together with structural changes and gains in educational attainment, account for the bulk of the dramatic increase in the labor force attachment of prime-age women and older workers in the past three decades.
- On the other hand, technological advances, such as routinization—the automation of tasks for which labor can be easily substituted by capital—have weighed on the participation rates of most groups of workers. The decrease in the relative price of investment is associated with larger declines in participation in countries that are more exposed to

routinization because of the mix of their workers' occupations, which may partially explain lower prime-age male participation.

- While analysis of micro data confirms the significant impact of exposure to routinization on people's detachment from the labor force, it also suggests that policy efforts aimed at enhancing connective networks in labor markets can partially offset this effect. Higher spending on active labor market programs and education is associated with a lower likelihood that a person previously employed in a routinizable occupation will drop out of the labor force. This likelihood is also significantly lower in urban areas, pointing to the importance of access to diverse pools of jobs.

The findings in the chapter suggest that many countries have so far successfully counteracted the negative forces of aging on aggregate labor force participation by strengthening the attachment of specific groups of workers to the labor force. Policies that reduce disincentives for joining or remaining in the labor force and policies that help workers combine family and work life can broaden these gains by enabling people who are willing to work to do so.<sup>3</sup> Further investment in education, training, and activation policies can not only encourage individuals to be active in the labor market but also make the workforce more resilient to global developments, such as technological progress or globalization, that may obviate the need for certain skills.

Ultimately, however, dramatic shifts in demographic structure projected in advanced economies could overwhelm the ability of policies to offset the forces of aging. The chapter's illustrative simulations suggest that aggregate participation will eventually decline—even if gender gaps are fully closed—and that the participation of older workers must rise significantly to stem the decline

<sup>3</sup>Beyond the obvious contribution to potential output from an increase in the labor supply, higher female labor force participation has been shown to bring about other macroeconomic benefits, such as greater economic diversification (Kazandjian and others 2016), lower inequality (Gonzales and others 2015b), and growth that is less sensitive to inequality (Grigoli and Robles 2017). Greater representation of women in senior corporate positions is associated with higher firm profitability (Christiansen and others 2016a), while appointing more women to bank supervisory boards is correlated with enhanced bank stability and financial sector resilience (Sahay and others 2017). Evidence also suggests that later-life employment improves nonfinancial outcomes, such as a person's sense of identity, social integration, and support (Erikson, Erikson, and Kivnick 1986; Cohen 2004), as well as emotional and physical well-being (for example, Cohen 2004; and Calvo 2006).

in aggregate participation. Unless technology delivers offsetting productivity gains, these findings highlight the need for many advanced economies to rethink immigration policies to boost their labor supply, alongside policies to encourage older workers to postpone retirement. Although receiving migrants can pose challenges, potentially prompting a political backlash, it can also be a boon for host countries. The chapter analysis suggests that net migration accounts for roughly half of the population growth in advanced economies over the past three decades. Migration can relieve the strain of population aging and contribute to other long-term gains, such as higher growth and productivity, documented elsewhere (see Chapter 4 of the October 2016 WEO).

It is important to emphasize from the outset that this chapter seeks to identify patterns and correlations rather than to establish causality between various policies, structural, and individual characteristics on one hand and labor force participation on the other. Many of the variables explored when looking at individuals—including choices about education, marriage, and fertility—coincide with decisions about participating in the labor force. Changes in national labor market policies and institutions may also reflect the evolution of societal and cultural attitudes toward work that influence observed trends in labor supply beyond their impact on policies.<sup>4</sup> Sorting out these possibilities is beyond the scope of this chapter, which aims to present a rich description of the patterns of labor force participation across countries and over time and their association with a broad set of drivers, thus offering valuable guidance on potential areas for policy action.

## Patterns of Labor Force Participation in Advanced Economies

An investigation into the long-term trends of aggregate labor force participation and the workforce attachment of individual groups of workers in advanced economies reveals several striking patterns.<sup>5</sup>

<sup>4</sup>For example, the evolution of social norms toward more egalitarian gender roles may induce both family legislation and higher female labor force participation. Female labor supply shifts may also create political support for more family-friendly policies, leading simultaneously to higher female employment and greater parental leave rights (Olivetti and Petrongolo 2017).

<sup>5</sup>The discussion of the long-term trends is based on the analysis of participation rates in 21 advanced economies for which 1985–2016 data are available to ensure sample consistency. The patterns described are qualitatively identical if all advanced economies are included in the analysis.

### Aggregate Participation Rates

Over the past 30 years, the *aggregate* average labor force participation rate in advanced economies as a group has barely changed (Figure 2.3, panel 1). However, the group aggregate masks significant differences in the experience of individual countries. While in a large share of advanced economies aggregate labor force participation in 2016 was within a couple of percentage points of what it was in 1985, several countries saw very significant increases in the workforce attachment of their populations, with aggregate participation rates gaining more than 5 percentage points in such countries as Germany, Korea, the Netherlands, and Spain (Figure 2.3, panel 2). Moreover, there has been a remarkable narrowing of the distribution of participation rates across advanced economies.

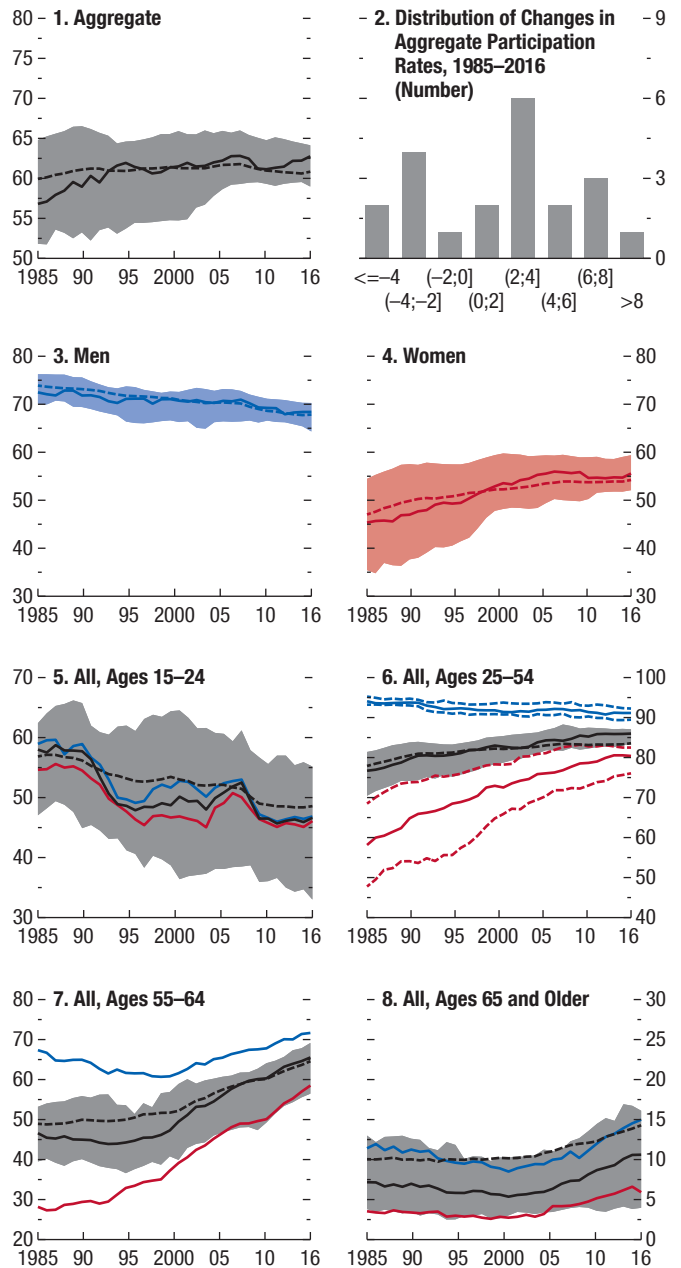
### Participation of Specific Groups of Workers

Even more striking is the divergence in the trends in labor force participation of *different groups of workers* (Figure 2.3, panels 3–8). Across advanced economies, the share of women who are employed or actively looking for work has increased dramatically. For the median advanced economy, the female labor force participation rate has increased by close to 10 percentage points. Gains in female participation were substantially larger in countries where women were historically less likely to be part of the workforce (see Annex Figure 2.2.1), a convergence that has significantly narrowed the dispersion in women’s participation across advanced economies since 1985. The rise in women’s labor force participation is also consistent with the increasing share of two-earner households (see Annex Figure 2.2.2). Conversely, participation rates of men, which are significantly higher and tend to be much more similar across countries, have come down almost across the board. For the median advanced economy, the participation rate among men was more than 4 percentage points lower in 2016 than in 1985. These divergent trends have narrowed gender gaps.

Significant differences also exist in how participation rates have evolved across individuals of different ages (Figure 2.3, panels 5–8). The young (between ages 15 and 24) were significantly less likely to be part of the labor force in 2016 than in 1985, with similar trends observed for men and women (see Box 2.1 for trends in youth labor force participation across advanced and emerging market and developing economies). To a significant extent, declining labor force attachment

**Figure 2.3. Labor Force Participation Rates by Gender and Age**  
(Percent, unless noted otherwise)

Trends in participation rates in advanced economies also differ dramatically by gender and age groups.

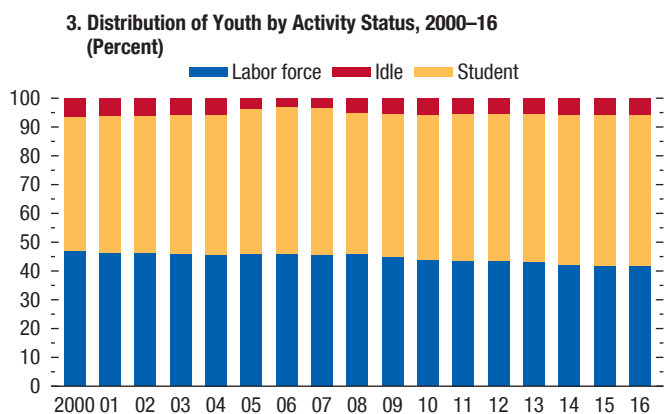
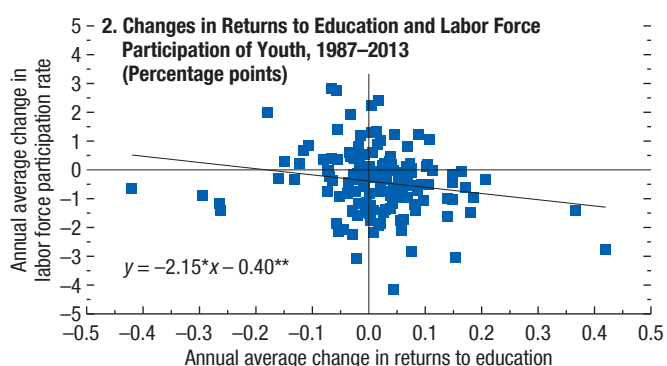
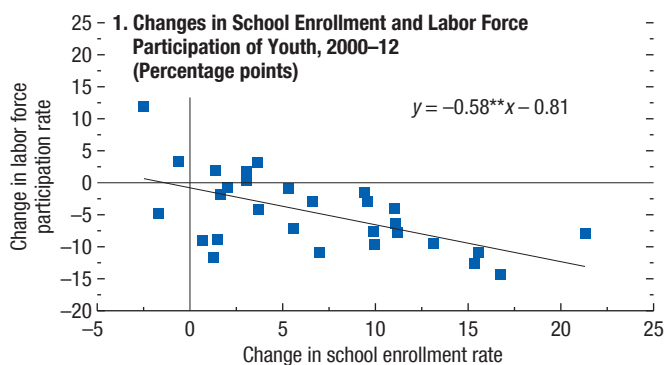


Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: In panels 1, 3, and 4, lines show median; shaded areas show interquartile range; and dotted lines denote population-weighted average. In panels 5–8, black lines show median; gray shaded areas show interquartile range; and black dotted lines show population-weighted average for total age group, respectively. Blue and red lines show median for men and women, respectively. In panel 6, dotted blue and red lines show interquartile range for men and women, respectively. Figure is based on a balanced panel of 21 advanced economies.

**Figure 2.4. Labor Force Participation and School Enrollment of the Young**

Labor force participation of the young (ages 15–24) in advanced economies is falling, while their school enrollment is rising.



Sources: Eurostat, European Union Labour Force Survey; Luxembourg Income Study Database; Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: Markers in panel 2 refer to annualized changes between year pairs. Intervals can be of different lengths due to limited data availability. Reported statistics in panel 3 are estimated from the European Union Labour Force Survey at the country level over the period 2000–16. The panel reports the youth population-weighted average across countries. In panel 3, “idle” youth includes those who are neither employed, unemployed, nor enrolled in school.

reflects the secular trend toward greater investment in human capital and higher school enrollment rates (Figure 2.4).<sup>6</sup> In fact, the share of “idle” youth—defined as those who are neither employed, unemployed, nor enrolled in school—is quite small and has been stable since the early 2000s.<sup>7</sup> Given the increase in the returns to schooling in many advanced economies, the decline in labor force participation among the young could in part reflect an expected response to economic incentives (Krueger 2017). Indeed, there is a negative correlation between changes in youth labor force participation and changes in returns to tertiary education relative to the returns to primary education across countries.<sup>8</sup>

At the same time, participation rates of older men and women (ages 55 and older) have increased significantly since the mid-1990s, following decades of steady decline.<sup>9</sup> The increase is particularly pronounced for the 55–64 age group, but in the past decade, even individuals older than 65 have been remaining in the labor force longer.<sup>10</sup> The gains in participation among older workers should be viewed in the context of significantly longer lives. Life expectancy at birth has increased by about seven years, and at age 50 by more than five years, since 1985, prompting many countries to adopt policies to encourage longer working lives through later retirement.<sup>11</sup>

Among prime-age workers, the most notable pattern is diverging trends of the labor force attachment of

<sup>6</sup>While some in this age group are in school and in the labor force, there is a significant association between increasing enrollment rates and declining participation rates across countries. See Canon, Kudlyak, and Liu (2015) for evidence from the United States.

<sup>7</sup>The concept of idle youth is distinct from that of NEEts (defined as those not in employment, education, or training), given that the latter includes unemployed individuals. Youth unemployment increased and remains high since the global financial crisis in many advanced economies (Banerji, Lin, and Saksonovs 2015).

<sup>8</sup>Returns to education are proxied by the ratio of the average labor income of prime-age men with higher education relative to the average labor income of prime-age men with only primary education and are computed from the Luxembourg Income Study Database during 1987–2013. More recent evidence suggests that skill premiums have stagnated or marginally declined during the past decade across most advanced economies (see Box 2.1 of the October 2017 WEO).

<sup>9</sup>For a discussion of earlier trends in retirement, see Blöndal and Scarpetta (1999), Gruber and Wise (1999), and OECD (2001).

<sup>10</sup>For men, the observed increase in workforce attachment at older ages reflects reduced retirement rates (higher participation among the 55 and older age group) amid stable or slightly declining labor force participation at younger ages (those below 55). For women, the observed increase is the result of a growing pool of working women reaching those ages, as well as changes in retirement behavior.

<sup>11</sup>Gains in life expectancy have been generally accompanied by increases in healthy life expectancy as documented by Salomon and others (2012).

men versus women, as discussed. The small decline in participation rates of prime-age men, which remains very high and varies little across countries, has been more than offset by the dramatic entry of prime-age women into the labor force, leading to overall gains in the participation rates of prime-age workers in most advanced economies. While it is possible that higher female participation has allowed some men to drop out of the labor force, there is little evidence to that effect at the country level. Correlations between changes in prime-age female and male participation rates are, if anything, positive (see Annex Figure 2.2.3), and participation of married men has declined less than participation of single men (Figure 2.5, panel 2).<sup>12</sup>

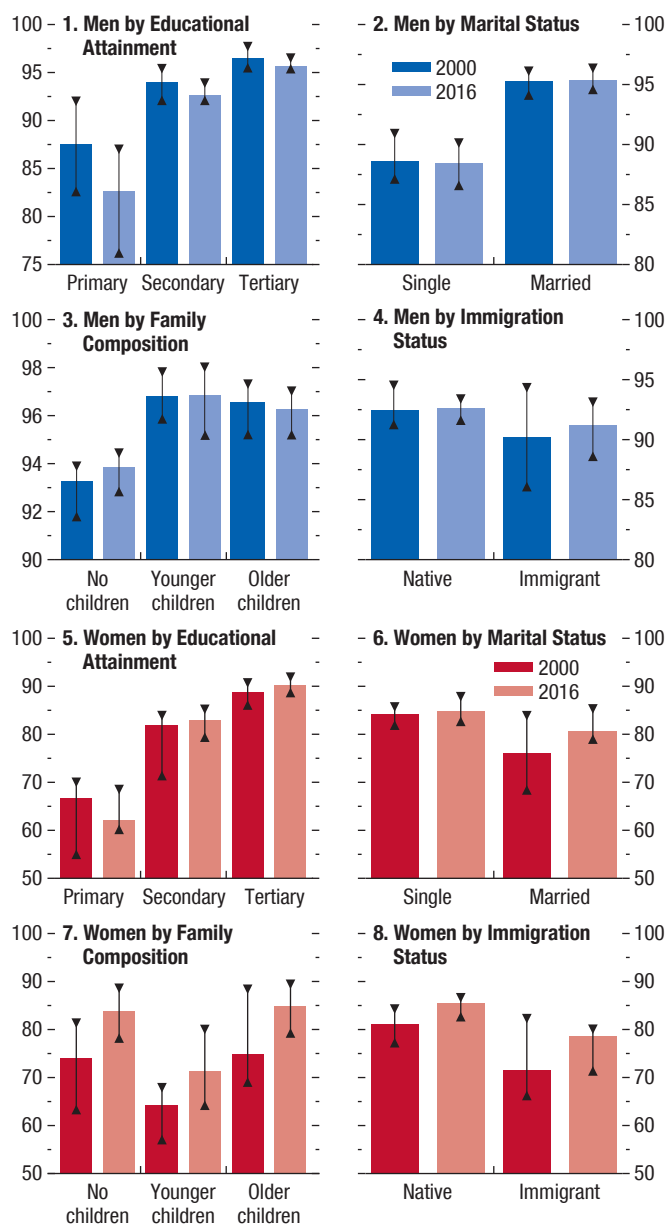
Because labor force participation patterns could reflect significant shifts in the characteristics of prime-age populations—such as education, fertility, marriage, and immigration status—Figure 2.5 provides a more granular picture of the changes in the participation of subgroups since 2000 for most advanced economies (panels 1 and 5) and advanced European economies (panels 2–4, 6–8).<sup>13</sup> With the notable exception of relatively less-educated women, the rise in female labor force participation has been remarkably widespread. Across Europe, single and married women, those with young children (below the age of 6), or older children (below the age of 15), natives and immigrants, were significantly more likely to be employed or looking for work in 2016 than in 2000. For prime-age men, the decline in participation has been the deepest for those with the lowest educational attainment. Across all remaining groups, there has been a small decline or stagnation in the median advanced economy. This suggests that changes in population characteristics toward groups with lower participation, such as the falling share of married prime-age men,

<sup>12</sup>The Council of Economic Advisers (2016) similarly finds limited evidence that reliance on spousal income has contributed significantly to the decline in prime-age male labor force participation in the United States. Rising participation among prime-age women may be driven by falling household income; although this is difficult to examine in country-level analysis due to endogeneity concerns, this issue is examined in greater detail when looking at people's decision to participate.

<sup>13</sup>Data availability constraints allow analysis on participation by various demographic characteristics only for a significantly shorter time span and a smaller sample of countries. The analysis relies on individual-level data from the European Union Labour Force Survey to construct country-level participation rates for subgroups of workers by marital status, number of children, and immigration status, and on Eurostat data, complemented with data from national authorities, to build a picture of participation by educational attainment.

**Figure 2.5. Labor Force Participation Rates of Prime-Age Men and Women by Demographic Characteristics, 2000 and 2016 (Percent)**

Women's participation has increased almost across the board in advanced economies, while men's participation has stagnated or declined, especially for the less educated.

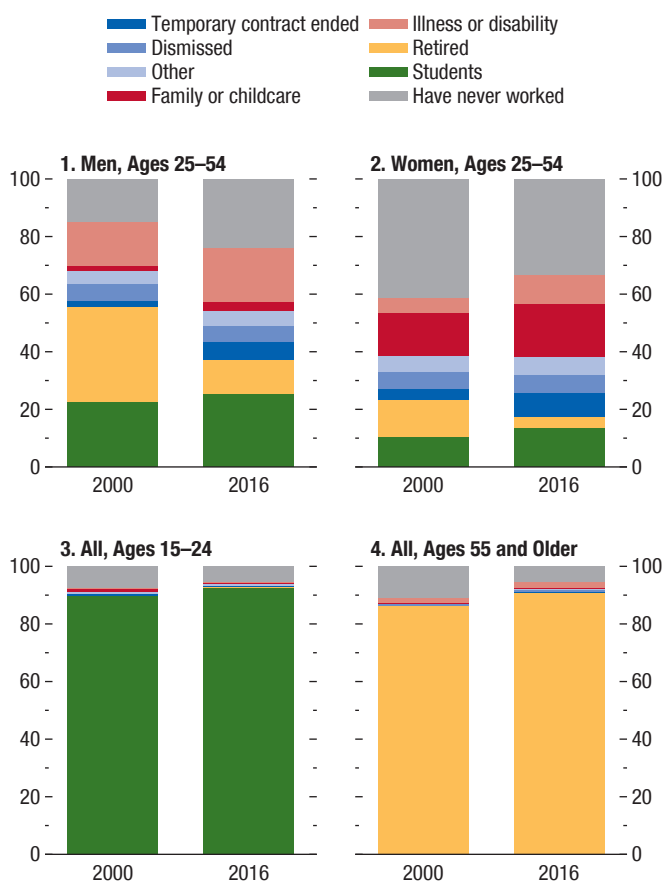


Sources: Eurostat, European Union Labour Force Survey; national authorities; and IMF staff calculations.

Note: Bars show median and lines show interquartile range. Panels 1 and 5 are based on data from most advanced economies, while panels 2–4, 6–8 are based on data from advanced European economies. Panels 3 and 7 report statistics for married individuals. In panels 4 and 8, dark bars show data for 2004 instead of 2000. Prime age is defined as 25–54. Young children are those below the age of 6; older children are those ages 6–14. Level of educational attainment is defined according to the International Standard Classification of Education (ISCED). Primary education contains ISCED 2011 levels 0–2; secondary education contains ISCED 2011 levels 3–4; and tertiary education contains ISCED 2011 levels 5–8.

**Figure 2.6. Subgroups of the Inactive, 2000 and 2016**  
(Percent)

Nonparticipants consist of very different subgroups, including students, retired, those taking care of children, (“voluntarily inactive”), as well as those inactive for economic reasons (“involuntarily inactive”).



Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations.

Note: Reported statistics are estimated from a random sample of 10,000 respondents per country per year from the European Union Labour Force Survey. Categories in blue and red are subgroups of those who have worked before and are not retired. Retired includes early retirement.

have been sizable. The United States stands out, with particularly deep declines in participation for both women and men in the prime-age category across all levels of educational attainment.

Although the decline in labor force participation of prime-age men appears small for the median advanced economy, it is worrisome for several reasons. First, the decline is broad-based, occurring in almost all advanced economies. Second, given that prime-age men are still the largest segment of the labor force in advanced economies and have traditionally been the

main income earners for their families, even a small decline in their labor supply could have sizable macroeconomic consequences.<sup>14</sup> Finally, detachment from the labor force during a person’s peak productive years is associated with lower happiness and life satisfaction for men (Winkelmann and Winkelmann 1995; Lucas and others 2004; Knabe and Ratzel 2011; Krueger 2017), poorer health and higher mortality (Gerdtham and Johannesson 2003; Eliason and Storrie 2009; Sullivan and von Wachter 2009), and depressed employment prospects (Arulampalam, Booth, and Taylor 2000; Arulampalam, Gregg, and Gregory 2001).

### The Nonparticipants

Interesting insights can be gleaned from the reasons workers give for being out of the labor force. Figure 2.6 uses data from millions of workers surveyed across 24 countries in Europe to break down nonparticipants into those who are students, retired, not retired but have never worked, and were previously but are no longer employed. It further breaks down the last group of nonparticipants according to the reason they reported for their detachment from the labor force.

Comparing the responses of prime-age men and prime-age women points to important gender differences in reasons for inactivity: for instance, women are still more likely to drop out of the labor force to look after children, while a higher fraction of men report illness and disability as reasons for not being employed.

The responses also suggest that a nontrivial share of those out of the labor force may be “involuntarily inactive”: they used to work but stopped as a result of economic (demand-side) factors, rather than because of a personal decision. Those reporting being dismissed from their previous job as a reason for inactivity can be seen as a lower bound for this group.<sup>15</sup>

<sup>14</sup>In 2015, the composition of the labor force of the average advanced economy was as follows: 37 percent of workers were prime-age men, 31 percent were prime-age women, 11 percent were ages 15–24, and 21 percent were older than 55. The composition of the population of the average advanced economy was as follows: 20 percent were prime-age men, 20 percent were prime-age women, 12 percent were ages 15–24, and 31 percent were older than 55.

<sup>15</sup>In line with the stylized facts already discussed, comparing the years 2000 and 2016 suggests that, over time, the share of students increased, both among the young and those of prime working age, while the share of those in (early) retirement among prime-agers fell, as did the share of those who never worked among prime-age women and those 55 and older. Illness and disability became relatively more important over time as a reason for nonparticipation.



Involuntary nonparticipants drop out disproportionately from certain sectors of the economy (Figure 2.7, panel 1). Wholesale and retail trade, manufacturing, mining and quarrying, and utilities together account for more than half of the involuntarily inactive, even though fewer than one-third of active workers (including the employed and unemployed) are attached to these sectors. Excess involuntary inactivity—measured as the difference between the inactive individuals attached to a sector as a share of all nonparticipants and the active workers attached to the same sector as a share of the labor force—tends to be concentrated precisely in sectors that have a greater share of routine jobs that are vulnerable to automation (Figure 2.7, panel 2).

These stylized facts provide suggestive evidence of the potential harm of technological progress to participation rates of certain types of workers, an issue this chapter examines in greater detail. They also highlight potentially important income distributional consequences of involuntary inactivity. Displacement of workers tends to occur disproportionately among lower- and middle-skill occupations (Figure 2.7, panel 3), and vulnerability to routinization is especially pronounced in the middle and lower parts of the income distribution (Figure 2.7, panel 4).

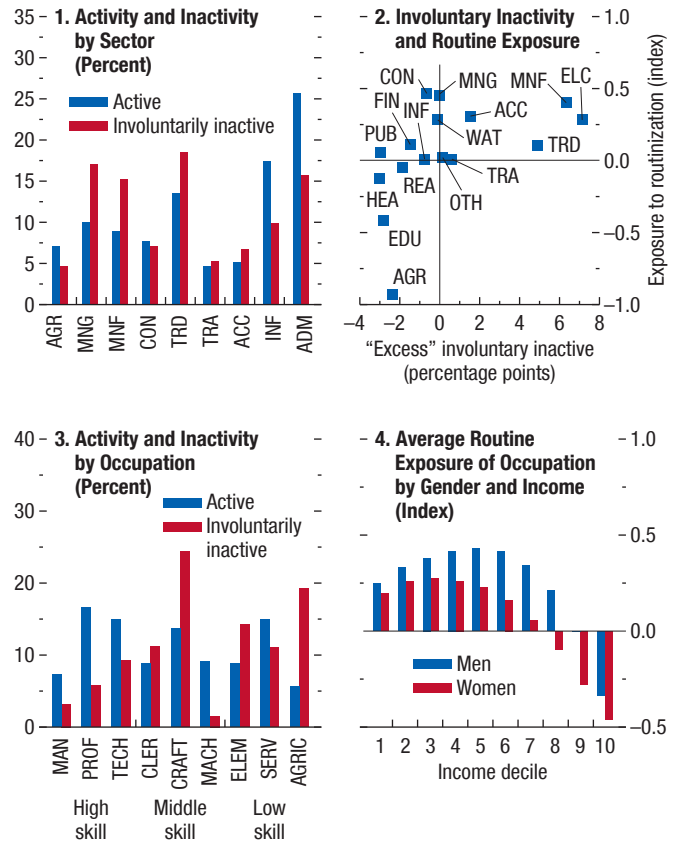
**Participation after the Global Financial Crisis**

The extent to which trends in labor force participation have changed since the global financial crisis varies depending on the groups of workers considered (Figure 2.8). For young and older workers, there is little difference in the trends in participation rates for the median economy. However, the decline in participation accelerated for prime-age men, and the rate at which prime-age women joined the labor force fell after 2008. It is difficult, however, to isolate the effect of the crisis from the steady decline in the gains in women’s participation over the past three decades. These patterns are broadly similar in countries that experienced relatively large output losses as a result of the global financial and European debt crises and those that were relatively shielded from their adverse effects (see Annex Figure 2.2.4).

Employment rates increased in most advanced economies before the global financial crisis, but have since declined in over half of them. Figure 2.9 decomposes changes in employment into changes in unemployment and participation and shows that, before the crisis, employment gains were matched by unemployment declines and increases in participation in most

**Figure 2.7. The Role of Exposure to Routinization**

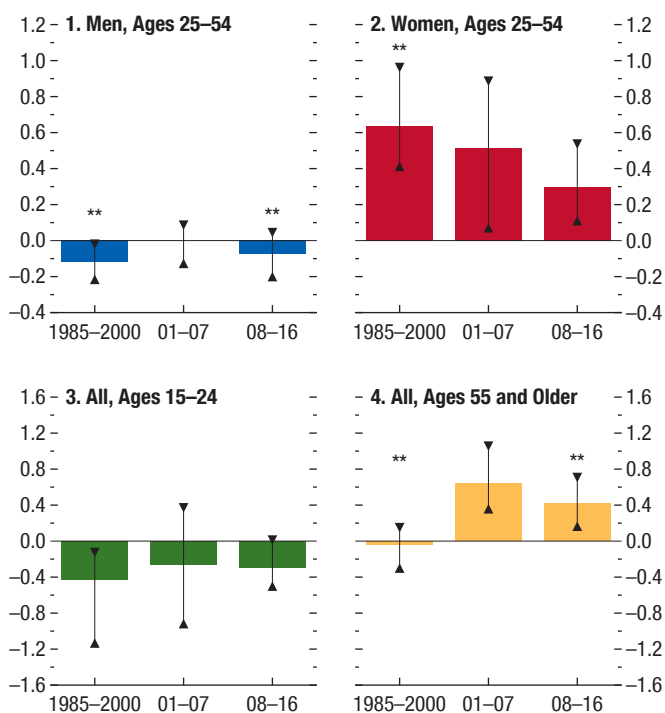
The involuntarily inactive drop out disproportionately from highly routinizable sectors and occupations. Vulnerability to routinization is especially pronounced for men in the middle of the income distribution.



Sources: Das and Hilgenstock (forthcoming); Eurostat, European Union Labour Force Survey; and IMF staff calculations.  
 Note: Reported statistics are estimated from a random sample of 10,000 respondents per country per year from the European Union Labour Force Survey over the period 2000–16. In panels 1 and 3, active includes employed and unemployed, and involuntarily inactive refers to people inactive due to dismissal. For the inactive, sector or occupation is that of last employment. In panel 2, “excess” involuntary inactive refers to the difference between inactive individuals in a sector as a share of all nonparticipants and the active individuals attached to the sector as a share of the labor force. In panel 2, routine exposure is a proxy for the share of jobs in a given sector that are at risk of being automated based on Das and Hilgenstock (forthcoming). Panel 4 in turn shows how automatable given occupations are. ACC = accommodation and food service activities; ADM = administrative and support service activities; AGR = agriculture, forestry, and fishing; AGRIC = skilled agricultural workers; CLER = clerical workers; CON = construction; CRAFT = craft workers; EDU = education; ELC = electricity, gas, steam, and air-conditioning supply; ELEM = elementary occupations; FIN = financial and insurance activities; HEA = human health and social work activities; INF = information and communication; MACH = plant and machine operators; MAN = managers; MNF = manufacturing; MNG = mining and quarrying; OTH = other services; PROF = professionals; PUB = public administration and defense; REA = real estate activities; SERV = sales and service workers; TECH = technicians; TRA = transportation and storage; TRD = wholesale and retail trade; WAT = water supply, sewerage, waste management, and remediation activities.

**Figure 2.8. Average Annual Changes in Labor Force Participation Rates**  
(Percentage points)

The decline in prime-age men's participation in advanced economies became more pronounced after the global financial crisis, while gains in prime-age women's participation slowed.



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: Bars denote median; and vertical lines show interquartile range. Asterisks denote statistically significant difference from 2001-07 at the 10 percent level.

countries, yet in about half of the sample postcrisis employment declines translated into both rising unemployment and falling participation.

Flows into inactivity suggest that the share of discouraged workers (inactive now, but unemployed the previous year) has been increasing since the crisis and is approaching the precrisis peak (Annex Figure 2.2.5)

## Understanding Trends in Participation Rates

### Conceptual Framework and Research Design

Assessing the appropriate policy responses to counteract downward pressure on the labor supply as a result of aging requires a clear understanding of the drivers of the aggregate labor force participation rate and individuals' decisions to be in the job market.

Two key factors underpin changes in aggregate participation rates: shifts in the age structure of the pop-

ulation and changes in the labor force attachment of individuals of different ages. Labor force participation varies considerably over a person's life, rising rapidly in adolescence, flattening through the working years, and falling with age and retirement. Hence, shifts in the age distribution are an important driver of movements in the aggregate participation rate. These shifts have become particularly pronounced in the past decade in advanced economies (Figure 2.1, panel 3) as the exceptionally large cohort of people born in the years following World War II began reaching retirement age.

In turn, numerous interrelated factors influence individuals' decisions to supply labor at various points in their life as they assess the expected return to market work relative to nonparticipation. Individual characteristics, such as gender, educational attainment, previous occupation, and household structure, clearly shape such decisions, because they determine potential earnings in the marketplace relative to nonparticipation.

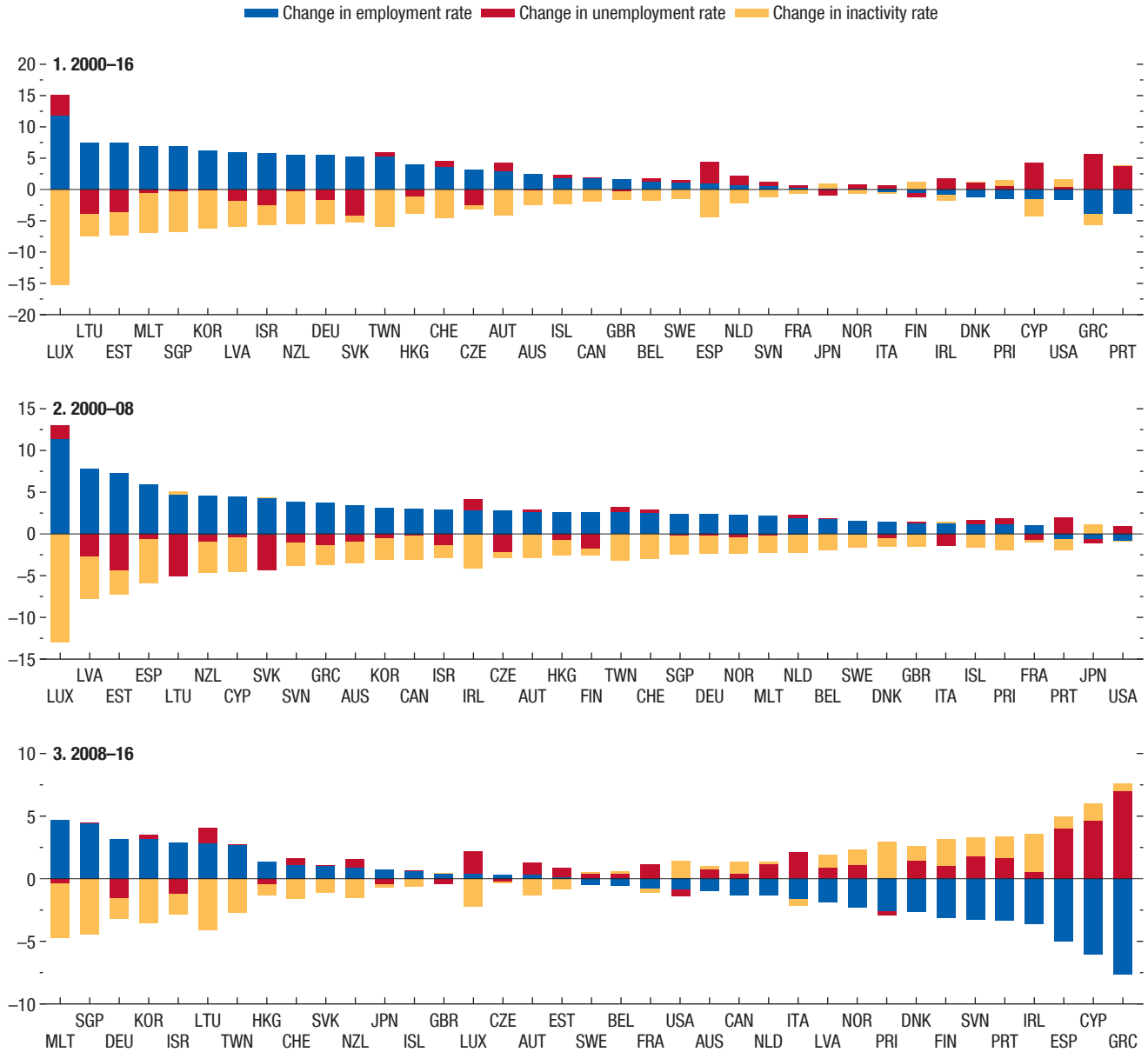
But labor market policies, institutions, and noneconomic factors that govern the prospect of finding (or retaining) a job and the relative benefit from working can also affect participation. Some of these policies, such as the tax-benefit system, directly affect the incentive to supply labor; others, such as wage-setting institutions, may shape supply indirectly through reduced labor demand. For example, an increase in the labor tax wedge could reduce the incentive to work or seek employment, both by reducing net wages and suppressing firms' labor demand as a result of higher labor costs. Conversely, active labor market programs that support jobseekers in finding vacancies may induce individuals to join the labor force and prevent those who temporarily lose employment from becoming permanently detached. Cultural attitudes toward people's role in society are also important because they determine the disutility of market work—for example, through social norms or personally held beliefs (Fernandez 2013).

Policies tailored to addressing the challenges faced by specific workers can also influence their labor supply decisions. For example, provision of childcare, as well as family-friendly policies that make work more flexible, make it easier for women to combine paid employment and motherhood and may discourage exit from the labor market.<sup>16</sup> For older workers, financial

<sup>16</sup>In a simple static labor supply model, parents could choose to stay home and take care of an infant or a young child at the cost of their hourly wage (forgone earnings) minus the price of child care. A more generous childcare subsidy would increase the parent's wage net of childcare costs, thus raising the opportunity cost of staying home and increasing labor supply on the extensive margin.

**Figure 2.9. Decomposition of Labor Market Shifts**  
(Percentage points)

Employment declines became more pronounced after the global financial crisis and increasingly translated into lower participation alongside rising unemployment.



Source: IMF staff calculations.

Note: Employment rate, unemployment rate, and inactivity rate are defined as total employment, total unemployment, and total inactive population as a percentage of total population, respectively. Data labels in the figure use International Organization for Standardization (ISO) country codes.

incentives embedded in pension systems and other social transfer programs are important considerations in retirement decisions. Policies that enable immigrants' swift integration into labor markets, such as authorization to work, access to language and active

labor market programs, and the like, can help them overcome their many disadvantages, including lack of information, poor access to informal networks, lack of transferable skills and qualifications, and low language proficiency (Aiyar and others 2016).

Long-lasting changes in demand for workers' skills could also influence individuals' workforce attachment. For example, the secular expansion of the service sector in many advanced economies (see Chapter 3 of this report) may have created significant employment opportunities for women, who are seen to have a comparative advantage in services, thus raising female participation.<sup>17</sup> On the other hand, technological progress that enabled routine jobs to be automated may have reduced the demand for less-skilled labor in advanced economies and made certain jobs obsolete. While these global developments benefit the economy as a whole, and create new opportunities in other sectors, workers may be unable to take advantage of these opportunities due to lack of relevant skills and training, preferences, hardship involved in relocating geographically, or an inadequate return compared with their previous earnings.

Participation decisions are also shaped by even more short-lived changes in labor demand, such as those caused by cyclical fluctuations (for example, Elsby, Hobijn, and Sahin 2015). The rise in unemployment during recessions may lead some workers to drop out of the labor force permanently. Diminished job prospects during recessions may also induce students to remain in school longer or lead parents (women especially) with young children to stay at home instead of seeking jobs.<sup>18</sup>

The chapter uses several complementary approaches, each one tailored to measure a distinct set of potential drivers. It starts by quantifying the contribution of shifts in the age structure to aggregate participation changes in the past decade, using a standard shift-share decomposition.

Given that both the shift-share analysis and the stylized facts presented previously point to sizable changes in the workforce attachment of specific groups

<sup>17</sup>See, for example, Ngai and Petrongolo (2017) for a model of structural transformation in which relative gains in women's labor market outcomes are driven by changes toward the service-producing sector, as well as Olivetti and Petrongolo (2016) for empirical evidence on the role of the industrial structure in accounting for cross-country differences in gender outcomes. For a discussion of gender-based comparative advantage, see Feingold (1994); Galor and Weil (1996); Baron-Cohen, Knickmeyer, and Belmonte (2005); Christiansen and others (2016a); Rendall (2017); and Cortes, Jaimovich, and Siu (2018), among others.

<sup>18</sup>Increasing evidence suggests that adverse initial labor market conditions can have substantial long-term effects on the earnings of college graduates. See, for example, Genda, Kondo, and Ohta (2010); Kahn (2010); and Oreopoulos, von Wachter, and Heisz (2012).

of workers, the analysis uses cross-country panel regressions to disentangle the influence of labor policies and other factors on the participation of different population segments. While the potential set of drivers is large, the analysis focuses on the variables most commonly discussed in the policy debate: the tax-benefit system, activation policies, wage-setting institutions, and the role of structural changes and exposure to routinization. The cross-country panel approach has the advantage of capturing the general equilibrium effects of various drivers and quantifying their role in a unified framework. However, the measurement of policies is often imperfect, and the identification of causal impacts can be problematic.

Alongside the analysis of macro data, individual-level data from 24 European economies allow for a deeper look at the effect of individual characteristics, including the extent to which (past) occupation can be automated, on workforce attachment, and the potential for policies to shape this relationship.

### The Role of Aging and Cyclical Conditions

To quantify the effect of aging, this section performs a standard shift-share analysis of aggregate participation of men and women. It decomposes observed changes in aggregate male and female participation since 2008 into changes in participation rates within each age group while holding population shares fixed ("within changes"), a shift in the relative sizes of age groups while holding participation rates fixed ("between changes"), and an interaction term. The role of aging can be approximated by the "between changes"; in other words, the imputed change in participation if participation rates for each age group had remained at their 2008 levels.<sup>19</sup>

Because the demographic inflection point coincided with the global financial crisis, the analysis also quantifies the role of the unusually severe recessions in many advanced economies. The cyclical component of participation changes is estimated from the historical relationship between detrended aggregate participation rates and output (or unemployment) gaps, allowing for

<sup>19</sup>See Box 1.1 of the October 2017 WEO for a shift-share analysis of labor force participation for selected advanced economies and Aaronson and others (2006) and Council of Economic Advisers (2014) for the United States.

a differential response of labor force participation to severe recessions.<sup>20,21</sup>

On average, the observed changes in participation of men are broadly consistent with shifts in the population age profile since 2008 and the drag from the global financial crisis (Figure 2.10). Women, however, have become significantly more likely to work or seek employment, despite aging, in the average advanced economy (although not in the United States), suggesting that policies and other factors are also at play. For both men and women, there are notable differences across geographical regions. In the United States, participation has declined significantly more than aging alone would have predicted. In the average European and other advanced economy, on the other hand, gains in participation within each demographic group have partially offset, and in some cases exceeded, the drag from aging.

The role of cyclical developments is also evident. High unemployment and poor job prospects after the crisis depressed participation, especially in Europe and the United States. But as the recovery has taken hold, the drag from cyclical developments has diminished.

### Drivers of Participation Rates of Specific Groups of Workers

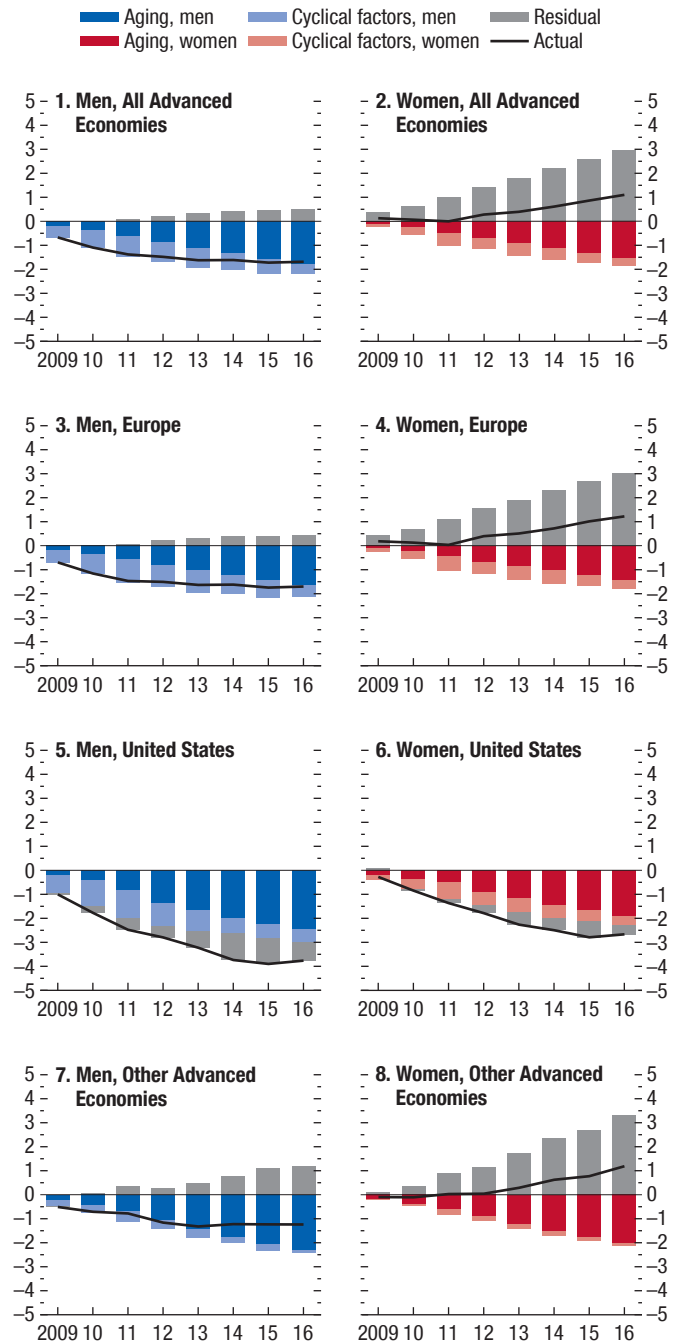
The finding that changes in aggregate participation cannot be fully explained by demographic shifts or cyclical effects in some countries and the wide cross-country heterogeneity in participation rates point to a potentially important role for policies and other factors influencing the decision to keep working or seek employment. This section examines the historical relationship between the participation of individual groups of workers and potential drivers since 1980 across 23 advanced economies. It then uses the estimated associations to provide an illustrative quanti-

<sup>20</sup>The estimates of the cyclical effect for the United States are in line with those of other studies (Ergec and Levin 2014, Aaronson and others 2014, Council of Economic Advisers 2014, Hall 2015, Balakrishnan and others 2015), despite differences in specifications and revisions to estimates of potential output (Grigoli and others 2015).

<sup>21</sup>Duval, Eris, and Furceri (2011) document that severe recessions have significant and persistent impacts on participation, while moderate downturns do not. The econometric analysis relates detrended aggregate participation rates to measures of the cyclical position in a distributed lag specification, allowing for the sensitivity of participation rates to differ in crisis episodes. See Annex 2.3 for details.

**Figure 2.10. Changes in Participation Rates, 2008–16**  
(Percentage points)

Aging can explain the bulk of the decline in men’s participation since 2008. In most regions, women’s participation increased, despite the forces of aging.



Source: IMF staff calculations.

Note: Panels 1–4 and 7–8 show simple averages across countries. Other advanced economies comprise Australia, Canada, Japan, Korea, and New Zealand.

cation of these drivers' contributions to the observed changes in labor supply.<sup>22</sup>

The chapter estimates a reduced-form model of labor force participation, looking separately at the young, prime-age men, prime-age women, and older workers. The model links their participation rates to factors that may affect the decision to supply labor, controlling for all differences across countries that are constant over time and all shocks that affect countries equally.<sup>23</sup> The choice of the predictors is guided by the conceptual framework outlined previously and data availability constraints.

The analysis examines the tax-benefit system, as captured in the labor tax wedge and generosity of unemployment benefits, and looks at policies specifically geared toward improving the job-matching process: spending on active labor market programs (for example, training programs, job-search assistance, and so forth) and major policy changes that help migrants integrate in a host country. When studying women's participation decisions, the analysis expands the set of policies to include public spending on early childhood education and care, length of job-protected maternity leave, and opportunities for part-time employment.<sup>24</sup> For older workers, the analysis considers the statutory retirement age and the generosity of pension plans.<sup>25</sup> Wage-setting institutions and frameworks are prox-

ied by union density and the level of coordination in wage bargaining.

Changes in the demand for different types of workers due to structural transformation and globalization are captured in the ratio of services to manufacturing employment, the degree of urbanization, and trade openness. Following Chapter 3 of the April 2017 WEO and Das and Hilgenstock (forthcoming), the potential for technology to displace workers is proxied by the "routinizability" of a country's initial occupation mix interacted with the relative price of investment goods in advanced economies—that is, the automation of routine tasks. The empirical specification controls for the output gap, while education, measured as the share of population in the age-gender group with secondary and tertiary education, is included as a proxy for workers' potential returns to work.<sup>26</sup>

The analysis indicates that education, cyclical and long-lasting shifts in labor demand, and labor market policies are strongly associated with participation rates (Table 2.1). However, there are significant differences in the responsiveness of workforce attachment to these factors across groups of workers.

In line with economic theory, education is a powerful predictor of labor force participation. An increase in the share of workers with secondary and especially tertiary education is associated with significantly higher participation, particularly for prime-age women and older workers. Higher education is also positively associated with participation of prime-age men, but to a smaller degree, in line with the much

<sup>22</sup>The baseline results are based on the set of countries classified as advanced in the WEO for most of the time period, thus excluding the eight countries that became advanced after 2006. The chapter's findings are robust to using the full set of countries currently classified as advanced.

<sup>23</sup>The empirical specification is

$$LFP_{i,t}^g = \beta^{X,g} X_{i,t}^g + \beta^{D,g} D_{i,t} + \beta^{GAP,g} GAP_{i,t-1} + \beta^{Z,g} Z_{i,t} + \pi_i^g + \tau_t^g + \varepsilon_{i,t}^g$$

in which  $LFP$  denotes the participation rates of worker group  $g$  in country  $i$  at time  $t$ ,  $GAP$  is the cyclical position of the economy,  $X$  represents the set of policies and institutions (some of these are specific to group  $g$ ),  $D$  are factors that may shift the demand for worker group  $g$ ,  $Z$  comprises other determinants of labor supply (education), and  $\pi_i$  and  $\tau_t$  are country and time fixed effects. See Annex 2.4 for further details on the empirical estimation and robustness tests, and a full description of the variables used and their sources.

<sup>24</sup>Data availability on taxes on the secondary earner in the household is limited, thus the variable is not included in the empirical specification.

<sup>25</sup>In the baseline specification, the generosity of pension plans is measured as old-age and incapacity spending as a percent of GDP, purged of fluctuations resulting from cyclical and demographic factors. Conceptually more appropriate measures of incentives for early retirement, such as the change in net pension wealth from an additional year in the labor force, or pension replacement rates, would severely restrict the sample, but are examined in robustness tests.

<sup>26</sup>The empirical approach in the chapter is widely used in the cross-country literature. Blanchard and Wolfers (2000); Genre, Gómez-Salvador, and Lamo (2005); Bertola, Blau, and Kahn (2007); Bassanini and Duval (2006, 2009); de Serres, Murtin, and Maisonneuve (2012); Murtin, de Serres, and Hijzen (2014); and Gal and Theising (2015) examine determinants of employment and unemployment, among others. See, for example, Jaumotte (2003); Genre, Gómez-Salvador, and Lamo (2010); Blau and Kahn (2013); Cipollone, Patacchini, and Vallanti (2013); Thévenon (2013); Dao and others (2014); and Christiansen and others (2016b) for cross-country analysis of female labor force participation and employment and Blöndal and Scarpetta (1999) and Duval (2004) for cross-country analysis of retirement decisions. Relative to the literature, the chapter expands the temporal coverage of the analysis, capturing the last decade during which significant changes in participation occurred. The chapter's focus on the effects of long-lasting shocks to labor demand, such as those stemming from technological advances, and on migrant integration policies is also new.

Table 2.1. Drivers of Labor Force Participation Rates

	(1)	(2)	(3)	(4)	(5)	
	All, Ages 15–24	Men, Ages 25–54	Women, Ages 25–54	All, Ages 55+	All, Ages 15+	
Other Factors	Lag of Output Gap	0.360*** (0.112)	0.072*** (0.020)	0.170* (0.092)	–0.006 (0.068)	0.183*** (0.044)
	Routinization × Relative Price of Investment	0.303 (0.299)	0.302*** (0.048)	1.793*** (0.206)	0.505* (0.288)	0.536*** (0.175)
	Lag of Trade Openness	0.059*** (0.022)	–0.005 (0.005)	0.010 (0.014)	–0.059*** (0.009)	0.012* (0.007)
	Relative Service Employment	–0.002 (0.010)	–0.002 (0.002)	0.015*** (0.005)	0.009 (0.006)	0.010** (0.004)
	Urbanization	0.668*** (0.142)	0.101*** (0.019)	0.355*** (0.071)	0.194 (0.115)	0.249*** (0.047)
	Education (percent secondary)	–0.050 (0.042)	0.019*** (0.007)	0.211*** (0.017)	0.038* (0.021)	0.063*** (0.017)
	Education (percent tertiary)	–0.275*** (0.057)	0.019 (0.015)	0.332*** (0.030)	0.389*** (0.050)	0.135*** (0.031)
	Policies	Tax Wedge	–0.103 (0.064)	–0.002 (0.015)	–0.129*** (0.029)	–0.263*** (0.037)
Unemployment Replacement Ratio		–0.002 (0.068)	–0.041*** (0.007)	–0.035 (0.033)	–0.081 (0.050)	–0.078*** (0.025)
Public Spending on ALMP		0.041*** (0.014)	0.005 (0.005)	0.039*** (0.006)	–0.025** (0.009)	0.031*** (0.007)
Restrictiveness of Migrant Integration Policies		0.491*** (0.098)	–0.047** (0.020)	–0.462*** (0.049)	0.056 (0.088)	–0.207*** (0.049)
Union Density		–0.009 (0.068)	–0.001 (0.011)	0.153*** (0.044)	–0.115*** (0.032)	–0.015 (0.025)
Coordination of Wage Setting		1.104*** (0.245)	0.131** (0.063)	0.701*** (0.219)	0.040 (0.222)	0.256** (0.120)
Public Spending on Early Childhood Education and Care				3.708*** (1.210)		
Share of Part-Time Employment				0.946*** (0.118)		
Job-Protected Maternity Leave				0.025*** (0.006)		
Statutory Retirement Age					0.661*** (0.174)	
Public Spending on Old-Age Pensions					–0.750*** (0.154)	
Public Spending on Incapacity					–0.421 (0.562)	
Number of Observations		571	571	489	568	570
Countries	23	23	23	23	23	
R <sup>2</sup>	0.515	0.606	0.887	0.686	0.578	

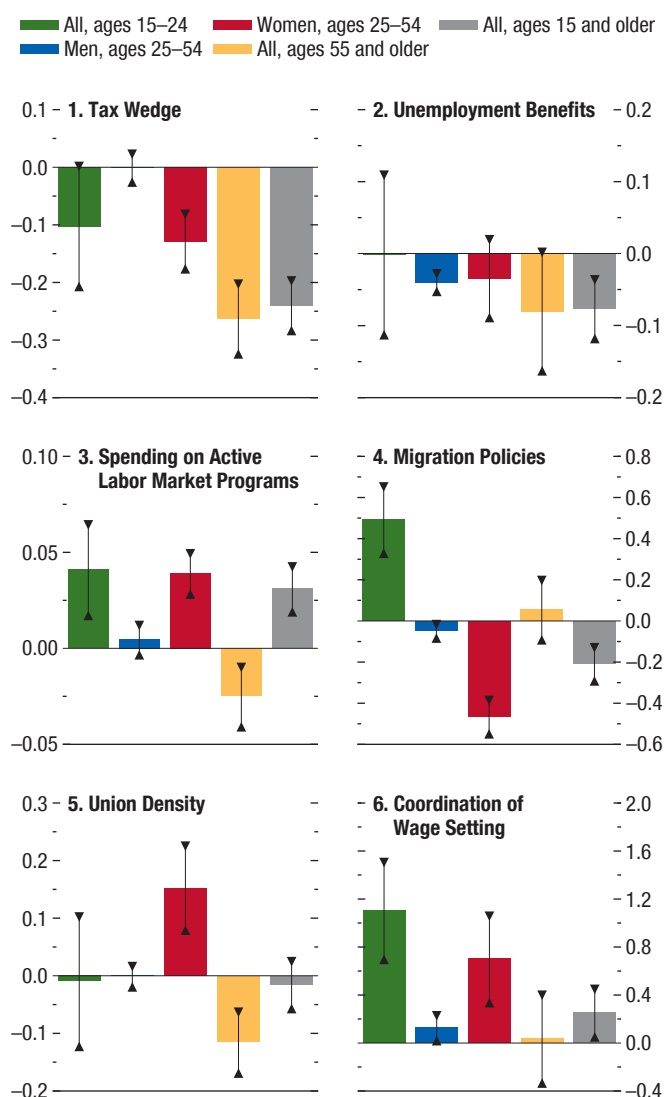
Source: IMF staff calculations.

Note: The table presents results from the estimation of equation (2.3) with separate regressions for the participation rate for each group of workers on a sample of 23 advanced economies during 1980–2011 using annual data. See Annex 2.4 for the construction of the explanatory variables and Annex Table 2.1.2 for the countries in the sample. All specifications include country and year fixed effects. Driscoll-Kraay standard errors are in parentheses. ALMP = active labor market programs.

\* $p < .10$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

**Figure 2.11. Drivers of Participation Rates: Policies**  
(Percentage points)

Higher tax wedges and more generous unemployment benefits depress participation, while spending on active labor market programs and higher levels of wage-setting coordination are associated with higher participation. Policies that encourage the integration of migrants are associated with higher participation of prime-age workers.



Source: IMF staff calculations.

Note: The bars denote the estimated change in participation from a one-unit increase in the policy variable, while the vertical lines show the 90 percent confidence interval. See Annex 2.4 for variable definitions and specification details. Tax wedge is measured in percent of labor costs. The unemployment benefits gross replacement rate is measured in percent of work income. Public spending on active labor market policies is measured per unemployed person and as percent of per capita GDP. Union density is measured as net union membership as a proportion of wage earners in employment. Migration policy is an index constructed by cumulating major changes in policies and regulations guiding the postentry rights and other aspects of migrants' integration, with a higher value denoting more restrictive policies. Coordination of wage setting is an index, ranging from 1 (decentralized) to 5 (centralized).

smaller variability in their participation rates seen in Figure 2.5.<sup>27</sup>

For most groups of workers, participation rates depend on the state of the business cycle. As expected, the association is significantly higher for those more marginally attached to the workforce, such as the young and women.

The analysis also confirms that structural transformation that may shift the demand for certain types of workers affects their labor market involvement. A relative increase in service sector employment is typically followed by the entry of prime-age women into the labor force, while urbanization brings gains in the participation of all groups, potentially by exposing them to a larger set of job opportunities.

Conversely, although technological change can benefit the economy as a whole and create new opportunities in other sectors, it may not be fully benign from the point of view of some workers. A decline in the relative price of investment is associated with lower participation rates in countries where the initial occupation mix is tilted toward routine-task occupations, highlighting the difficulties of workers displaced by automation in finding alternative employment (see Box 2.2 and Box 2.3 for subnational evidence from the United States and Europe, respectively).<sup>28</sup>

Participation rates are also responsive to labor market policies and institutions (Table 2.1; Figures 2.11–12). In particular:

- The tax-benefit system has a robust relationship with participation rates. Higher labor tax wedges and more generous unemployment benefits are associated with lower labor force attachment for most groups of workers, in line with findings in the cross-country literature on their effect on employment (see, for example, Gal and Theising 2015 and its references).<sup>29</sup>

<sup>27</sup>The negative association between labor force participation and the share of population ages 15–24 with partial or completed tertiary education likely reflects that they are still in school.

<sup>28</sup>This finding is consistent with the role of technological progress, along with varying exposure to routine occupations, in the decline in the labor share in advanced economies documented in Chapter 3 of the April 2017 WEO and Dao and others (2017). Acemoglu and Restrepo (2017) provide evidence of significant employment losses in local US labor markets with greater exposure to robots; Autor and Dorn (2013) examine the impact of the falling cost of automating routine jobs on polarization and jobs of different skill levels.

<sup>29</sup>In theory, the net effect of higher taxes on labor supply is ambiguous. If higher labor taxes lower net wages, individuals may respond by working more to maintain their income. On the other hand, by lowering the relative return to market work, higher taxes may lead to lower participation. The negative relationship between



- On the other hand, policies specifically geared toward improving the job-matching process are generally associated with stronger participation rates.<sup>30</sup> Higher public spending on active labor market programs tends to raise the share of young and prime-age women working or seeking employment. The analysis also indicates that policies that encourage the integration of migrants can help boost prime-age workers' participation, with more pronounced effects on women. The positive association likely reflects the success of these policies in narrowing the sizable participation gaps between native and immigrant workers, which are especially wide for women. However, other channels are possible. A more migrant-friendly policy stance may bring in more immigrants. Although migrants have a lower propensity to work than natives when they arrive, they are more likely to be prime age than the native population and may boost aggregate participation rates through compositional shifts (see Box 2.4). Several recent studies have also emphasized the complementarity of migrants' skills to those of the native population, which has helped boost natives' labor market outcomes, especially women's.<sup>31</sup> The negative association between more friendly migration policies and youth labor force participation is not surprising, given that integration measures include giving migrants access to education and training, which could lead to more foreign students and increase school enrollment of nonnative young people.
- Women's willingness to work or seek employment is significantly influenced by policies that help them reconcile work inside and outside the house-

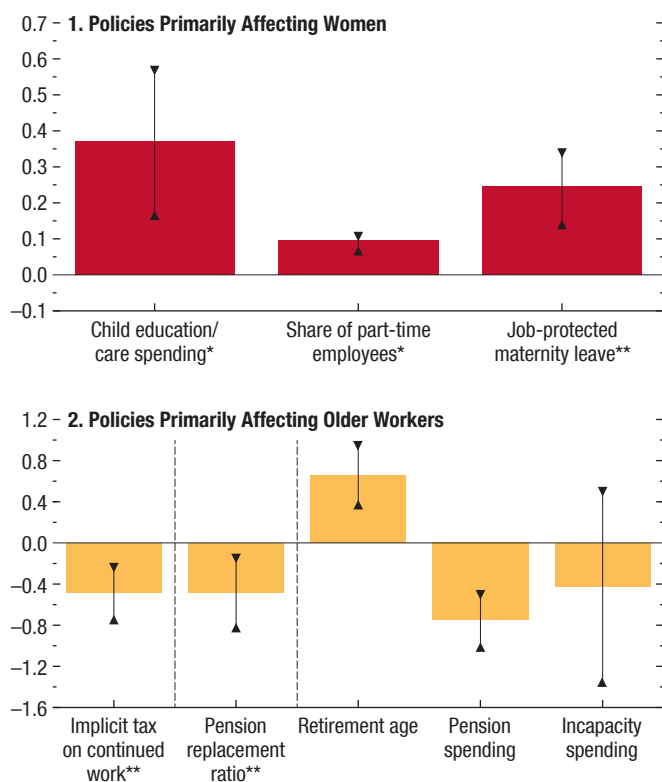
participation rates and the generosity of unemployment benefits, measured as the gross benefit replacement rate, is consistent with (1) the positive correlation found in cross-country data between generosity of unemployment benefits and unemployment levels, which could depress participation through a discouragement effect; and (2) the fact that in many countries the unemployment insurance system provides a path to early retirement for older workers.

<sup>30</sup>Activation policies are proxied by spending on active labor market programs per unemployed person as a share of GDP per capita. To measure migrant integration policies, the chapter constructs an index based on major policy changes in rules governing the integration of migrants, such as their postentry access to language, housing, and cultural integration programs; social benefits; health, education, and unemployment benefits; and the like from the DEMIG POLICY database (de Haas, Natter, and Vezzoli 2014).

<sup>31</sup>See, for example, Carrasco, Jimeno, and Ortega (2008); D'Amuri and Peri (2014); Cattaneo, Fiorio, and Peri (2015); Foged and Peri (2015); Aiyar and others (2016); and Chapter 4 of the October 2016 WEO.

**Figure 2.12. Drivers of Participation Rates: Additional Policies**  
(Percentage points)

Family-friendly policies are associated with higher participation among women, while retirement incentives significantly affect the participation decisions of older workers.



Source: IMF staff calculations.

Note: The bars denote the estimated change in participation from an increase in the policy variable, while the vertical lines show 90 percent confidence intervals. See Annex 2.4 for variable definitions and specification details. \* indicates an increase in the variable by 0.1 unit. \*\* indicates an increase in the variable by 10 units. Public spending on childcare and education is measured as percent of GDP. Job-protected maternity leave is measured in weeks. Statutory retirement age is measured in years. Implicit tax on continued work is the change in the present value of the stream of future pension payments net of contributions to the system from working five more years, while the pension replacement ratio is the ratio of mean disposable income of those ages 65–74 to the mean disposable income of those ages 50–59. Spending on old-age pensions and incapacity are measured as percent of GDP and are purged of fluctuations due to cyclical and demographic factors. Dotted vertical lines in panel 2 denote results from different regressions.

hold (Figure 2.12). Consistent with the findings of a large body of literature, the chapter's analysis suggests that better access to childcare, longer maternity leave, and greater flexibility in work arrangements are associated with higher female labor force participation.<sup>32</sup>

- For older workers, incentives for retirement have a powerful effect on labor force attachment.<sup>33</sup> Raising the statutory retirement age is associated with delayed exit from the labor market, whereas greater pension plan generosity seems to encourage early retirement. The latter finding is robust to using conceptually more appropriate, but less widely available, measures of incentives for early retirement, such as the implicit tax on continued work or pension replacement rates (Figure 2.12).
- Finally, the evidence on the role of wage-setting institutions—unionization and the degree of wage bargaining coordination—is mixed (Figure 2.11). Higher coordination of wage setting is associated with greater labor force participation for most groups of workers, consistent with the idea that more coordinated bargaining systems may lead to faster wage moderation during downturns as unions internalize the potentially detrimental effects that excessive wage pressure may have on overall employment (Soskice 1990; Bassanini and Duval 2006).<sup>34</sup> However, the correlation between unionization and participation is less robust to changes in the sample or the inclusion of other policies.

Overall, these results suggest that policies can influence labor force participation decisions. But can they help explain the sizable cross-country differences in observed changes in participation rates? To answer this question, the chapter examines the change in the workforce attachment of different groups of workers between 1995 and 2011—for which data are available for almost every policy and every country—against the changes in labor force participation predicted by

two empirical models: one that deliberately excludes policies and institutions as determinants of participation and one that includes them. A comparison of how well these models account for the observed changes in participation across countries indicates that changes in labor market policies and institutions can explain a quantitatively meaningful fraction of the observed changes in labor force participation across countries (Figure 2.13). The correlation between actual and predicted participation is substantially higher for a model that includes labor market policies compared with a model that does not. However, there are sizable differences in how well the empirical model can explain cross-country variation in participation trends across population groups. Notably, a very large fraction of the observed change in labor force participation of the young remains unexplained by the factors considered in the analysis.

Combining policies, education, structural shifts, and technology, Figure 2.14 examines the contributions of these factors to changes in participation rates between 1995 and 2011. Supportive policies and educational gains have been key factors behind the dramatic increase in the participation of prime-age women and older workers, with structural transformation contributing positively as well. On the other hand, technological advances have weighed on participation for all groups of workers, except the young.

For the young, and to a certain extent prime-age male workers, a significant share of the decline in participation is attributed to a common component across advanced economies, captured by the time effects in the regressions. This common factor could reflect the common influence of global forces, such as technological progress or globalization, concurrent changes in policies, structural transformations, or other factors that may affect labor supply decisions across the advanced world, such as changing returns to education, rising life expectancy, or common scars from the global financial crisis. For older workers, the latter may have delayed retirement, as captured in the positive common component, as a result of suppressed returns on retirement savings as global interest rates fell, losses in financial wealth, and potentially higher debt.

Comparing how the various factors relate to participation changes across geographic regions can shed light on the reasons behind their (sometimes) divergent trends. For example, the analysis reveals that the striking difference in the participation trend for

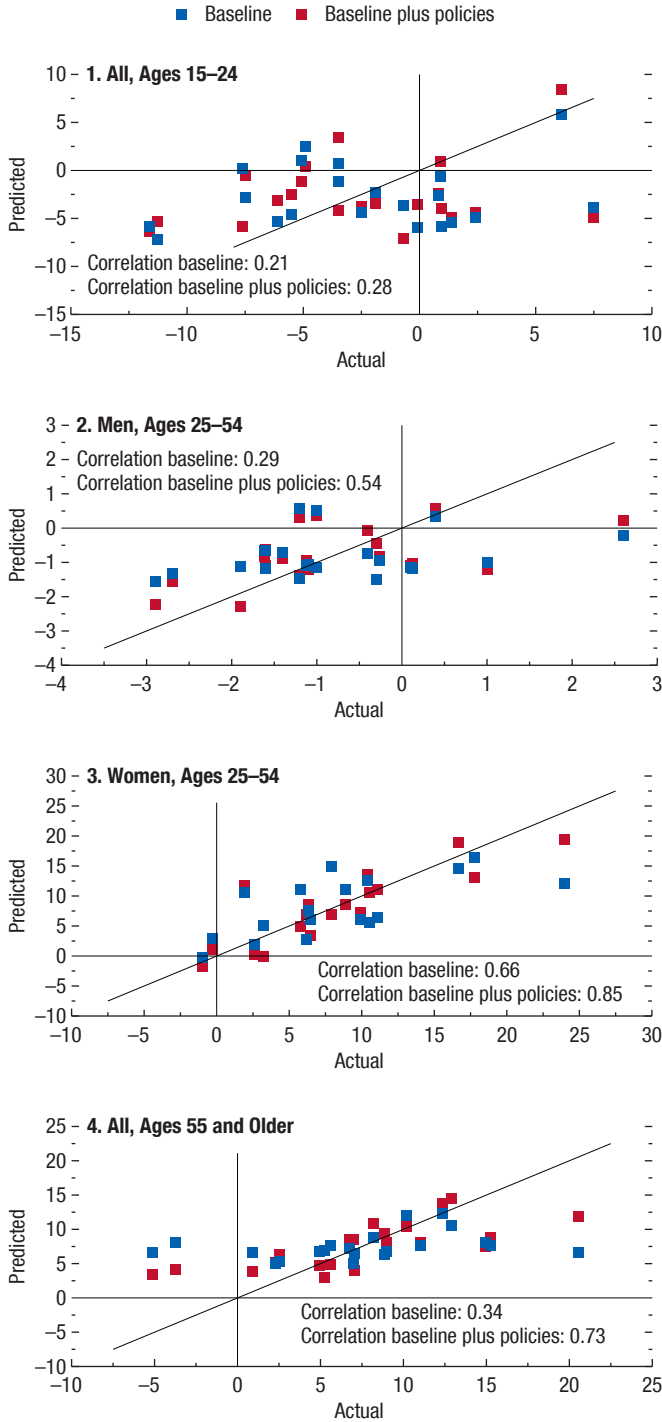
<sup>32</sup>See Olivetti and Petrongolo (2017) and its references for a recent review of evidence on the economic consequences of family policies as well as, for example, Jaumotte (2003); Genre, Gómez-Salvador, and Lamo (2010); Blau and Kahn (2013); Cipollone, Patacchini, and Vallanti (2013); Thévenon (2013); Dao and others (2014); Chapter 3 of the April 2016 WEO; and Christiansen and others (2016b).

<sup>33</sup>See Blundell, French, and Tetlow (2016) and its references for a review of the literature on retirement incentives and labor supply.

<sup>34</sup>Janssen (2018) similarly finds that the costs of worker displacement are higher in a more decentralized wage bargaining system, by studying a major reform of the wage bargaining system in Denmark.

**Figure 2.13. Changes in Participation Rates, Actual versus Predicted, 1995–2011**  
(Percentage points)

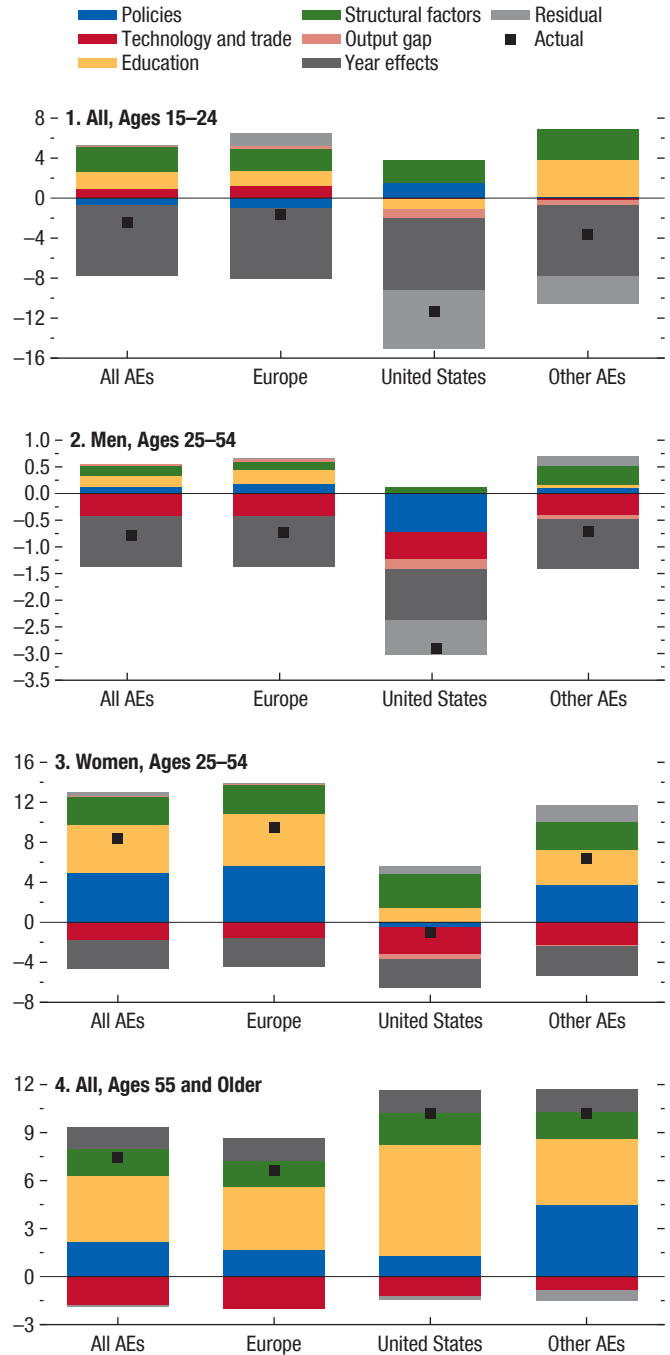
Policies help explain observed differences in changes in labor force participation across advanced economies.



Source: IMF staff calculations.  
 Note: See Annex 2.4 for variable definitions and specification details.

**Figure 2.14. Average Contributions to Changes in Participation Rates, 1995–2011**  
(Percentage points)

Technological change weighs on labor force participation. Gains in education and policies have, however, more than offset this effect for prime-age women and older workers.



Source: IMF staff calculations.  
 Note: See Annex 2.4 for variable definitions and specification details.  
 AEs = advanced economies. Other AEs comprise Australia, Canada, Japan, Korea, and New Zealand.

US women relative to the average European trend can be attributed to the more supportive policy changes in Europe and larger gains in educational attainment among prime-age European women. The factors behind the rise in participation among older workers are very similar across all regions: gains in education, structural transformation, and the introduction of policies that discourage early retirement.<sup>35</sup> However, the reason that US prime-age men and youth became so much more disconnected from the labor market than their European counterparts remains puzzling, as evidenced by the sizable residual in the decomposition of the change. Many hypotheses regarding this decline are specific to the United States and, consequently, cannot be evaluated in a cross-country setting—for example, the role of rising disability, opioid use, higher incarceration, and improved leisure technology.<sup>36</sup> Evidence from subnational data presented in Boxes 2.2 and 2.3 also suggests longer-lasting harm to participation from technological progress in the United States than in Europe.

### Drivers of Individual Participation Decisions

The final step of the analysis complements the cross-country findings by examining evidence from millions of individuals in Europe. The use of micro data offers important advantages relative to the cross-country results discussed so far. It allows for a deeper exploration of individual and household-level determinants of participation, thus mitigating the

endogeneity bias arising from omitted variables and reverse causality in regressions relying on aggregate data. The analysis also zooms in on the impact of technology and the extent to which policies can help offset its effect on individuals' decisions to drop out of the labor force.

The empirical analysis models the decision of an individual to participate in the labor market as a function of personal characteristics (education, immigration status, location), family composition (single versus living as part of a couple, with and without children), and exposure to routinization. To measure vulnerability to automation, the analysis uses information on the occupation of currently employed individuals, as well as on the most recent occupation of those unemployed or inactive, and assigns each a routinizability score based on their (most recent) occupation, following Chapter 3 of the April 2017 WEO and Das and Hilgenstock (forthcoming).<sup>37</sup>

In line with the aggregate findings, the analysis points to large and significant effects of higher education (Figure 2.15). Tertiary education roughly doubles the odds of being active over attainment of up to lower secondary education, with somewhat larger effects for women. Living in an urban area also raises participation, likely on account of access to a more diverse labor market with more opportunities. Natives are also more likely to participate than immigrants.

Family composition has a considerable influence on the decision of an individual to work or seek employment, although there are large gender differences. Relative to the baseline category of being the only adult in a household without children, being part of a couple and having children is associated with higher participation of men, but lower participation of women. Similarly, more children are associated with lower participation of women, but higher participation of men, consistent with the historical allocation of work across genders within a household. Interestingly, the presence of other employed adults in the household is associated with a higher likelihood of being active, likely pointing to common labor market

<sup>35</sup>See, among others, Blau and Goodstein (2008) and Hurt and Rohwedder (2011) for evidence from the United States and Börsch-Supan and Ferrari (2017) for evidence from Germany.

<sup>36</sup>See Eberstadt (2016), Council of Economic Advisers (2016), Krause and Sawhill (2017), and Abraham and Kearney (2018) for a review of the literature. Krueger (2017) discusses the poor health status of men not in the labor force and the rising use of pain medication. Case and Deaton (2017) document an increase in mortality rates as a result of addiction, depression, and suicide (“deaths of despair”) among white prime-age adults and hypothesize that it may be rooted in the steady deterioration of their job opportunities. Holzer, Offner, and Sorensen (2005); Pager, Western, and Sugie (2009); and Schmitt and Warner (2010) present evidence of a dramatic increase in incarceration and the ex-prisoner population in the United States, which faces significant barriers to employment. Aguiar and others (2017) argue that the decline in the labor supply of young men may be linked to improvements in video gaming and other recreational computer activities. It should be noted, however, that the extent and direction of causality of these hypotheses are difficult to establish empirically. Abraham and Kearney (2018) offer a rough quantification of the role of various factors in US employment rate trends since 1999 based on existing studies.

<sup>37</sup>The model is estimated on a subsample of 18 countries relative to the sample used in the stylized facts with detailed information on family composition. Logit regressions relate a binary outcome variable capturing whether a person is in or out of the labor force to the above-mentioned participation determinants, controlling for the aggregate output gap and country and year fixed effects. Annex 2.5 provides a detailed description of the empirical methodology.

effects. These findings should, however, be treated as associations rather than causal effects as labor supply decisions and family composition are likely jointly decided.<sup>38</sup>

Finally, in line with the country-level results, the micro analysis points to significant negative effects of exposure to routine tasks. Working or having worked in an occupation that is more vulnerable to routinization is associated with lower odds of participation. This effect is larger for men and is especially pronounced for workers 55 and older. The effects are both statistically and economically significant: a unit change in routinization scores roughly corresponds to the difference in the routinization score of technicians and the routinization score of managers. Whereas about 87 percent of prime-age male managers are active, about 84 percent of prime-age male technicians are in the labor force—the difference in their routinization scores alone can explain about one-third of this 3 percentage point difference in participation rates.<sup>39</sup>

Can policies help those vulnerable to losing their jobs to technology remain active in the labor market? To answer this question, the analysis examines whether various country-level labor market policies, such as spending on active labor market programs or employment protection, can offset some of the negative effect of routinization on participation. It augments the logit model described earlier in this chapter with an interaction between the routinization score and the relevant policy measure. Figure 2.16 plots the effect of a unit change in the routinization score, estimated at the 75th and 25th percentiles of the distribution of policies (in other words, in countries with relatively high versus relatively low spending on active labor market programs, and the like).

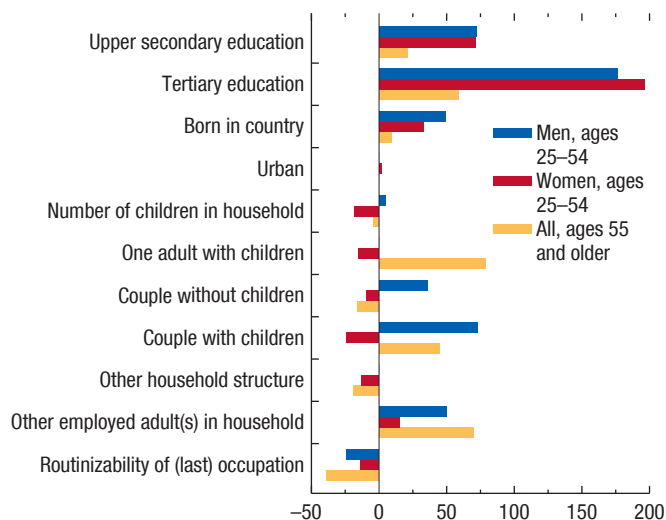
Policies can offset at least some of the negative association between routinization and participation.

<sup>38</sup>While baseline specifications do not control for household income due to data limitations, once a predicted income decile is included, the effect of being part of a couple and having children on the participation of women turns positive, the effect of other employed adults in the household turns negative, and income itself has a negative effect. This suggests that individuals in upper deciles may be able to afford to drop out of the labor force, or, alternatively, that some of the rise in women’s participation could be explained by declining household income (see Annex 2.5).

<sup>39</sup>While the baseline specification relies on a cross-country panel, country-by-country estimates confirm these findings: the effects of vulnerability to routinization are significant and negative in most countries and are typically more pronounced for men than for women.

**Figure 2.15. Change in the Odds of Being Active (Percent)**

Higher education is associated with higher odds of being active, while being married and having children is associated with lower labor force participation of prime-age women. Those in more routinizable occupations are more likely to become detached from the labor force.



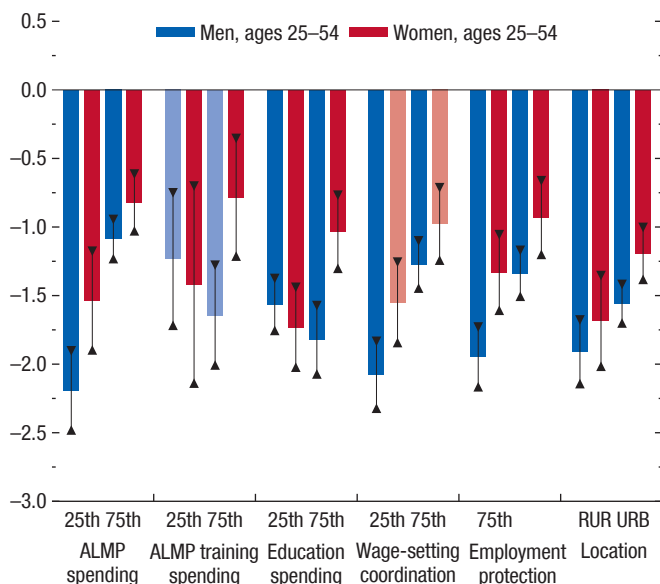
Sources: Das and Hilgenstock (forthcoming); Eurostat, European Union Labour Force Survey; and IMF staff calculations. Note: Logit regressions based on a random sample of 10,000 respondents per country per year from the European Union Labour Force Survey over the period 2000–16 and for 18 countries. Only effects significant at the 10 percent level are shown. The base category for education is “up to lower secondary education.” For family composition, the base category is “one adult without children.” Changes in odds ratios are shown. See Annex 2.5 for specification details.

In particular, higher spending on active labor market programs seems to attenuate the link between participation and routinizability of occupation. The negative association between routinizability and participation is about one-third as large in countries at the 75th percentile of active labor market spending as in countries at the 25th percentile. Disaggregated data on different active labor market programs suggest that the finding is driven by spending on training, which mitigates some of the negative effect for prime-age women.<sup>40</sup>

<sup>40</sup>It should, however, be added that active labor market programs can be expensive; their success hinges crucially on specific design features, and evidence on their effectiveness more broadly is mixed (see IMF/WB/WTO 2017 for a recent literature review). Surveying the evidence from North American and European studies, Heckman, Lalonde, and Smith (1999) conclude that public employment and training programs had at best a modest positive impact on earnings by raising employment probabilities. Card, Kluge, and Weber (2010) find substantial variation in estimated program effectiveness across studies.

**Figure 2.16. Policies and the Effect of Routine Exposure on Labor Force Participation**  
(Percent)

Policies, such as spending on active labor market programs and education, can help mitigate some of the negative effects of exposure to routinization on labor force participation, especially for women. The negative effects of automation are also smaller in urban areas.



Sources: Das and Hilgenstock (forthcoming); Eurostat, European Union Labour Force Survey; and IMF staff calculations.

Note: Bars show the effect of a one-unit increase in routine exposure on the probability of being active for policies at given percentiles, based on logit regressions on a random sample of 10,000 respondents per country per year from the European Union Labour Force Survey over the period 2000–16 for 24 countries. Lines show 95 percent confidence interval. Lighter colors denote that the effects are not statistically significantly different from each other at the 10 percent level. See Annex 2.5 for specification details. ALMP = active labor market programs; RUR = rural; URB = urban.

For both men and women, stricter employment protection (making hiring and firing more difficult) also offsets some of the adverse individual participation effect of being in a routinizable occupation, though possibly at the cost of reduced labor market flexibility at the country level and fewer job market prospects for some other groups, such as youth (see, for example, OECD 2004, 2010; Betcherman 2012). For prime-age men, a higher level of wage-setting coordination is associated with a smaller negative effect of routinization, as more coordinated wage bargaining may internalize some of the negative shocks to employment.

The negative effect of routinization is smaller in urban than in rural areas, as cities may offer more diverse labor markets and hence more opportunities

for displaced workers to find other employment. This finding underscores the importance of easing geographical mobility to help workers adjust to local labor demand shocks.<sup>41</sup>

Finally, while the negative effects of routinization are larger for older workers, policies also provide less of an offset.

## Prospects for Labor Force Participation

To conclude its analysis, this chapter examines the long-term prospects for labor force participation. Using a cohort-based model, this section estimates trend labor force participation for finely disaggregated age groups of men and women across 17 advanced economies, accounting for all age-gender-specific and birth-year-gender-specific determinants of labor supply. These estimates are combined with projections on the demographic distribution over the next 30 years to forecast the aggregate trend labor force participation rate. Finally, the analysis presents three illustrative simulations of how these trends would evolve under the assumption of significantly higher labor market participation of women and older workers and of the implementation of policies to boost participation.

### A Cohort-Based Analysis

A cohort-based analysis of labor force participation is a widely used tool to model trend participation rates and forecast labor supply.<sup>42</sup> This approach exploits variation in participation across age and gender groups and over time for each country to uncover the underlying age participation profile (age effects) and the shifts from these profiles as a result of new cohorts entering the labor force (cohort effects).<sup>43</sup> These cohort effects

<sup>41</sup>Encouraging people to move where there are more employment opportunities could, however, further worsen the situation for those staying behind and increase geographic polarization.

<sup>42</sup>See, for example, Fitzenberger and Wunderlich (2004) for Germany; Aaronson and others (2006, 2014), Fallick and Pingle (2007), and Balakrishnan and others (2015) for the United States; Chapter 3 of the April 2015 WEO; Euwals, Knoef, and van Vuuren (2011) for the Netherlands; Balleer, Gómez-Salvador, and Turunen (2014) for selected European countries; and Blagrove and Santoro (2017) for Chile. Annex 2.6 provides further details on the estimation methodology.

<sup>43</sup>More precisely, the cohort-based model consists of estimating a country- and gender-specific system of equations in which the participation rate of each five-year group between ages 15–64, and of those ages 65 and older is regressed on a constant, dummies for different birth cohorts, and a proxy for the cyclical position of the economy. Given that a key goal of the analysis is the estimation

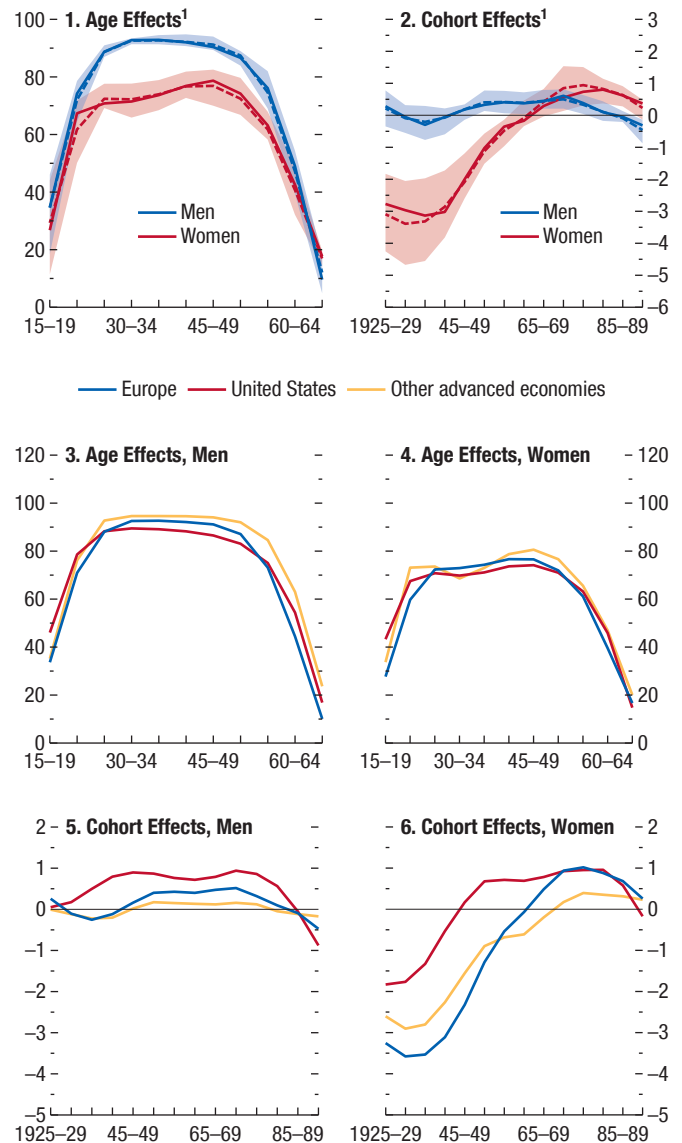
include all factors associated with a particular year of birth, such as the impact of choices made early in life (for example, investment in education, and decisions regarding marriage and children) that have persistent effects on labor supply as well as slowly changing social norms, institutions, and preferences toward work. Future aggregate participation is forecast by combining the estimated age effects with projections of the distribution of population across age groups.

Before turning to the forecast, it is useful to examine the estimated age and cohort effects. Labor force attachment of both men and women exhibits a well-known hump shape over the life cycle, with important gender differences (Figure 2.17, panels 1, 3, and 4). Across all ages, men are more likely to be part of the labor force than women, but the gender gap is particularly pronounced during the prime-age years.

How these age profiles have shifted from cohort to cohort is also vastly different for men and women. Trend male participation rates have not changed significantly across cohorts, except for the slight dip in the participation of recent cohorts, which is notably deeper in the United States. For women, there has been a large increase in participation across cohorts, in line with the stylized facts discussed earlier.<sup>44</sup> For example, women born in the 1970s are 4 percentage points more likely to work or seek employment than women born in the early 1930s. Moreover, the dispersion of cohort effects for women is significantly smaller for later cohorts, underscoring the convergence of women's labor force participation across countries. However, cohort effects have plateaued recently and even edged down, especially in the United States. This finding has important implications: the historical gains in female labor force participation owing to the entry of new birth cohorts and the exit of older ones may no longer be an option for raising participation in many advanced economies without significant policy efforts.

**Figure 2.17. Age and Cohort Effects of Labor Force Participation (Percent)**

Gains in female participation across cohorts have plateaued, and even edged down recently, especially in the United States. The age participation profile of women remains below that of men, significantly so for the prime-age population.



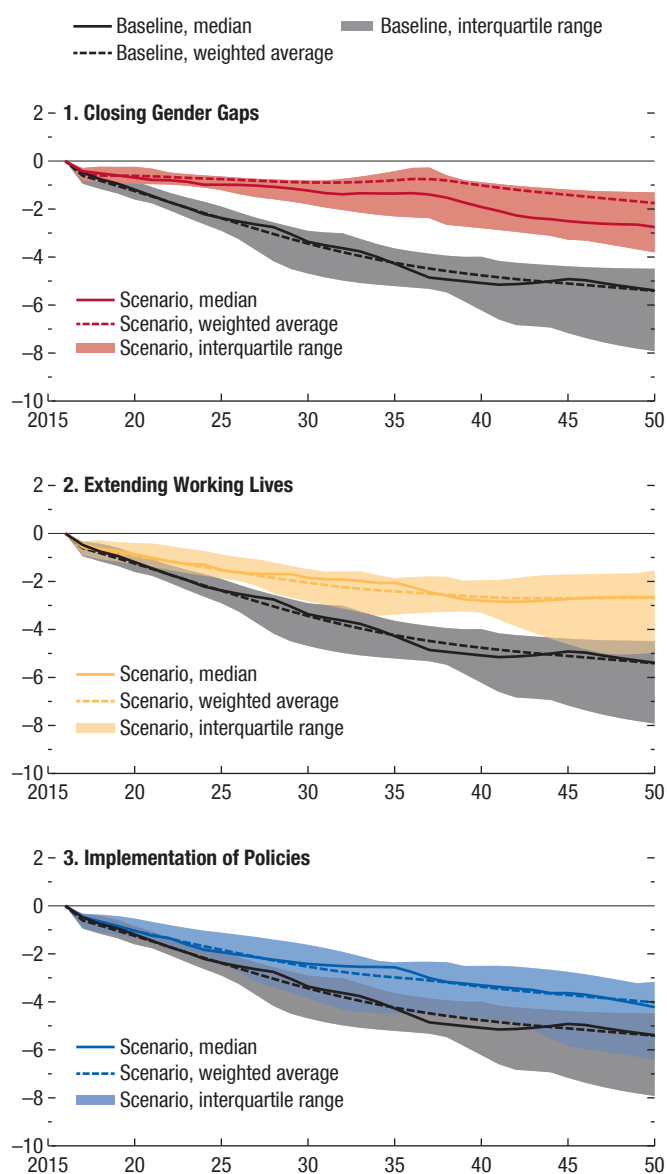
Source: IMF staff calculations.  
 Note: Other advanced economies comprise Australia, Canada, and Japan. Age effects describe the age-participation profile, and cohort effects describe the shifts in the age-participation profile across cohort. See Annex 2.6 for specification details.  
<sup>1</sup>Lines denote median, dotted lines show population-weighted average, and shaded areas show interquartile range.

of cohort effects, which requires sufficiently long data series, other determinants of labor supply, such as educational attainment and policies, are not included because of limited temporal coverage.

<sup>44</sup>To explain the presence of cohort effects in women's labor force participation, Fernandez (2013) proposes a theoretical model in which women learn from the participation behavior of earlier generations. Goldin (2006), on the other hand, attributes the positive cohort effects to the increase in returns to education, changes in preferences, and higher human capital accumulation.

**Figure 2.18. Projected Changes in Participation Rates under Alternative Scenarios**  
(Percentage points)

Increasing the participation of prime-age women and older workers by implementing policies aimed at boosting incentives to participate could partially offset some of the negative effects of aging.



Source: IMF staff calculations.

Note: The “Closing Gender Gaps” scenario assumes that the participation rate of women ages 25–54 converges to the participation rate of men ages 25–54 over 20 years; the “Extending Working Lives” scenario assumes that the participation rate of the 55–59 age group converges to the participation rate of the 50–54 age group over 20 years and that the participation rate of the 60–64 age group converges to the participation rate of the 50–54 age group over 40 years; the “Implementation of Policies” scenario assumes that policies converge to the 10th or 90th percentile of the level observed among advanced economies.

## Projection Scenarios

A baseline projection scenario for trend labor force participation up to 2050 is constructed by combining the estimated age-gender-group trend rates with projections of how demographic distributions will evolve based on the United Nations World Population Prospects.<sup>45</sup> The simulation suggests that, absent policies to boost participation, the median trend participation rate will fall by 5½ percentage points over the next 30 years (Figure 2.18). All else being constant, a decline in aggregate participation of this magnitude would translate into a 3 percentage point reduction in potential output by 2050 for the typical advanced economy.<sup>46</sup> The decline in participation is projected to be broad-based, with rates hovering around 50 percent or lower in Belgium, France, Italy, Portugal, and Spain.

To give a sense of the scope for boosting labor supply, an illustrative simulation makes the stark assumption that prime-age women’s participation rates gradually converge to those of prime-age men over the next 20 years (Figure 2.18, panel 1).<sup>47</sup> In this scenario, the median aggregate participation rate would decline more gradually, and by the end of the projection horizon, it would be 2½ percentage points higher than in the baseline scenario.

An alternative simulation assumes that older workers remain in the labor force longer. Specifically, the participation rate of the 55–59 age group converges to the participation rate of the 50–54 age group over the next 20 years, and the participation rate of the 60–64 age group converges to that of the 50–54 age group over the next 40 years, keeping gender gaps in participation across age groups unchanged (Figure 2.18, panel 2). Raising the participation of older

<sup>45</sup>It is assumed that new cohorts entering the labor force do not shift the age-participation profile and that output is equal to potential during the projection horizon.

<sup>46</sup>For the purpose of this exercise, the labor share of income is assumed to be 56 percent, which corresponds to the average labor share of income in 2017 for a subset of advanced economies (Australia, Canada, Germany, Italy, Japan, Spain, United States). The fall in potential output is thus obtained by multiplying the average labor share of income by the projected fall in labor force participation during 2017–50. If this were to occur at the same rate every year, it would correspond to a loss in potential output of 0.09 percentage point a year over 33 years.

<sup>47</sup>This scenario assumes unchanged birth rates, as higher female labor force participation need not go hand in hand with lower fertility. Sweden, for example, enjoys both one of the highest female labor force participation rate and one of the highest fertility ratios among advanced economies due to policies designed to support both objectives.



workers would also make the decline in the median trend participation rate more gradual. In 2050, the median aggregate participation is projected to be 2¾ percentage points higher than in the baseline scenario. Of course, sufficiently large increases in participation rates among older workers, especially among those older than 65, could entirely offset or even reverse the drag from aging.<sup>48</sup>

Finally, the analysis attempts to quantify the extent to which policies can offset the projected decline in aggregate participation. In an illustrative scenario, policy settings are assumed to converge gradually over the next 20 years to their “best possible” levels, defined as the 90th (or 10th) percentile of the level observed among advanced economies (Figure 2.18, panel 3). The coefficients estimated in the cross-country empirical model are used to forecast the impact of these policy changes on trend participation rates by age-gender group, which are then aggregated using projected demographic weights. This simple simulation suggests that bringing policies to what can be viewed as best practice (from the point of view of labor force participation) can offset some, but not much, of the drag from aging. Aggregate participation rates would be about 1¼ percentage points higher than in the baseline by 2050.

## Conclusions and Policy Implications

The increase in longevity is one of the most remarkable successes in human history (Bloom and others 2015). Yet it could have serious macroeconomic consequences when coupled with the decline in population growth. Because older workers participate in the labor force at much lower rates, population aging raises concerns about the supply of labor in advanced economies, which has implications for potential growth and the sustainability of social insurance systems.

This chapter documents that—despite the acceleration in population aging over the past decade—many advanced economies have been able to counteract its downward pressure on labor force participation. In about half of advanced economies, the aggregate labor force participation rate increased after the global financial crisis. Yet these aggregate developments

mask strikingly different shifts in the workforce attachment of men and women. In most countries, the aggregate participation rates of men have declined since the crisis, broadly in line with changes in the age structure of populations and the drag from the global financial crisis. Women’s participation, however, increased in most countries, despite aging and adverse cyclical developments, underscoring the importance of policies and other factors in shaping participation rates.

Disparate developments in labor market involvement across different age groups of workers are evident over the long term. Participation of young men and women and prime-age men has been declining for the past 35 years. Participation of prime-age women has increased dramatically since the mid-1980s, and for older workers it has picked up considerably since the mid-1990s.

The chapter’s analysis suggests that changes in labor market policies and institutions, together with structural changes and gains in educational attainment, account for the bulk of the increase in the labor force attachment of prime-age women and older workers in the past three decades. Conversely, technological advances, namely automation—while beneficial for the economy as a whole—have weighed on the labor supply of most groups of workers and can partially explain declining prime-age male participation. Individual-level evidence confirms the significant impact of vulnerability to routinization. Detachment from the labor force is significantly more likely among individuals whose current or past occupations are more vulnerable to automation. But encouragingly, higher spending on education and active labor market programs, and access to more diverse labor markets, tend to attenuate this negative effect.

What does this mean for labor force participation prospects in advanced economies? In the absence of policy efforts, expected demographic developments could lead to large declines in aggregate participation rates. The chapter’s simulations imply that by 2050, overall participation rates could fall by 5½ percentage points in the median advanced economy.

There is, however, scope for policies to counteract the forces of aging by making sure those who are willing to work can do so. In particular, reforming the tax-benefit system, for example, by reducing the labor tax wedge, along with strengthening policies that improve the job-matching process, can encourage individuals to keep working or seek employment.

<sup>48</sup>Data constraints on participation by age groups of workers older than 65 prevent the simulation of alternative scenarios such as raising effective retirement ages to maintain the proportion of life spent in retirement or indexation of effective retirement ages to healthy life expectancy.

There is also strong evidence of the effectiveness of family-friendly policies that help people combine market work with the demands of parenthood—public spending on early childhood education and care, flexible work arrangements, and parental leave—in attracting women to the labor force. For older workers, reducing the incentives to retire early, by raising statutory retirement ages or making pension systems more actuarially fair, could lengthen working lives, although care should be taken that reforms do not jeopardize other goals, such as a basic social safety net for vulnerable individuals.<sup>49</sup>

However, the chapter's simple illustrative simulations suggest that even if countries converge to the best (observed) policy settings for encouraging labor supply, expected demographic shifts may still depress participation rates in advanced economies, taking a toll on economic activity. Unless technological progress delivers offsetting productivity gains, many countries may need to reconsider immigration policies to boost domestic labor supply, alongside policies to encourage older workers to postpone retirement. Although receiving migrants can pose challenges for host countries, the chapter's analysis suggests that net migration accounts for roughly half of the population growth in advanced

<sup>49</sup>It is important to recognize that some of these policies may entail significant fiscal costs, while others may be politically challenging because of their cross-generational distributional consequences.

economies over the past three decades—any efforts to curb international migration would thus further exacerbate demographic pressure.<sup>50</sup>

Finally, technological advances that transform production processes and reduce the need for labor could help alleviate the challenges to aggregate growth from aging. But policymakers should be mindful of the difficult adjustment such transformations may entail for some sectors, occupations, and geographic areas and deal with the concerns of workers displaced by technology, including through effective support for retraining, skill building, and occupational and geographic mobility. As the chapter's findings suggest, increasing investment in education and training can not only make the workforce more resilient to changing labor needs, but also encourage labor force participation. Investing more in the education of the young is also critical to prepare them for the jobs of the future.

<sup>50</sup>As discussed in Chapter 4 of the October 2016 WEO, cultural and language differences, as well as concerns about displacement of native workers, can stir social tensions and provoke a political backlash against migration in host countries. The prompt integration of migrants is key to alleviate such concerns. In source countries, migration can weigh on long-term growth prospects if it is associated with brain drain, though such effects can be mitigated by remittances or diaspora networks.

### Box 2.1. Youth Labor Force Participation in Emerging Market and Developing Economies versus Advanced Economies

Median labor force participation rates for the overall working-age population in advanced and emerging market and developing economies have fluctuated around 60 percent over the past 25 years. Youth labor force participation, however, has fallen in both groups of economies (Figure 2.1.1).<sup>1</sup> Whether these declines are a cause for concern depends largely on whether they reflect primarily growth in school enrollment or an increasing share of idle youth. This is particularly important in emerging market and developing economies, where young people comprise about 18 percent of the population on average, about 6 percentage points higher than their share in advanced economies.<sup>2</sup> Motivated by these considerations, this box looks at how youth labor force participation has evolved in recent years across advanced and emerging market and developing economies.<sup>3</sup>

Low and declining youth labor force participation rates are a greater cause for concern in emerging market and developing economies than in advanced economies. In both cases, there has been an uptick in youth human capital investment (Figure 2.1.2). For the median advanced economy, secondary school enrollment rose more than 10 percentage points since 1990, to about 97 percent in 2010. The pickup in schooling has been even more dramatic in emerging market and developing economies—median secondary enrollment rose almost 40 percentage points, to about 70 percent. However, the lower overall schooling rate and similar youth labor force participation suggest that a larger share of emerging market and developing economy youth is neither in the labor force nor studying. There are, moreover, significant differences in

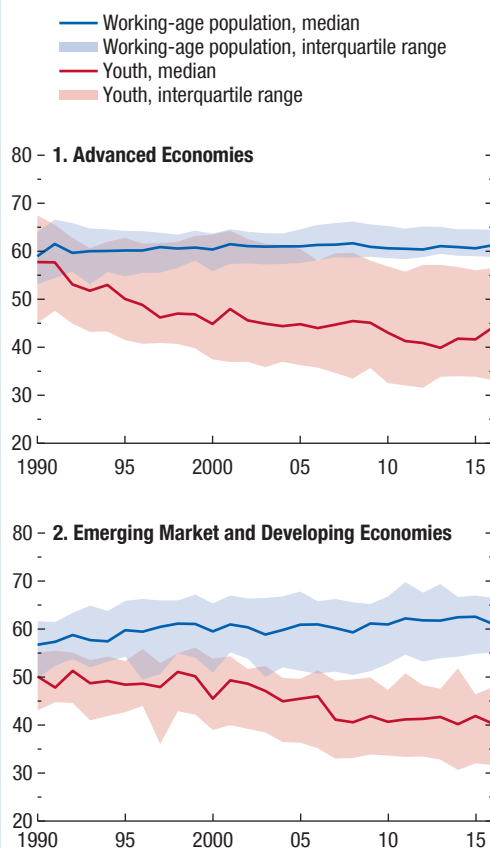
The authors of this box are John Bluedorn and Davide Malacrinno with research assistance from Daniela Muhaj.

<sup>1</sup>Age ranges defining the youth population sometimes differ across data sets and publications. Unless indicated otherwise, the International Labour Organization definition of 15–24 years old is used. Working age population is 15–64 years old.

<sup>2</sup>Country group median population shares in 2015 (United Nations Department of Economic and Social Affairs Population Division 2017).

<sup>3</sup>Ahn and others (forthcoming) investigate in greater depth the patterns and drivers of youth labor market outcomes in emerging market and developing economies, including potential policy implications.

**Figure 2.1.1. Labor Force Participation by Age Group (Percent)**



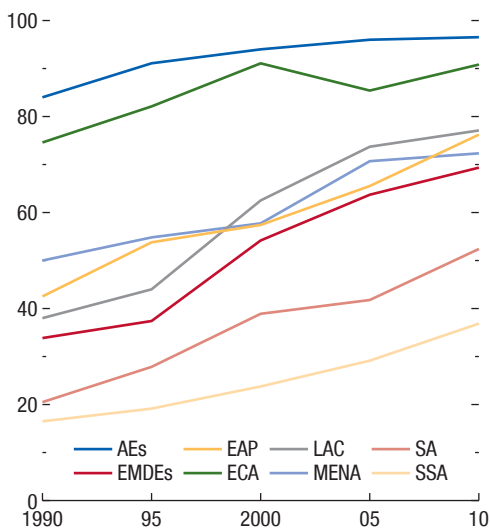
Sources: International Labour Organization; and IMF staff calculations.

enrollment rates across regions—in emerging Europe enrollment rates are nearly the same as in advanced economies, while sub-Saharan Africa, although improved, is well behind.

The gender gap in youth labor force participation is also much larger in emerging market and developing economies (Figure 2.1.3). Median youth labor force participation has trended down for both females and males in advanced economies: the initial female partic-

**Box 2.1 (continued)**

**Figure 2.1.2. Median Secondary Enrollment by Geographic Region (Percent)**



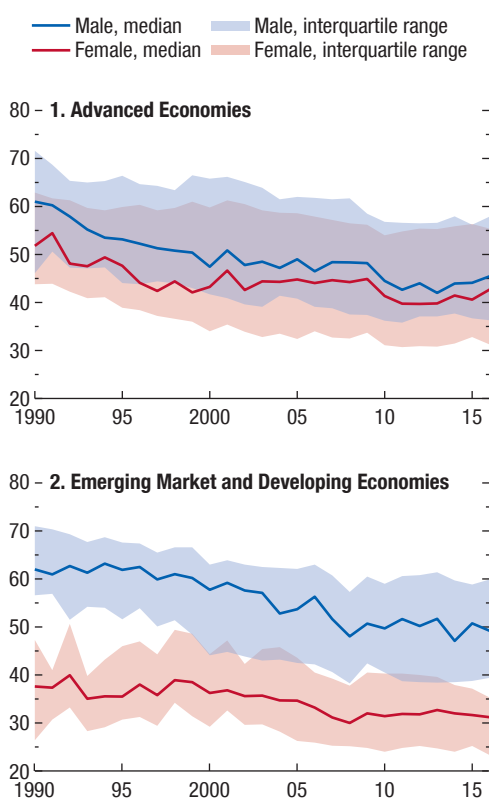
Sources: Lee and Lee, Long-Run Education Dataset (2016); and IMF staff calculations.  
 Note: Adjusted gross enrollment ratios are shown.  
 AEs = advanced economies; EAP = East Asia and Pacific; ECA = Europe and central Asia; EMDEs = emerging market and developing economies; LAC = Latin America and Caribbean; MENA = Middle East and North Africa; SA = south Asia; SSA = sub-Saharan Africa.

icipation gap of about 10 percentage points has shrunk to just a couple of percentage points in recent years. By contrast, the gender gap remains very large in emerging market and developing economies, at about 20 percentage points.

Individual-level census data allow for deeper investigation into the dynamics of the youth gender gap across countries. From these data, for each country and year, the predicted probability of participating in the labor market can be calculated for each young woman, given her observable characteristics.<sup>4</sup> The

<sup>4</sup>More specifically, the analysis estimates multinomial logit probability models by country-year, gender, and age group (young and not young) for individual labor market outcomes (that is, in school, unemployed, employed, out of the labor

**Figure 2.1.3. Youth Labor Force Participation by Gender (Percent)**



Sources: International Labour Organization; and IMF staff calculations.

counterfactual likelihood can also be calculated for each young woman: the predicted probability of labor force participation if she were male, holding all other observable characteristics constant. The average difference between these two quantities at the individual level yields an alternative measure of the gender gap

force, or unoccupied) conditional on individual-level observable characteristics (such as marital status, parent or not, educational attainment, and others). The models are then used to calculate predicted probabilities at the individual level, which can be aggregated up to get a sense of the average behavior.

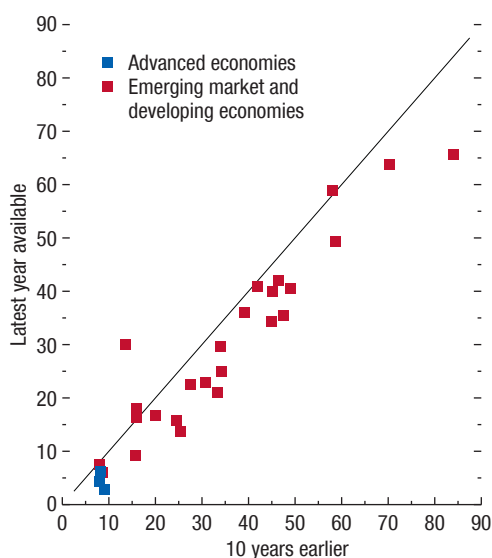
**Box 2.1 (continued)**

in labor force participation facing young women in that country and year, with the advantage that it takes account of the effects of non-gender-related individual characteristics.

There is a wide range of youth gender gaps across countries, from about 5 percentage points to almost 70 percentage points in the latest year for which data are available (Figure 2.1.4).<sup>5</sup> That said, there has been a broad-based improvement—most points lie below the 45-degree line, indicating that the gender gap has shrunk. While this decline is encouraging, there is still a long way to go to fully close the gender gap in youth labor force participation. As discussed in Elborgh-Woytek and others (2013), Gonzales and others (2015a), and Ahn and others (forthcoming), potential policy responses include a mix of labor market, social policy, and other reforms.

<sup>5</sup>See Minnesota Population Center (2017). IPUMS International underlying data set sources: Argentina (National Institute of Statistics and Censuses), Austria (National Bureau of Statistics), Bangladesh (Bureau of Statistics), Bolivia (National Institute of Statistics), Botswana (Central Statistics Office), Brazil (Institute of Geography and Statistics), Cambodia (National Institute of Statistics), Colombia (National Administrative Department of Statistics), Costa Rica (National Institute of Statistics and Censuses), Dominican Republic (National Statistics Office), Ecuador (National Institute of Statistics and Censuses), El Salvador (General Directorate of Statistics and Censuses), France (National Institute of Statistics and Economic Studies), Ghana (Ghana Statistical Services), India (Ministry of Statistics and Programme Implementation), Indonesia (Statistics Indonesia), Iran (Statistical Center), Kyrgyz Republic (National Statistical Committee), Malaysia (Department of Statistics), Mexico (National Institute of Statistics, Geography, and Informatics), Nicaragua (National Institute of Statistics and Censuses), Panama (Census and Statistics Directorate), Peru (National Institute of Statistics and Informatics), Portugal (National Institute of Statistics), Romania (National Institute of Statistics), South Africa (Statistics South Africa), Tanzania (National Bureau of Statistics), Trinidad and Tobago (Central Statistical Office), United States (Bureau of the Census), Uruguay (National Institute of Statistics), Venezuela (National Institute of Statistics), Zambia (Central Statistical Office).

**Figure 2.1.4. Implied 10-Year Improvement in Country Gender Gaps for Youth**  
(Percentage points)



Sources: Integrated Public Use Microdata Series International; and IMF staff calculations.

Note: A country's gender gap is defined as the average across the individual-level difference between a young woman's predicted probability of labor force participation given her observables and her predicted probability given the same observables if she were male (a counterfactual). See text Footnote 4 for a brief description of the underlying probability models. Each country shown has at least two years of census data, but the time difference varies between 5 and 20 years. For comparability across countries, the latest data are taken as given and the change in gender gap is normalized to back out the implied gender gap 10 years earlier for each country. Youth are defined as 15–29 years old.

### Box 2.2. Permanently Displaced? Labor Force Participation in US States and Metropolitan Areas

The decline in US labor force participation over the past two decades has been widely documented and, as highlighted in this chapter, deviates from the evolution of participation in many advanced European economies.

Many hypotheses have been put forth for this puzzling decline (alongside the effects of aging). These include cyclical effects and the severity of the Great Recession, structurally lower labor demand brought on by the forces of trade and technology (especially for those with low skills), and lower labor supply (because of incarceration, disability, and pain) as well as waning cohort effects for women’s participation and the role of policy.<sup>1</sup>

This box examines regional differences in labor force participation in the United States to shed light on the factors that may underpin participation declines. It documents a broad-based decline in participation, especially in rural areas. Moreover, it finds that lower participation in metropolitan areas is strongly associated with exposure to routinization and offshoring. This supports hypotheses about the role of deteriorating job opportunities for some workers as a result of technology and globalization in their increasing detachment from the workforce (in line with the findings of Acemoglu and Autor 2011, Council of Economic Advisers 2016, and Krause and Sawhill 2017).

#### Broad-Based Decline across States

The decline in participation rates is very broad based across US states (Figure 2.2.1, panel 1). Between 2000 and 2016, participation declined in almost all states,<sup>2</sup> but declines were most pronounced in the Southeast<sup>3</sup> and parts of the Midwest and West.<sup>4</sup> The decline was much smaller in the Mid-Atlantic<sup>5</sup> and New England.<sup>6</sup>

These declines stand in marked contrast to pre-2000 developments, when participation increased almost across the board by an average of more than 5 percentage points between 1976 and 2000 (Figure 2.2.1, panels 2 and 3).

The authors of this box are Benjamin Hilgenstock and Zsóka Kóczán.

<sup>1</sup>See, for example, Aaronson and others (2006); Fallick and Pingle (2007); Blau and Kahn (2013); Council of Economic Advisers (2014, 2016); Balakrishnan and others (2015); Case and Deaton (2017); Krause and Sawhill (2017); and Krueger (2017). See Abraham and Kearney (2018) for a recent review.

<sup>2</sup>The District of Columbia is treated as a state for the purpose of this box.

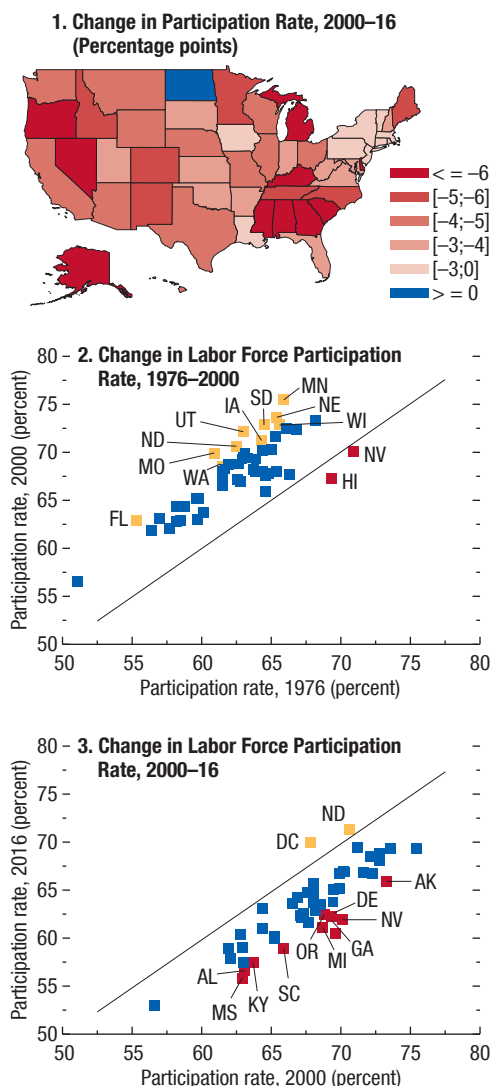
<sup>3</sup>Alabama, Georgia, Kentucky, Mississippi, South Carolina.

<sup>4</sup>Alaska, Michigan, Nevada, Oregon.

<sup>5</sup>Maryland, New Jersey, Pennsylvania.

<sup>6</sup>Connecticut, Massachusetts.

**Figure 2.2.1. Labor Force Participation and Change in Labor Force Participation by State**



Sources: US Bureau of Labor Statistics; US Census Bureau; and IMF staff calculations.

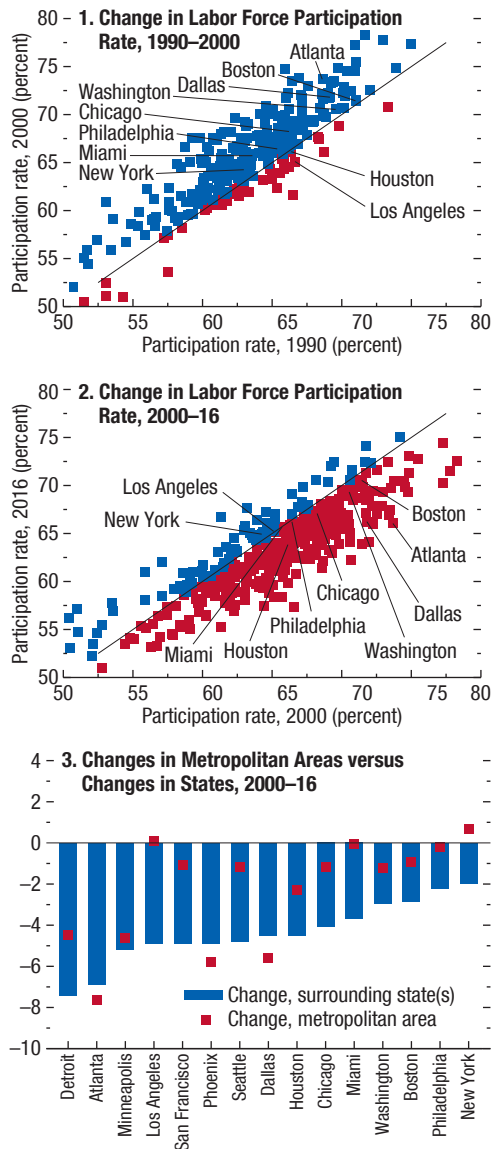
Note: Red markers denote states with decreases (panel 2) or particularly pronounced decreases (panel 3). Gold markers denote states with increases (panel 3) or particularly pronounced increases (panel 2). Labels in the figure use International Organization for Standardization (ISO) state codes.

#### More Pronounced outside Metropolitan Areas

Similar patterns can be observed at the metropolitan area level (Figure 2.2.2). Labor force participation rates declined between 2000 and 2016 in three-quarters of metropolitan areas; among the 50 most populated areas

Box 2.2 (continued)

**Figure 2.2.2. Change in Labor Force Participation Rate by Metropolitan Area**

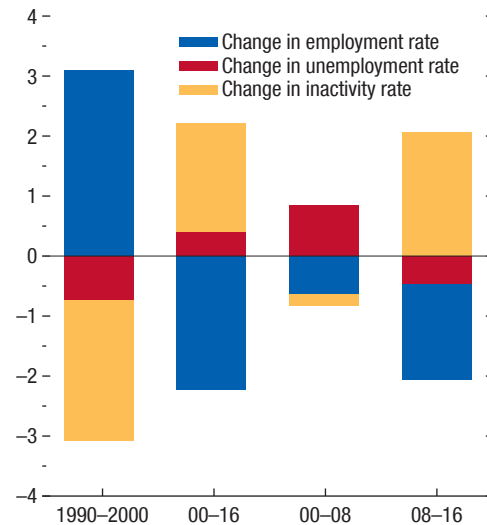


Sources: US Bureau of Labor Statistics; US Census Bureau; and IMF staff calculations.  
 Note: In panels 1 and 2, red markers display metropolitan areas with decreases in labor force participation rates. The 10 largest areas by 2016 population are labeled. In panel 3, if metropolitan areas are assigned to multiple states, blue bars show population-weighted averages of surrounding states.

only 16 (typically with already high participation) displayed increases, of which most were comparably small.<sup>7</sup>

<sup>7</sup>Because several metropolitan areas cross state lines, Figure 2.2.2, panel 3, assigns metropolitan areas to states based on the definition of the US Office of Management and Budget.

**Figure 2.2.3. Decomposition of Labor Market Changes in Metropolitan Areas (Percentage points)**



Sources: US Bureau of Labor Statistics; US Census Bureau; and IMF staff calculations.  
 Note: Employment rate, unemployment rate, and inactivity rate are defined, respectively, as total employment, total unemployment, and total inactive population as a percentage of total population. Numbers represent simple averages across metropolitan areas.

However, declines were typically larger in a state as a whole than in its metropolitan areas, exacerbating urban-rural differences (Figure 2.2.2, panel 3; in line with the findings of Weingarden 2017).

*The Role of the Crisis and Changing Margins of Adjustment*

The decline in participation became more widespread after the global financial crisis, when lower employment increasingly translated into lower participation (Figure 2.2.3). Before 2000 employment increased, on average, and was matched by declines in unemployment and increases in participation. After 2000, employment declined, matched by increasing unemployment and falling participation. Although most of the decline in employment translated into rising unemployment before the crisis, after the crisis participation fell sharply.

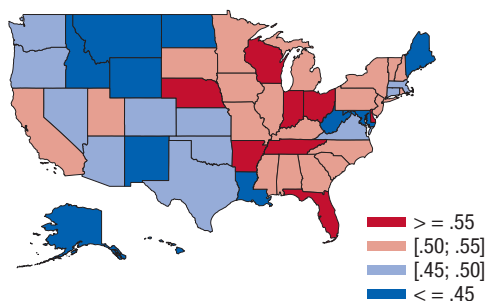
*Drivers of Labor Force Participation*

Cross-sectional regressions at the metropolitan area level examine the association between 2000-16 changes in labor force participation rates and cyclical conditions, aging, and education, as well as the impact of

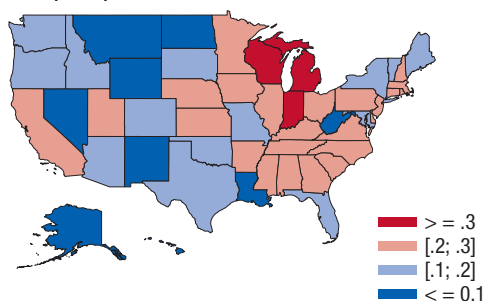
**Box 2.2 (continued)**

**Figure 2.2.4. Routine and Offshoring Exposure by State**

**1. Routine Exposure by State, 2000 (Index)**



**2. Offshoring Exposure by State, 2000 (Index)**



Sources: US Bureau of Labor Statistics; US Census Bureau; and IMF staff calculations.

technology and trade, captured by the initial exposures to routinization and offshoring.<sup>8</sup> These results confirm the significant effects of cyclical conditions, aging, and education highlighted in the chapter (Table 2.2.1).<sup>9</sup>

Furthermore, metropolitan areas with higher initial exposures to automation and offshoring due to their occupational employment compositions saw larger subsequent declines in participation rates.<sup>10</sup> This suggests that automation and offshoring may have permanently displaced some workers, even if their effects on the economy as a whole were beneficial through the creation of job opportunities in other sectors or productivity gains.

In the short and medium term, support should thus be provided to workers displaced as a result of automation and globalization to dampen the negative effects of labor market shocks that may be highly concentrated in some sectors, occupations, or geographic areas.

<sup>8</sup>Exposures to routinization and offshoring act as proxies for the share of jobs at risk of being automated or offshored (see Chapter 3 of the April 2017 WEO; and Das and Hilgenstock, forthcoming). Regressions include state fixed effects.

<sup>9</sup>State-level cyclical effects are also documented by Erceg and Levin (2013), Council of Economic Advisers (2014), and Balakrishnan and others (2015). Dao, Furceri, and Loungani (2014) highlight the increasing role of participation as an absorber of state-level labor demand shocks. Sanchez, Shen, and Peng (2004) look at the impact of mobility on employment outcomes at the metropolitan area level.

<sup>10</sup>Figures 2.2.4 and 2.2.1, panel 1, suggest that this link holds at the state level as well: exposure to routinization and offshoring was especially high in the Southeast and Midwest, which also exhibited the largest declines in participation.

**Table 2.2.1. Drivers of Labor Force Participation Rates in US Metropolitan Areas**

	(1)	(2)	(3)	(4)	(5)
Average Real GDP Growth			0.442*** (0.145)	0.444*** (0.144)	0.368*** (0.140)
Change in Old-Age-Dependency Ratio			-0.144*** (0.040)	-0.130*** (0.041)	-0.152*** (0.038)
Change in Postsecondary Share			0.037 (0.023)	0.040* (0.023)	0.053** (0.022)
Initial Exposure to Routinization	-2.811** (1.153)			-2.492** (1.222)	
Initial Exposure to Offshoring		-4.212*** (0.935)			-4.929*** (0.962)
Observations	370	370	335	335	335
R <sup>2</sup>	0.289	0.319	0.360	0.369	0.414

Source: IMF staff calculations.

Note: Standard errors are in parentheses. The dependent variable is change in labor force participation rate.

\*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.



### Box 2.3. Still Attached? Labor Force Participation Trends in European Regions

In addition to the significant cross-country variation in Europe documented in this chapter, there are also large within-country differences in labor force participation.<sup>1</sup> As in the United States (Box 2.2), rural areas saw larger drops or smaller increases in labor force participation rates than urban areas, though declines typically started later and were less broad based than in the United States. However, European regions more exposed to routinization and offshoring through their initial occupation mix did not experience larger declines in participation over a longer horizon, once labor markets had time to adjust.<sup>2</sup>

#### *Heterogeneity across Regions*

Labor force participation declined in about one-third of European regions between 2000 and 2016. Although some countries exhibit similar patterns across regions (for instance participation declined in all regions in Norway and Romania and increased in all regions in Spain and Sweden), others (such as France, Germany, Portugal, and the United Kingdom) show significant within-country differences (Figure 2.3.1).<sup>3</sup> This contrasts with broad-based declines observed across US states and metropolitan areas (Box 2.2). Participation declined in only about 27 percent of European regions between 2000 and 2008 and in about 45 percent of regions between 2008 and 2016.<sup>4,5</sup>

The authors of this box are Benjamin Hilgenstock and Zsóka Kóczán.

<sup>1</sup>A great deal of literature analyzes the drivers of (especially women's) participation in Europe at the country level, focusing predominantly on the role of policy (such as incentives for part-time work and family-friendly measures—see, for example, Genre, Gómez-Salvador, and Lamo 2010; Cipollone and others 2013; Thévenon 2013; and Miani and Hoorens 2014), and cohort effects (see, for example, Balleer, Gómez-Salvador, and Turunen 2014 for a cross-country study and Euwals, Knoef, and van Vuuren 2011 for the Netherlands). Dauth, Findeisen, and Suedekum (2014) look at the impact of trade on German labor markets. The key contribution of this box is its focus on variation at the regional level, in particular the impact of technology.

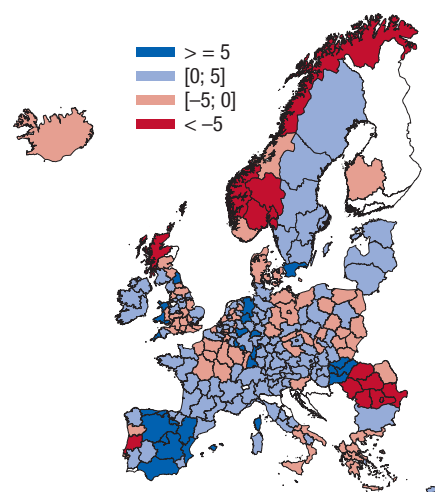
<sup>2</sup>In the following the term “regions” refers to Eurostat’s Nomenclature of Territorial Units for Statistics (NUTS) 2 level regions wherever data are available. When these data are not available, NUTS 1 and NUTS 0 regions are used instead. Most of the box includes regions in advanced Europe as well as in emerging Europe; for consistency with the chapter, the regression analysis focuses on advanced Europe only. Simple averages are used throughout.

<sup>3</sup>See also Centre for Cities (2018) on the economic divide in the United Kingdom.

<sup>4</sup>Regional participation rates are not available before 2000.

<sup>5</sup>Furthermore, this hides a great deal of underlying disparity: participation continued to increase after as well as before the crisis in 38 percent of regions (for example, Austria, Germany,

**Figure 2.3.1. Change in Labor Force Participation by Region, 2000–16**  
(Percentage points)



Sources: Eurostat; and IMF staff calculations.

However, as in the United States, there is a divide between urban and rural regions, with the latter showing larger decreases or smaller increases in participation rates (Figure 2.3.2, panel 3).

#### *The Role of the Crisis and Changing Margins of Adjustment*

Margins of adjustment changed in Europe too, though later than in the United States (Figure 2.3.3). While in the United States employment started to decline around 2000, employment increased, on average, in European regions until the crisis, matched by falling unemployment and rising participation. As employment started to decline after the crisis, this translated into rising unemployment, with, on average, still small increases in participation.

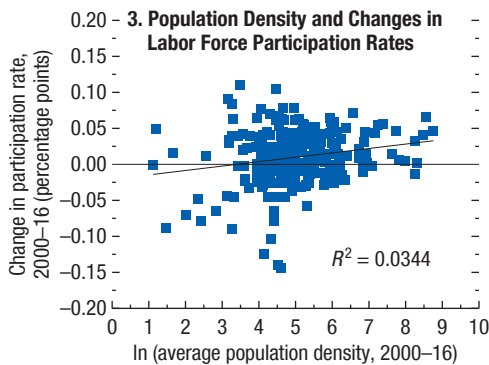
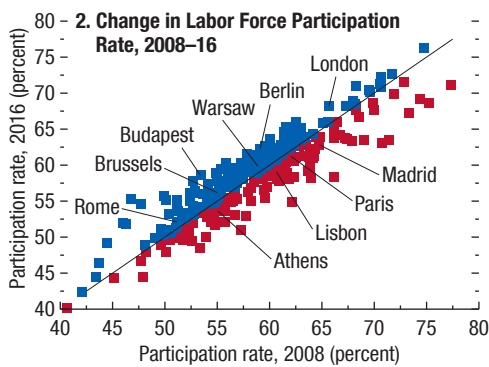
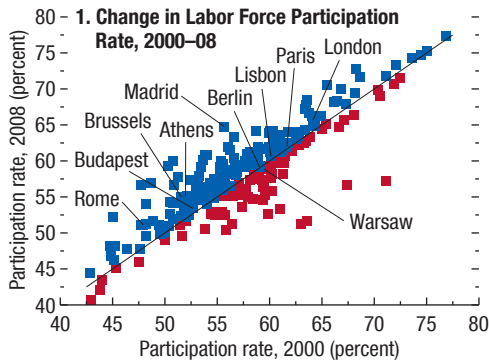
#### *Drivers of Labor Force Participation*

As in Box 2.2, cross-sectional regressions (here at the level of European regions) examine the link between 2000–16 changes in labor force participation and cycli-

and Switzerland); continued to fall in 10 percent (for example, Romania and the United Kingdom); started to decline in 35 percent (for example, Belgium, Denmark, the Netherlands, and Portugal); but started to increase in 18 percent (for example, the Czech Republic, Poland, and the Slovak Republic).

Box 2.3 (continued)

**Figure 2.3.2. Change in Labor Force Participation Rate by Region**

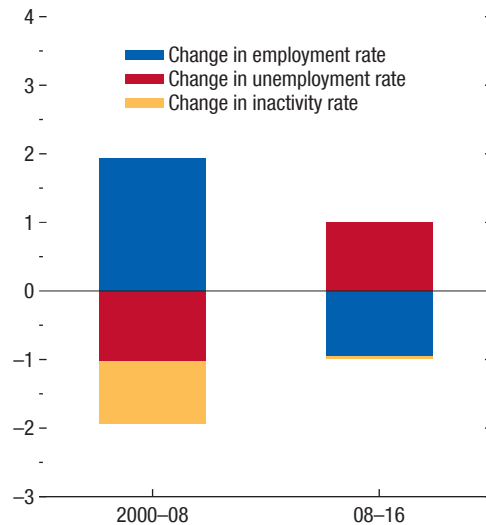


Sources: Eurostat; and IMF staff calculations.  
 Note: In panels 1 and 2, red markers display regions with decreases in labor force participation rates. The 10 largest regions by 2016 population are labeled.

cal conditions, aging, and education.<sup>6</sup> Subnational evidence confirms the significant effects of aging, cyclical conditions, and education highlighted in this chapter (Table 2.3.1). However, unlike in the United States

<sup>6</sup>Regressions control for country fixed effects.

**Figure 2.3.3. Decomposition of Labor Market Changes**  
 (Percentage points)



Sources: Eurostat; and IMF staff calculations.  
 Note: Employment rate, unemployment rate, and inactivity rate are defined, respectively, as total employment, total unemployment, and total inactive population as a percentage of total population. Numbers represent simple averages across regions.

(Box 2.2), European regions more exposed to routinization and offshoring as a result of their 2000 occupational mix experienced, if anything, larger participation gains during 2000–16 (Figures 2.3.4 and 2.3.5).<sup>7</sup>

There are several possible explanations for this finding, which seems contrary to the patterns observed in the chapter and across US metropolitan areas. First, unlike the analysis in the main text, which examines the participation consequences of annual variation in the relative price of investment as a proxy for firms' incentives to automate routine tasks, this specification focuses on changes in participation over a longer time horizon, allowing labor markets to adjust to demand shocks. The positive correlation across European regions could thus be picking up an added-worker effect. Secondary earners may enter the labor market as a result of lower household income. This would be

<sup>7</sup>Dauth, Findeisen, and Suedekum (2014) find that the rise of China and eastern Europe in the world economy caused substantial job losses in German regions specializing in import-competing industries, but caused employment gains in export-oriented industries, with an overall positive effect of trade integration on employment.

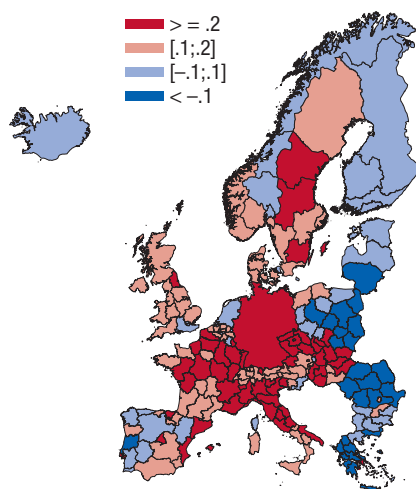
**Box 2.3 (continued)**
**Table 2.3.1. Drivers of Labor Force Participation Rates in European Regions**

	(1)	(2)	(3)	(4)	(5)
Average Real GDP Growth			0.457 (0.325)	1.061*** (0.383)	1.176*** (0.387)
Change in Old-Age-Dependency Ratio			-0.282*** (0.056)	-0.211*** (0.072)	-0.218*** (0.072)
Change in Postsecondary Share			0.187*** (0.053)	0.145** (0.069)	0.117* (0.070)
Initial Exposure to Routinization	4.258** (1.995)			5.435*** (1.815)	
Initial Exposure to Offshoring		4.157** (1.968)			5.518*** (1.846)
Observations	148	148	223	140	139
R <sup>2</sup>	0.645	0.644	0.646	0.730	0.729

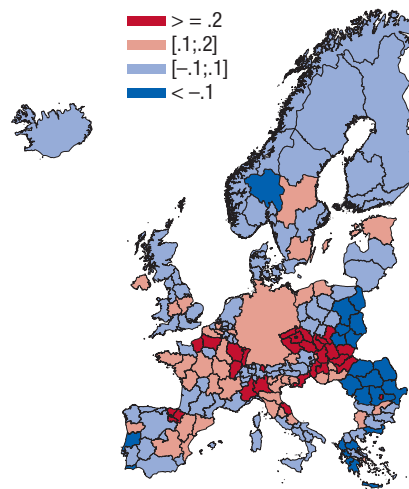
Source: IMF staff calculations.

Note: Standard errors are in parentheses. The dependent variable is change in labor force participation rate.

 \* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ .

**Figure 2.3.4. Initial Routine Exposure by Region, 2000**  
(Index)


Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations.

**Figure 2.3.5. Initial Offshoring Exposure by Region, 2000**  
(Index)


Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations.

consistent with the sharp rise in female participation observed in most European regions and the rise in two-earner households documented in the chapter. Second, institutional frameworks and policies in Europe may have allowed those potentially affected by routinization and offshoring to remain attached to the workforce and/or encouraged new entrants to the labor market. The former is consistent with the smaller changes in the occupational mix in European countries over this time period, which suggests that fewer jobs were automated or offshored than in the United

States. The latter is consistent with the significantly larger contribution of policy to labor force participation in Europe relative to the United States, which is documented in this chapter.

Striking within-country differences in the evolution of labor force participation have important implications for policy—they call for more explicit recognition of the spatial dimension of economic vulnerability given that short- and medium-term costs are concentrated not only in particular sectors and occupations but also affect different places in different ways.

### Box 2.4. Storm Clouds Ahead? Migration and Labor Force Participation Rates

As discussed in the chapter, slowing population growth and rising life expectancy will put significant downward pressure on labor supply. Even sizable gains in labor market participation of those more marginally attached to the labor force, such as women and older workers, could be ultimately outweighed by the pressure of aging. In this context, many argue that international migration could bring significant benefits, by boosting labor supply in recipient economies while leveraging the demographic dividend in other parts of world. Net migration has accounted for about half of the population growth in advanced economies since the mid-1980s, while natural population growth (measured as the difference between fertility and mortality) has been falling (Figure 2.4.1).

This box examines the effects of migration on future labor force participation in (receiving) advanced economies, as well as the drivers of migrants' decision to participate.

It documents that migration assumptions, already embedded in population projections for advanced economies, play a very significant role in alleviating aging pressures. In the absence of migration, the decline in participation would be significantly deeper. Support for migrants' rapid labor market integration will yield significant further gains.

#### Migration: The Role of Age Composition Effects

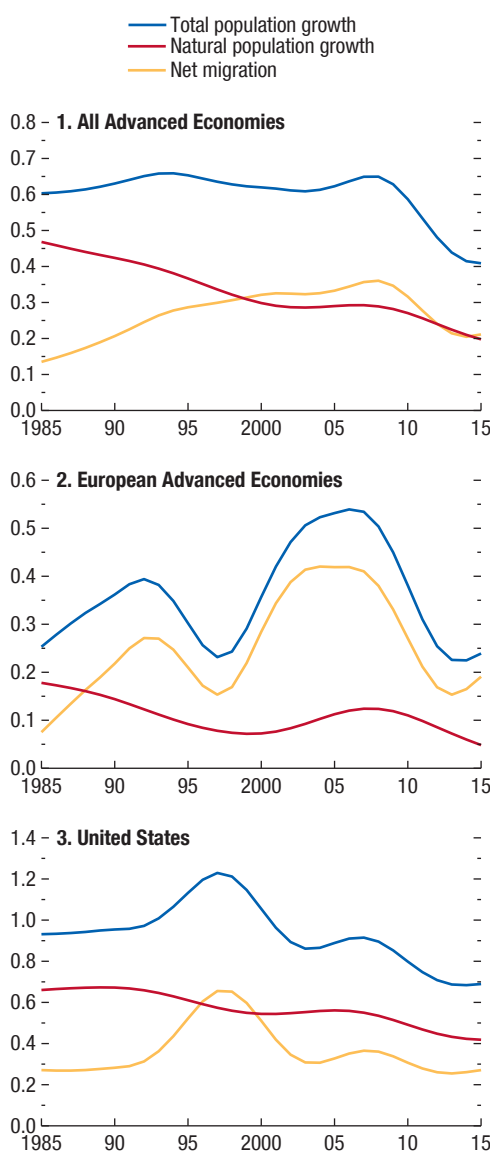
One way migrants affect the labor supply in recipient economies is through age composition. Migrants are more likely to be of prime working age than natives because they typically arrive after they have completed their education and often leave when they retire (Figure 2.4.2, panel 1). Because participation is highest among those of prime working age, age composition has significant implications for overall labor force participation.

Figure 2.4.2, panel 2, illustrates the expected evolution of aggregate labor force participation in advanced European economies under Eurostat's alternative migration scenarios; differences stem solely from changes in the age composition of the countries' populations as a result of net migration.<sup>1</sup> Under the

The authors of this box are Benjamin Hilgenstock and Zsóka Kóczán.

<sup>1</sup>The Eurostat baseline scenario is broadly based on trend extrapolation until 2050 (EC 2017). It would imply, for instance, an increase in Germany's migrant stock from the current 14 percent to 29 percent. The high (low) migration

**Figure 2.4.1. Contributions of Natural Population Growth and Net Migration to Total Population Growth (Percent)**



Sources: United Nations; and IMF staff calculations.  
Note: Panel 1 is based on a balanced sample of 34 advanced economies. Natural population growth refers to the difference between fertility and mortality.

**Box 2.4 (continued)**

baseline scenario, the average aggregate participation rate would decline by 7.4 percentage points by 2050. Allowing for an increase in net migration could offset some of this decline: the drop would be 0.8 percentage point less under the assumption of high migration (it would be 0.8 percentage point more under low migration). More restrictive immigration policies would significantly exacerbate the negative effect of population aging on participation. Strikingly, if no new migration is allowed, the decline in participation would be 2.7 percentage points larger. These effects would be especially large in high-migration countries (Figure 2.4.2, panel 3).

*Participation Effects of Migration*

While migration can boost aggregate participation rates through compositional shifts, it is important to recognize that participation rates differ significantly between migrants and natives, and these differences vary by gender and age.

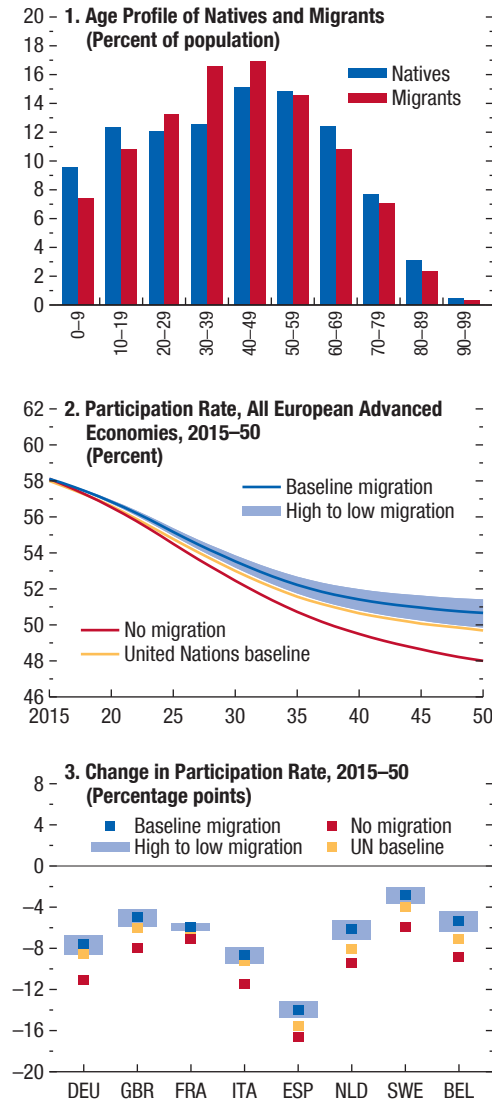
Disaggregated data from 24 advanced European economies suggest that young migrants are more likely to be in the labor force than young natives (42 percent versus 36 percent; young natives are, on average, more likely to be in education), but participation among migrants 55 and older is slightly lower than for natives in the same age group (5 percent versus 6 percent).<sup>2</sup> A close look at prime-age workers shows that participation of prime-age men is very similar for natives and migrants. The most significant difference relates to the participation of prime-age women, with significantly lower participation among migrant women (75 percent versus 81 percent; Figure 2.4.3, panel 1).

However, migrant participation rates converge toward those of natives over time: participation increases with years in the host country, especially for prime-age women (Figure 2.4.3, panel 2). This

scenarios refer to a one-third increase (decrease) in net migration relative to the baseline (so, for Germany, would result in migrant stocks of 25 and 33 percent, respectively, by 2050). The United Nations baseline scenario assumes a continuation of recent migration trends for nonrefugee flows until 2050, but also considers the country's migration policy stance (see UN 2017 for details). While, on average, this produces estimates broadly consistent with the European Union's low-migration scenario, this is not necessarily the case for individual countries. Figure 2.4.2, panel 2, shows population-weighted averages across countries.

<sup>2</sup>Disaggregated data are from Eurostat's European Labour Force Survey. The statistics described above are from a random sample of 10,000 respondents per country per year.

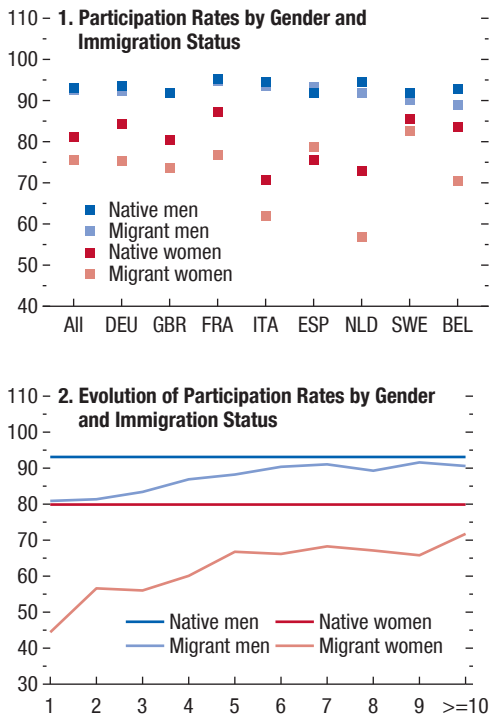
**Figure 2.4.2. Projected Evolution of Labor Force Participation Rates**



Sources: Eurostat; United Nations; and IMF staff calculations. Note: In panels 1 and 2, countries included are AUT, BEL, CYP, CZE, DEU, DNK, ESP, EST, FIN, FRA, GBR, GRC, IRL, ITA, LTU, LUX, LVA, MLT, NLD, NOR, PRT, SVK, SVN, and SWE. Labels in the figure and note use International Organization for Standardization (ISO) country codes. Detailed migration scenarios are based on Eurostat data and are compared to the United Nations baseline scenario.

**Box 2.4 (continued)**

**Figure 2.4.3. Labor Force Participation Rates of Prime-Age Natives and Migrants, 2000–16 (Percent)**



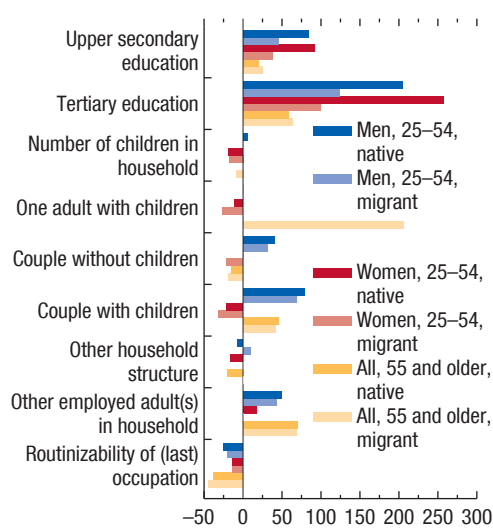
Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations.  
 Note: In panel 1, “All” refers to European advanced economies as listed in the note to Figure 2.4.2. Panel 2 is based on the eight countries listed in panel 1. x-axis in panel 2 denotes years since migration.

effect holds up even when controlling for individual and household characteristics: an additional year in the host country is estimated to increase the odds of participation by 5–6 percent.

Abstracting from the age composition effect discussed earlier, allowing migrants’ participation rates to increase to natives’ participation rates would result in an additional 1.4 percentage point increase in overall participation (relative to a no convergence scenario), even holding the relative shares of the age groups in the population constant.<sup>3</sup>

<sup>3</sup>This example keeps population shares of the eight groups (young, prime-age men, prime-age women, and people 55 and over for natives and migrants separately) constant at their

**Figure 2.4.4. Change in the Odds of Being Active (Percent)**



Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations.  
 Note: Logit regressions based on a 10,000 respondents per country per year random sample of 18 countries. Only effects significant at the 10 percent level are shown. The base category for education is “up to lower secondary education.” For family composition the base category is “one adult without children.” The routine exposure coefficient is scaled by the difference between the 25th and 75th percentiles. Regressions also control for age, gender, urban/rural location, year, country and region fixed effects, and the output gap. Standard errors are clustered at the country-year level.

**Migrants’ Participation Decisions**

What is holding back migrants’ involvement in the labor market? Figure 2.4.4 builds on the logit specification estimated in the chapter—looking at the effects of individual and household characteristics on individual participation decisions—but here it is examined separately for migrants and natives.

In many ways, migrants’ participation decisions are shaped by the same factors that shape those of natives. Those who are more educated participate more, house-

2000–16 average shares and examines what the overall rate would be if migrants’ participation equaled that of natives. Given that young migrants’ participation exceeds young natives’ this is assumed to stay constant; prime-age and 55-plus migrants’ participation are assumed to increase to natives’ levels.

**Box 2.4 (continued)**

hold composition matters, and the threat of automation is linked to a lower likelihood of being active.

However, the results also point to significant differences relative to natives. Although higher education increases the odds of being active for both migrants and natives, the effects are significantly smaller for migrants, likely pointing to difficulties in the recognition of foreign qualifications or language barriers to labor market integration.

The effects of household composition are much larger for migrants: being married and having children has larger negative effects on the participation of migrant women than on that of native women. Local labor market effects are also weaker for migrant women.

***Policies for Migrant Integration***

These results suggest that policies that support migrant integration, such as recognition of educational qualifications or language training, could increase the positive effect of migration on participation in (receiving) advanced economies, beyond its effects on age

composition (see also Chapter 4 of the October 2016 *World Economic Outlook* [WEO]). This could help mitigate some of the future negative effects of aging and help make social safety nets more sustainable in these economies.

Higher migration flows could contribute to labor supply and the host economy more broadly as well—increasing output per capita by boosting demand and investment, contributing to technological progress, and increasing labor productivity, including through skill complementarity.<sup>4</sup>

<sup>4</sup>See Chapter 4 of the October 2016 WEO for a summary; see also Peri and Sparber (2009); Hunt and Gauthier-Loiselle (2010); Farré, González, and Ortega (2011); D'Amuri and Peri (2014); Ortega and Peri (2014); Alesina, Harnoss, and Rapoport (2015); Cattaneo, Fiorio, and Peri (2015); Peri, Shih, and Sparber (2015); Aiyar and others (2016); and Jaumotte, Koloskova, and Saxena (2016). At the same time, the impact of migration on average wages or employment of native workers is found to be limited (see Card 1990; Peri 2014; IMF 2015; and Aiyar and others 2016).

## Annex 2.1. Data Sources and Country Coverage

The primary data sources for this chapter are the Organisation for Economic Co-operation and Development, IMF World Economic Outlook (WEO) database, and United Nations World Population Prospects. The micro-level analysis is based on data from the 2000–16 European Union Labour Force Surveys by the European Commission, which are available from Eurostat. All data sources used in the main analysis (excluding boxes) are listed in Annex Table 2.1.1.

The sample consists of the 39 economies classified as advanced economies in Table B of the April 2018 WEO, excluding the smallest economies (that is, Hong

Kong Special Administrative Region, Macao Special Administrative Region, Malta, Puerto Rico, San Marino, and Taiwan Province of China). However, due to data limitations, the included economies vary across the analyses, as indicated in Annex Table 2.1.2. The shift-share analysis relies on a sample of 32 advanced economies during 1980–2016 for which detailed data on labor force participation by age group and gender are available. The cross-country analysis on the role of policies and other factors is based on annual data for 23 advanced economies during 1980–2011, which were classified as advanced economies for the entire sample period and for which data on policy variables

**Annex Table 2.1.1. Data Sources**

Indicator	Source
Labor Force Participation	OECD, Employment database
Labor Force Participation by Education	Eurostat; National authorities
Employment Rate	OECD, Employment database
Unemployment Rate	IMF, WEO database
Output Gap	IMF, WEO database
Crisis Indicator	Gourinchas and Obstfeld (2012)
Relative Price of Investment	IMF, WEO database
Routine Exposure	Das and Hilgenstock (forthcoming) based on Autor and Dorn (2013), Eurostat, and population censuses
Trade Openness	IMF, WEO database
Sectoral Employment of Industry and Services	World Bank, World Development Indicators database; European Union, Level Analysis of Capital, Labour, Energy, Materials, and Service inputs (EU KLEMS)
Urban Population	World Bank, World Development Indicators database
Population by Education (primary, secondary, tertiary)	Barro-Lee Educational Attainment data set
Labor Tax Wedge	OECD, Tax database; Bassanini and Duval (2006); Chapter 3 of the April 2016 WEO
Unemployment Benefits	OECD, Benefits and Wages: Statistics
Public Spending on ALMP	OECD, Social Expenditure database
Migration Policies	International Migration Institute, DEMIG POLICY database
Union Density	OECD, Employment database
Coordination of Wage Setting	Amsterdam Institute for Advanced Labour Studies, Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention, and Social Pacts
Public Spending on Early Childhood Education and Care	OECD, Social Expenditure database
Part-Time Employment	OECD, Employment database
Job-Protected Maternity Leave	OECD, Family database
Statutory Retirement Age	International Social Security Association, Social Security Programs throughout the World
Old-Age-Pension Spending	OECD, Social Expenditure database
Incapacity Spending	OECD, Social Expenditure database
Implicit Tax on Continued Work	Duval (2003); Chapter 3 of the April 2016 WEO
Pension Replacement Ratio	Luxembourg Income Study database
Population Projections	United Nations World Population Prospects, 2017 revision
School Enrollment	OECD, Education database
Returns to Education	Luxembourg Income Study database
Education Spending	Eurostat
Employment Protection	OECD, Employment database

Source: IMF staff compilation.

Note: ALMP = active labor market programs; OECD = Organisation for Economic Co-operation and Development; WEO = *World Economic Outlook*.



**Annex Table 2.1.2. Country Coverage**

Exercise	Countries
Shift-Share Analysis	Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States
Aggregate Analysis	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States
Micro-Level Analysis	Austria, Belgium, Cyprus, Czech Republic, Denmark, Germany, Estonia, Finland, France, Greece, Iceland, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom
Cohort-Based Analysis	Australia, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Israel, Japan, Luxembourg, Norway, Portugal, Spain, Sweden, United Kingdom, United States

Source: IMF staff compilation.

are available. Micro-level analysis is based on annual data for 24 advanced European economies during 2000–16. Information on family composition is not available for Denmark, Finland, Iceland, Norway, Sweden, or Switzerland, so regressions including these variables are estimated on a subset of 18 economies. The cohort-based analysis relies on annual data for 17 advanced economies from 1985 to 2016 for which gender-specific labor force participation rate data are available for quinquennial age groups starting at age 15 and up to 64 and covering ages 65 to 99.

**Annex 2.2. Additional Stylized Facts**

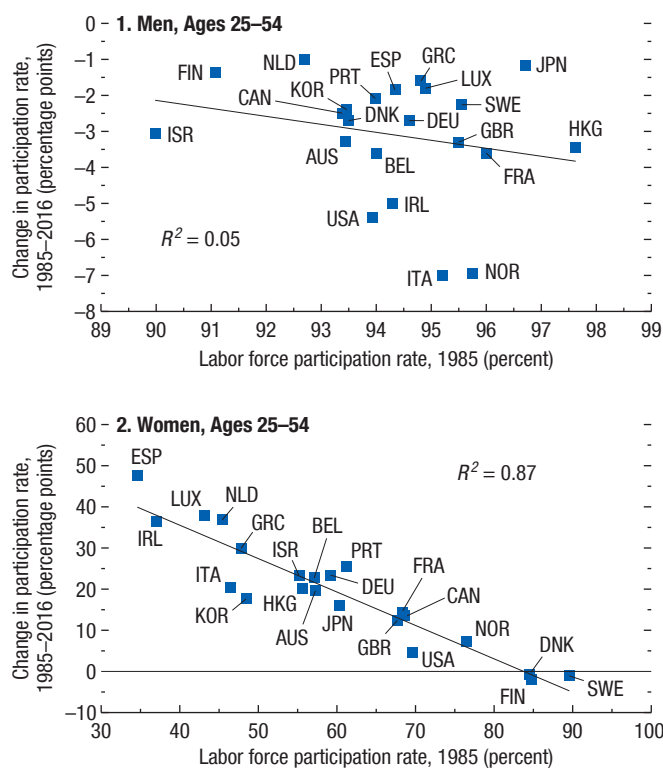
This section provides further stylized facts on convergence across economies in participation rates, the link between the participation of men and women, and the effects of the global financial crisis.

Annex Figure 2.2.1 examines whether there is evidence for convergence across economies in participation rates. While this seems to be limited for men, gains in female participation were indeed substantially larger in economies where women were historically less likely to be part of the workforce. As a result, as documented in the chapter, the dispersion in women’s participation across advanced economies has narrowed since 1985.

The rise in women’s labor force participation is also consistent with the rising share of two-earner households. Based on micro data from the European Union Labour Force Survey, Annex Figure 2.2.2 shows that the share of households with one adult working and one adult not working has fallen since 2000, while the share of households with both adults working has increased.

Annex Figure 2.2.3 examines the hypothesis that women’s increasing participation may have allowed

**Annex Figure 2.2.1. Changes in Labor Force Participation Rates, 1985–2016**

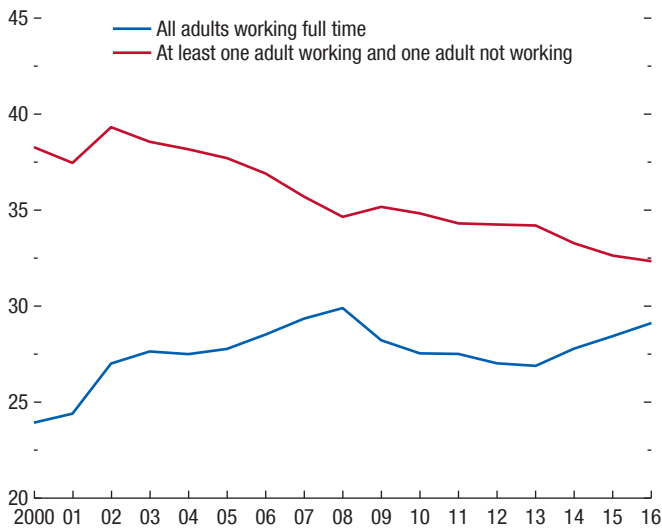


Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.

Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

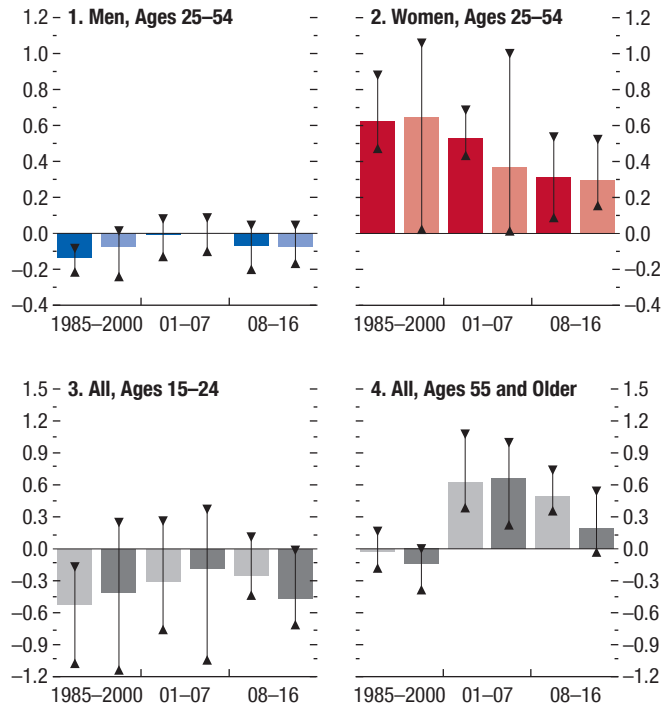
some men to drop out of the labor force and finds no evidence for this at the country level. Correlations between changes in prime-age female and male participation rates are, if anything, positive, though relatively weak.

**Annex Figure 2.2.2. Share of Households by Employment Composition, 2000–16**  
(Percent)



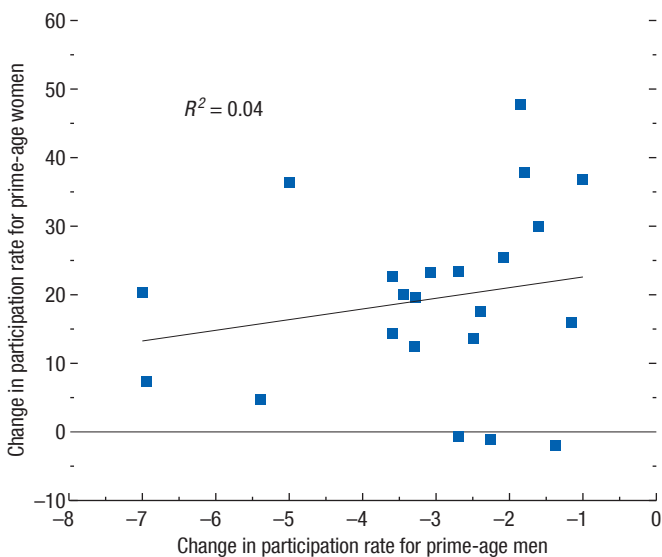
Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations.  
Note: Reported statistics are estimated from a random sample of 10,000 respondents per country per year from the European Union Labour Force Survey over the period 2000–16.

**Annex Figure 2.2.4. Average Annual Changes in Labor Force Participation Rates**  
(Percentage points)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.  
Note: Bars denote median; and vertical lines denote interquartile range. In all panels, left bars for each time period show countries above the median in terms of real GDP loss during 2008–12 and right bars show countries below the median.

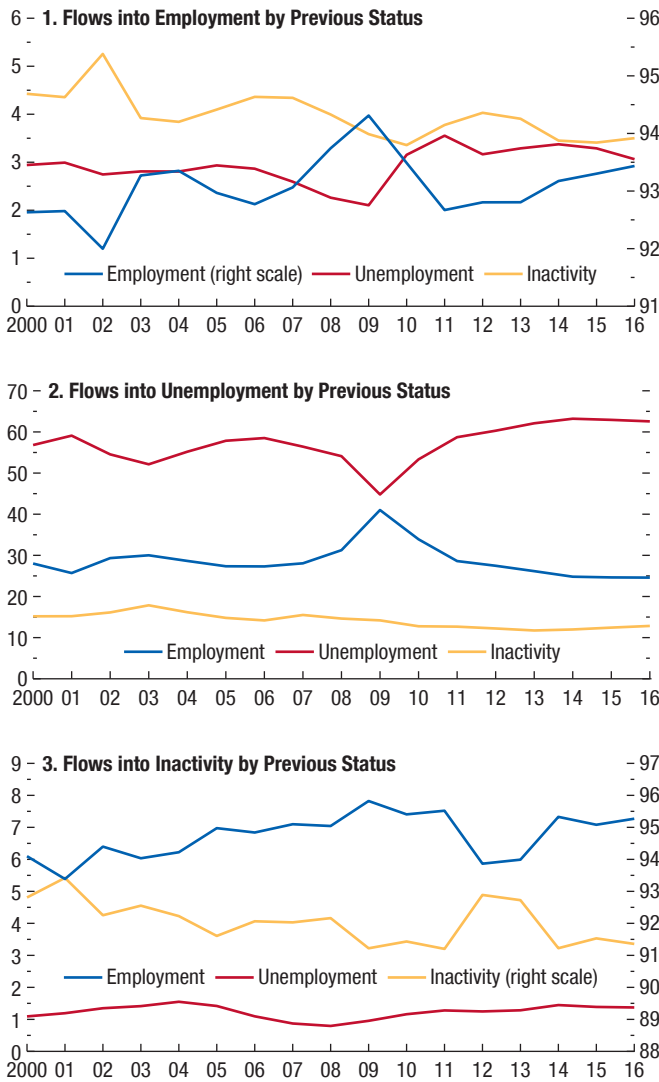
**Annex Figure 2.2.3. Changes in Labor Force Participation Rates of Prime-Age Men and Women, 1985–2016**  
(Percentage points)



Sources: Organisation for Economic Co-operation and Development; and IMF staff calculations.  
Note: Prime age is defined as between 25 and 54.

Annex Figures 2.2.4 and 2.2.5 analyze the effects of the global financial crisis and European debt crises further. Annex Figure 2.2.4 compares economies with above- and below-median GDP losses during the crisis and finds that the dynamics of their labor force participation rates were broadly similar. Annex Figure 2.2.5 in turn examines the evolution of transition probabilities—flows from employment, unemployment, and inactivity into employment, unemployment, and inactivity—over time. This suggests that the share of discouraged workers (those who are inactive but were unemployed the previous year) has been increasing since the crisis and is approaching the precrisis peak. This figure also illustrates the spike in flows from employment into unemployment during the global financial crisis, as well as flows from unemployment back into employment after the crisis.

**Annex Figure 2.2.5. Flows into Employment, Unemployment, and Inactivity**  
(Percent)



Sources: Eurostat, European Union Labour Force Survey; and IMF staff calculations. Note: Previous status refers to labor force status in the previous year. Reported statistics are estimated from a random sample of 10,000 respondents per country per year from the European Union Labor Force Survey over the period 2000–16.

**Annex 2.3. The Role of Aging and Cyclical Factors**  
**Shift-Share Analysis**

A standard shift-share analysis is performed to establish how demographic changes in advanced economies have contributed to the trends in participation rates since 2008. The gender-specific aggregate labor force

participation rate,  $LFP^a$ , can be rewritten as the participation rates of workers of gender  $a$  in age group  $g$ , weighted by their share in the male or female population, respectively:

$$LFP_{i,t}^a = \sum_{g=1}^n LFP_{i,t}^{a,g} \frac{pop_{i,t}^{a,g}}{pop_{i,t}}, \tag{2.1}$$

in which  $i$  denotes the country,  $t$  is the time index,  $a$  is the gender,  $g$  is the age group (15–24, 25–54, 55–64, 65 and over), and  $pop$  is the population. The aging effect is obtained as the difference between the actual participation rate and the one obtained by holding constant the gender and group-specific participation rates at their 2008 level,  $LFP_{i,2008}^{a,g}$ , but allowing the population shares,  $\frac{pop_{i,t}^{a,g}}{pop_{i,t}}$ , to vary as observed in the data.

**Estimating the Role of Cyclical Conditions**

Economic contractions generally result in greater unemployment and lower labor force participation as some workers get discouraged and permanently separate from the workforce, and others choose to delay entry. To capture the effect of the cycle on labor force participation, the chapter estimates the following regression:

$$LFP_{i,t}^* = \sum_{k=0}^1 \beta^k UG_{i,t-k} + \sum_{k=0}^1 \delta^k Crisis_{i,t-k} + \sum_{k=0}^1 \gamma^k UG_{i,t-k} Crisis_{i,t-k} + \pi_i + \tau_t + \varepsilon_{it} \tag{2.2}$$

in which  $LFP^*$  is the detrended aggregate labor force participation rate, obtained by applying the Hodrick-Prescott (HP) filter to the labor force participation rate;  $UG$  is the unemployment gap, defined as the gap between current unemployment and the nonaccelerating inflation rate of unemployment (NAIRU);<sup>51</sup>  $Crisis$  is a dummy variable that takes a value of 1 for when there is either a currency crisis, a sudden stop, a debt crisis, or a banking crisis, based on the Gourinchas-Obstfeld database; and  $\pi_i$  and  $\tau_t$  are country and time fixed effects.

The regression is estimated using annual data during 1980–2016, and the cyclical effect at time  $t$  is obtained as the predicted value of the regression. The difference in the predicted cyclical component relative to its 2008 value captures the role of the cycle in the change in

<sup>51</sup>The NAIRU is constructed as in Chapter 3 of the April 2013 *World Economic Outlook*.

aggregate participation since then. While the findings rely on a specification with a single lag ( $k = 1$ ) estimated in a panel setting, the results are qualitatively similar if a richer lag structure is used instead, or if the sensitivity of labor force participation to the cycle is allowed to vary across economies. Results are also robust to employing the Corbae-Ouliaris (CO) filter instead of the HP filter to obtain the detrended aggregate labor force participation rate in equation (2.2), as well as to calculating it as deviations from a three-year moving average, limiting the distortions generated by the endpoint problem of the HP filter.

### Annex 2.4. The Role of Policies and Other Factors: Aggregate Cross-Country Analysis

This analysis estimates a reduced-form specification of labor force participation that relates the participation rate of specific groups of workers to factors that may affect the decision to supply labor. It controls for all differences across economies that are constant over time and shocks that affect all economies. While the potential set of drivers is large, the analysis, guided by the conceptual framework described in the main text, focuses on factors that can be measured relatively consistently across economies and over time and that are most commonly discussed in policy debates.<sup>52</sup> More specifically, the aggregate analysis is based on the estimation of the equation

$$LFP_{i,t}^g = \beta^{X,g} X_{i,t}^g + \beta^{D,g} D_{i,t} + \beta^{GAP,g} GAP_{i,t-1} + \beta^{Z,g} Z_{i,t} + \pi_i^g + \tau_i^g + \varepsilon_{i,t}^g \quad (2.3)$$

in which  $LFP$  denotes the participation rate of worker group  $g$  in country  $i$  in year  $t$ ,  $GAP$  is the cyclical position of the economy,  $X$  represents the set of policies and institutions (some of which are specific to group  $g$ ),  $D$  denotes a set of factors that may shift the demand for worker group  $g$ ,  $Z$  includes other determinants of labor supply (education), and  $\pi_i$  and  $\tau_i$  are

<sup>52</sup>The vast theoretical literature on labor supply offers a large number of models with different assumptions, including about (1) the ability of consumers to transfer capital across periods and to consider more generally a life-cycle framework; (2) the extent to which labor supply decisions are made by the household rather than the individual worker; (3) the role of uncertainty about future income, household composition, and health status; and (4) how government programs affect the incentives to work (see Blundell and MaCurdy 1999 for a review). Developing a macroeconomic theory of labor supply encompassing all these features for different groups of workers is beyond the scope of this chapter.

country and time fixed effects.<sup>53</sup> Some of the evidently endogenous variables are included in the specification with a one-year lag. The groups comprise young workers (15–24), prime-age men (25–54), prime-age women (25–54), and older workers (55 and over); an additional equation is estimated for a group encompassing all workers 15 and older.

Given the complex correlation structure of the error term with dependence across economies, autocorrelation due to the slow-moving nature of the dependent variable, and heteroscedasticity, the Driscoll and Kraay (1998) correction to the standard errors is used to make statistical inferences. The findings are robust to various alternative corrections of standard errors as discussed later.

The analysis then decomposes the contributions from each regressor to changes in participation of group  $g$  between years  $t$  and  $t'$  as

$$C_{i,t,t'}^{S,g} = \widehat{\beta}^{S,g} (S_{i,t'}^g - S_{i,t}^g), \quad (2.4)$$

in which  $S = \{X, D, GAP, Z\}$  and  $C_{i,t,t'}^{S,g}$  is the contribution of variable  $S$ .

The key variables included in the analysis are the following:

- The cyclical position is captured using the output gap. The results are not sensitive to using alternative measures, such as the unemployment rate.
- Exposure to technological progress is measured following Chapter 3 of the April 2017 *World Economic Outlook* (WEO) and Das and Hilgenstock (forthcoming). The relevant variable is the interaction between the relative price of investment and the country's exposure to routinization through its initial occupational mix. The latter consists of scores that rely on occupation-level measures by Autor and Dorn (2013), which order occupations by their share of routine tasks, and then use the employment shares of these occupations to construct country-level measures of routinizability. The average relative price of investment across all advanced economies is used to minimize endogeneity concerns and capture changes that are due to global technological progress (rather than, for example, country-specific capital taxation policies).

<sup>53</sup>Results from panel unit root tests suggest that the time series of labor force participation rates for different age groups are trend stationary. Because of limited data availability for some of the explanatory variables, using a dynamic specification in the presence of country fixed effects would return biased estimates (Nickell 1981).

- Potential shifts in the demand for different types of labor due to structural transformation are measured as the ratio of employment in the service sector relative to employment in the industrial sector and the share of urban population.
- Educational attainment is from the Barro-Lee database (Lee and Lee, 2016) and is measured as the share of the population within a specific age-gender group with the highest level of education reported as primary, secondary, or tertiary.
- The labor tax wedge is defined as the ratio between the average tax paid by a single-earner family (one parent at 100 percent of average earnings with two children) and the corresponding total labor cost for the employer. The labor tax wedge is available from the Organisation for Economic Co-operation and Development (OECD) for 2000–16 and is extended back to 1979 using Bassanini and Duval (2006) and Chapter 3 of the April 2016 WEO. The latter series is available only in odd years; the value of the labor tax wedge in even years is obtained by linear interpolation.
- The generosity of the unemployment benefits system is measured as the gross replacement rate, which is equal to the gross unemployment benefit levels as a percentage of previous gross earnings and is published by the OECD. The OECD summary measure with the best coverage is the average of the gross unemployment benefit replacement rates for two earnings levels, three family situations, and three durations of unemployment. Such measures are available in odd years and are interpolated for even years. The reported values are for the average worker from 2001 to 2011 and the average production worker from 1981 to 2005. The two series are spliced.
- Public expenditure on active labor market programs, published by the OECD, is calculated as active labor market program spending per unemployed person in percent of GDP per capita, following Gal and Theising (2015).
- Restrictiveness of migration policy is obtained from the DEMIG POLICY database compiled by the International Migration Institute, which codes all changes to the existing legal framework relevant for migration (see also de Haas, Natter, and Vezzoli 2014). The chapter focuses on major changes in policies guiding the postentry rights or other aspects of migrants' integration. These changes are cumulated starting in 1980 to construct an index for each country, with a higher value denoting more restrictive policies.
- Union density is measured as net union membership as a proportion of wage earners in employment. The variable is published by the OECD.
- Coordination of wage setting is an index of the centralization of bargaining, published by the Amsterdam Institute for Advanced Labour Studies Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts. The index runs from 1 to 5 with values defined as (1) fragmented wage bargaining, confined largely to individual firms or plants; (2) mixed industry and firm-level bargaining, weak government coordination through minimum wage setting or wage indexation; (3) negotiation guidelines based on centralized bargaining; (4) wage norms based on centralized bargaining by peak association with or without government involvement; and (5) maximum or minimum wage rates/increases based on centralized bargaining.
- Policies that help reconcile work inside and outside the household are proxied by public spending on early childhood education and care as a percent of GDP; the proportion of employees with a part-time contract to total employees; and job-protected maternity leave, defined as the total number of weeks of job-protected maternity, parental, and extended leave available to mothers, regardless of income support. These variables are published by the OECD.
- Retirement incentives are proxied by the statutory retirement age and by the generosity of pension plans. A database of statutory retirement ages is compiled from various publications of *Social Security Programs Throughout the World*. Several alternatives are used to capture the generosity of pension plans. The measure with the best country and time coverage is old-age and incapacity spending as a percent of GDP from the OECD. This measure is first purged of fluctuations resulting from cyclical and demographic factors (namely, share of the population in different age groups and health status, proxied by life expectancy) that may mechanically generate a negative correlation with the labor force attachment of older workers. As a robustness check, the analysis considers the (conceptually more appropriate but less widely available) implicit tax on continued work, calculated as the change in the present value of the stream of future pension payments

net of contributions to the system from working five more years for typical workers at different ages (see Duval 2004 and Chapter 3 of the April 2016 WEO). An alternative measure also considered is the aggregate replacement ratio, calculated as the ratio of the mean disposable income of people ages 65–74 to the mean disposable income of those ages 50–59, from the Luxembourg Income Study Database. This variable can be computed for selected years based on the availability of household survey data and is interpolated for the missing years.

Annex Tables 2.4.1–2.4.5 present the key results from the cross-country panel regressions, along with numerous robustness checks. Annex Table 2.4.1 contains the estimated coefficients for the regression on the young, Annex Table 2.4.2 on the prime-age male workers, Annex Table 2.4.3 on the prime-age female workers, Annex Table 2.4.4 on older workers and Annex Table 2.4.5 on the aggregate participation rate. Each table shows the results from the baseline specification discussed in the main text (Table 2.1, column 1) and establishes its robustness to alternative measures, specification, error structure, and the like.

- *Logistic transformation:* Given that participation rates are bounded by 0 and 100 by construction, the analysis is repeated using the logistic transformation of the dependent variable in column (2).
- Alternative corrections to standard errors are as follows:
  - *Cross-equation correlation:* There may be correlation across the error terms of the estimations for different worker groups. Estimating a system including one equation for each group in a seemingly unrelated regression framework returns similar results in column (3).
  - *Cross-sectional dependence:* Tests by Pesaran (2004) and Frees (1995) reject the null hypothesis of cross-sectional independence, but the results of the test by Friedman (1937) suggest that cross-sectional dependence is not present. The results are generally robust to alternative correc-

tions of the standard errors. In particular, the conclusions are broadly unchanged when employing the Beck and Katz (1995) estimator in column (4), correcting the standard errors only for heteroscedasticity and autocorrelation in column (5) and adopting the Newey-West correction for the standard errors in column (6).

- *Cyclical effects:* Possible distortions arising from inability to control for cyclical effects are controlled for by estimating the equation on five-year averages, which could also rule out the possibility that the results depend on some undetected local unit root. The dependent variables in the regressions are trend stationary, which excludes the possibility of undetected cointegrating relationships with the explanatory variables. While some of the explanatory variables are locally nonstationary, most of these are shares bounded between 0 and 100. The results based on five-year averages presented in column (7) are broadly comparable to those of the baseline estimates.
- *Global financial crisis:* The significance and the magnitude of the coefficients are not affected by dropping 2008 and 2009 from the sample, as shown in column (8).
- *Other advanced economies:* Broadening the sample to economies that were classified as advanced in the WEO database after 2006 does not generally alter the results, as can be seen in column (9).
- *Alternative measures of the output gap:* In column (10), the analysis replaces the output gap with the unemployment rate. This specification returns qualitatively comparable results. However, in this case, older workers' participation rates turn out to be sensitive to the cyclical conditions of the economy.
- *Sample selection:* The analysis rules out the possibility that single economies drive the results by estimating the same specification dropping one economy at a time. The estimates display remarkable stability, as is shown in column (11). This exercise also allays concerns that the findings on the role of certain variables may be an artifact of measurement errors in the series of some economies.

Annex Table 2.4.1.1. Drivers of Youth (Ages 15–24) Labor Force Participation Rates: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Baseline	Logistic Transformation	SUR	Beck and Katz	HAC Standard Errors	Newey-West Standard Errors	Five-Year Averages	Excluding GFC	Including All AEs	Replacing Output Gap with Unemployment Rate	Dropping One Country at a Time
Lag of Output Gap	0.360*** (0.112)	0.015*** (0.005)	0.219*** (0.073)	0.226*** (0.063)	0.360*** (0.080)	0.360*** (0.103)	0.473*** (0.183)	0.366*** (0.121)	0.286*** (0.100)	-0.519*** (0.100)	0.354 (0.292; 0.393)
Routinization x Relative Price of Investment	0.303 (0.299)	0.012 (0.012)	0.313 (0.280)	-0.143 (0.377)	0.303 (0.262)	0.303 (0.344)	0.358 (0.299)	0.358 (0.313)	0.295 (0.293)	0.404 (0.293)	0.297 (0.184; 0.489)
Lag of Trade Openness	0.059*** (0.022)	0.003*** (0.001)	0.045*** (0.016)	0.020 (0.019)	0.059*** (0.018)	0.059*** (0.019)	0.059* (0.026)	0.053** (0.024)	0.043* (0.022)	0.021 (0.028)	0.057 (0.045; 0.071)
Relative Service Employment	-0.002 (0.010)	-0.000 (0.000)	-0.026*** (0.008)	-0.020** (0.009)	-0.002 (0.009)	-0.002 (0.011)	-0.004 (0.012)	-0.004 (0.009)	0.002 (0.009)	0.004 (0.009)	-0.001 (-0.01; 0.001)
Lag of Urbanization	0.668*** (0.142)	0.030*** (0.006)	-0.089 (0.098)	0.575*** (0.135)	0.668*** (0.085)	0.668*** (0.159)	0.560*** (0.139)	0.700*** (0.170)	0.685*** (0.139)	0.715*** (0.175)	0.669 (0.626; 0.702)
Education (percent secondary)	-0.050 (0.042)	-0.002 (0.002)	0.007 (0.022)	-0.042 (0.032)	-0.050* (0.026)	-0.050 (0.036)	-0.049 (0.060)	-0.062 (0.049)	-0.050 (0.042)	-0.050 (0.049)	-0.049 (-0.076; -0.031)
Education (percent tertiary)	-0.275*** (0.057)	-0.012*** (0.002)	-0.105*** (0.038)	-0.227*** (0.047)	-0.275*** (0.042)	-0.275*** (0.054)	-0.253* (0.105)	-0.290*** (0.064)	-0.286*** (0.048)	-0.294*** (0.062)	-0.273 (-0.303; -0.247)
Tax Wedge	-0.103 (0.064)	-0.005* (0.003)	-0.021 (0.046)	-0.029 (0.050)	-0.103** (0.048)	-0.103* (0.058)	-0.086 (0.060)	-0.082 (0.064)	-0.094 (0.059)	0.057 (0.074)	-0.104 (-0.127; -0.058)
Unemployment Replacement Ratio	-0.002 (0.068)	-0.000 (0.003)	0.111*** (0.035)	0.009 (0.044)	-0.002 (0.039)	-0.002 (0.059)	-0.001 (0.140)	0.016 (0.070)	-0.009 (0.065)	0.007 (0.066)	0.003 (-0.036; 0.034)
Public Spending on ALMP	0.041*** (0.014)	0.002** (0.001)	-0.004 (0.013)	0.031 (0.023)	0.041*** (0.014)	0.041** (0.019)	0.023 (0.033)	0.048*** (0.014)	0.045*** (0.014)	0.030* (0.017)	0.041 (0.036; 0.048)
Restrictiveness of Migrant Integration Policies	0.491*** (0.098)	0.021*** (0.004)	0.421*** (0.079)	0.277** (0.108)	0.491*** (0.090)	0.491*** (0.146)	0.521*** (0.091)	0.492*** (0.109)	0.464*** (0.094)	0.421*** (0.114)	0.487 (0.414; 0.539)
Union Density	-0.009 (0.068)	-0.000 (0.003)	-0.065 (0.046)	-0.116** (0.057)	-0.009 (0.046)	-0.009 (0.066)	-0.021 (0.091)	-0.020 (0.069)	-0.001 (0.061)	0.011 (0.065)	-0.01 (-0.026; 0.016)
Coordination of Wage Setting	1.104*** (0.245)	0.045*** (0.010)	0.942*** (0.241)	0.081 (0.180)	1.104*** (0.251)	1.104*** (0.329)	1.848*** (0.451)	1.117*** (0.252)	1.088*** (0.233)	0.694** (0.284)	1.105 (0.852; 1.255)
Number of Observations	571	571	489	571	571	571	132	525	593	525	525
Countries	23	23	23	23	23	23	23	23	25	23	23
R <sup>2</sup>	0.515	0.521		0.922	0.515	0.515	0.573	0.529	0.517	0.540	0.540

Source: IMF staff calculations.

Note: The table presents results from estimation equation (2.3) with the participation rate of youth (ages 15–24) as the dependent variable on a sample of 23 advanced economies (AEs) during 1980–2011 using annual data. See Annex 2.4 for the construction of the explanatory variables and Annex Table 2.1.2 for the countries in the sample. All specifications include country and year fixed effects. Column (1) reports the baseline estimation results; column (2) reports the results after applying the logistic transformation to the dependent variable; column (3) reports the estimates from a seemingly unrelated regressions (SUR) estimation of a four-equation system (one for each group of workers); column (4) shows the results using the Beck and Katz (1995) estimator; column (5) reports the estimates with heteroskedasticity and autocorrelation consistent (HAC) standard errors, without the correction for cross-sectional dependence; column (6) shows the results with the Newey-West correction for the standard errors; column (7) shows the results based on a sample of five-year averages; column (8) reports the results dropping global financial crisis (GFC) years 2008 and 2009 from the sample; column (9) reports the coefficients when Czech Republic and Slovak Republic, which recently joined AEs, are added to the sample; column (10) shows the results when the lag of the output gap is replaced with the lag of the unemployment rate; and column (11) reports the median coefficient from a distribution of estimates obtained by dropping one country at a time from the sample. Driscoll-Kraay standard errors are reported in parentheses in columns (1), (2), (7)–(10); bootstrapped standard errors are reported in parentheses in column (3); HAC standard errors assuming a panel-dependent correlation structure are reported in column (4). Column (11) reports the 10th and 90th percentile of the estimated coefficients in parentheses. ALMP = active labor market programs.

\*p < .10, \*\*p < .05, \*\*\*p < .01.

**Annex Table 2.4.2. Drivers of Prime-Age Male (Ages 25–54) Labor Force Participation Rates: Robustness**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Baseline	Logistic Transformation	SUR	Beck and Katz	HAC Standard Errors	Newey-West Standard Errors	Five-Year Averages	Excluding GFC	Including All AEs	Replacing Output Gap with Unemployment Rate	Dropping One Country at a Time
Lag of Output Gap	0.072*** (0.020)	0.012*** (0.003)	0.058*** (0.017)	0.020 (0.016)	0.072*** (0.018)	0.072*** (0.022)	0.117*** (0.037)	0.070*** (0.022)	0.062*** (0.019)	-0.002 (0.029)	0.07 (0.06; 0.081)
Routinization × Relative Price of Investment	0.302*** (0.048)	0.070*** (0.011)	0.204*** (0.067)	0.217*** (0.057)	0.302*** (0.057)	0.302*** (0.074)	0.266*** (0.072)	0.303*** (0.048)	0.284*** (0.037)	0.315*** (0.049)	0.302 (0.285; 0.33)
Lag of Trade Openness	-0.005 (0.005)	-0.001 (0.001)	-0.012*** (0.004)	-0.015*** (0.005)	-0.005 (0.004)	-0.005 (0.005)	-0.003 (0.009)	-0.007 (0.006)	-0.005 (0.004)	-0.010 (0.006)	-0.005 (-0.006; -0.003)
Relative Service Employment	-0.002 (0.002)	-0.000 (0.000)	-0.000 (0.002)	-0.000 (0.002)	-0.002 (0.002)	-0.002 (0.002)	0.001 (0.002)	-0.002 (0.002)	-0.003 (0.002)	-0.002 (0.002)	-0.002 (-0.003; -0.001)
Lag of Urbanization	0.101*** (0.019)	0.015*** (0.004)	0.006 (0.023)	0.105*** (0.027)	0.101*** (0.019)	0.101*** (0.020)	0.072*** (0.023)	0.105*** (0.023)	0.104*** (0.020)	0.110*** (0.026)	0.101 (0.091; 0.114)
Education (percent secondary)	0.019*** (0.007)	0.003** (0.001)	0.037*** (0.008)	0.022*** (0.009)	0.019** (0.008)	0.019** (0.009)	0.015** (0.005)	0.022*** (0.007)	0.018** (0.007)	0.023*** (0.008)	0.019 (0.016; 0.026)
Education (percent tertiary)	0.019 (0.015)	0.001 (0.002)	0.023** (0.010)	0.030* (0.016)	0.019* (0.010)	0.019 (0.012)	0.017 (0.019)	0.027 (0.019)	0.018 (0.014)	0.029 (0.018)	0.018 (0.012; 0.027)
Tax Wedge	-0.002 (0.015)	-0.003 (0.002)	-0.009 (0.010)	0.005 (0.011)	-0.002 (0.010)	-0.002 (0.010)	-0.002 (0.027)	-0.001 (0.016)	0.004 (0.014)	0.002 (0.017)	-0.002 (-0.007; 0.001)
Unemployment Replacement Ratio	-0.041*** (0.007)	-0.007*** (0.001)	-0.037*** (0.008)	-0.024** (0.010)	-0.041*** (0.008)	-0.041*** (0.011)	-0.031*** (0.008)	-0.041*** (0.008)	-0.039*** (0.008)	-0.044*** (0.008)	-0.04 (-0.045; -0.034)
Public Spending on ALMP	0.005 (0.005)	0.001 (0.001)	-0.000 (0.003)	0.005 (0.005)	0.005 (0.003)	0.005 (0.005)	0.005 (0.009)	0.007 (0.005)	0.006 (0.005)	0.010* (0.005)	0.005 (0.004; 0.006)
Restrictiveness of Migrant Integration Policies	-0.047** (0.020)	-0.007** (0.003)	-0.052*** (0.019)	-0.019 (0.024)	-0.047** (0.020)	-0.047** (0.023)	-0.092** (0.025)	-0.053** (0.020)	-0.048** (0.021)	-0.056** (0.022)	-0.046 (-0.062; -0.034)
Union Density	-0.001 (0.011)	0.002 (0.002)	-0.016 (0.011)	-0.023* (0.012)	-0.001 (0.010)	-0.001 (0.013)	-0.011 (0.019)	0.000 (0.011)	-0.004 (0.011)	-0.000 (0.013)	-0.001 (-0.01; 0.007)
Coordination of Wage Setting	0.131** (0.063)	0.018* (0.010)	0.074 (0.057)	0.073* (0.040)	0.131** (0.055)	0.131* (0.069)	0.302** (0.090)	0.134* (0.068)	0.139** (0.062)	0.131 (0.080)	0.131 (0.117; 0.15)
Number of Observations	571	571	489	571	571	571	132	525	593	525	525
Countries	23	23	23	23	23	23	23	23	25	23	23
R <sup>2</sup>	0.606	0.622	0.997	0.997	0.606	0.606	0.695	0.622	0.600	0.611	0.611

Source: IMF staff calculations.

Notes: The table presents results from estimation equation (2.3) with the participation rate of prime-age men (ages 25–54) as the dependent variable on a sample of 23 advanced economies (AEs) during 1980–2011 using annual data. See Annex 2.4 for the construction of the explanatory variables and Annex Table 2.1.2 for the countries in the sample. All specifications include country and year fixed effects. Column (1) reports the baseline estimation results; column (2) reports the results after applying the logistic transformation to the dependent variable; column (3) reports the estimates from a seemingly unrelated regressions (SUR) estimation of a four-equation system (one for each group of workers); column (4) shows the results using the Beck and Katz (1995) estimator; column (5) reports the estimates with heteroskedasticity and autocorrelation consistent (HAC) standard errors, without the correction for cross-sectional dependence; column (6) shows the results with the Newey-West correction for the standard errors; column (7) shows the results based on a sample of five-year averages; column (8) reports the results dropping global financial crisis (GFC) years 2008 and 2009 from the sample; column (9) reports the coefficients when Czech Republic and Slovak Republic, which recently joined AEs, are added to the sample; column (10) shows the results when the lag of the output gap is replaced with the lag of the unemployment rate; and column (11) reports the median coefficient from a distribution of estimates obtained by dropping one country at a time from the sample. Driscoll-Kraay standard errors are reported in parentheses in columns (1), (2), (7)–(10); bootstrapped standard errors are reported in parentheses in column (3); HAC standard errors assuming a panel-dependent correlation structure are reported in column (4); HAC standard errors are reported in parentheses in column (5); and Newey-West corrected standard errors are reported in column (6). Column (11) reports the 10th and 90th percentile of the estimated coefficients in parentheses. ALMP = active labor market programs.

\*  $p < .10$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$ .



Annex Table 2.4.3. Drivers of Prime-Age Female (Ages 25–54) Labor Force Participation Rates: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Baseline	Logistic Transformation	SUR	Beck and Katz	HAC Standard Errors	Newey-West Standard Errors	Five-Year Averages	Excluding GFC	Including All AEs	Replacing Output Gap with Unemployment Rate	Dropping One Country at a Time
Lag of Output Gap	0.170* (0.092)	0.008* (0.004)	0.180*** (0.052)	0.114** (0.050)	0.170*** (0.056)	0.170* (0.095)	0.114 (0.223)	0.201* (0.098)	0.119 (0.072)	-0.407** (0.151)	0.167 (0.139; 0.188)
Routinization × Relative Price of Investment	1.793*** (0.206)	0.072*** (0.008)	1.866*** (0.206)	1.245*** (0.192)	1.793*** (0.222)	1.793*** (0.326)	1.565*** (0.229)	1.720*** (0.204)	1.578*** (0.205)	1.692*** (0.237)	1.781 (1.672; 1.914)
Lag of Trade Openness	0.010 (0.014)	0.000 (0.001)	0.016 (0.012)	0.009 (0.013)	0.010 (0.013)	0.010 (0.016)	0.013 (0.022)	0.022 (0.020)	-0.003 (0.011)	0.014 (0.018)	0.009 (0.002; 0.02)
Relative Service Employment	0.015*** (0.005)	0.000* (0.000)	0.015*** (0.005)	0.010* (0.006)	0.015** (0.006)	0.015** (0.007)	0.017** (0.006)	0.016*** (0.005)	0.020*** (0.005)	0.016*** (0.005)	0.015 (0.01; 0.019)
Lag of Urbanization	0.355*** (0.071)	0.021*** (0.004)	0.373*** (0.068)	0.313*** (0.061)	0.355*** (0.073)	0.355*** (0.075)	0.343*** (0.048)	0.372*** (0.079)	0.398*** (0.078)	0.341*** (0.077)	0.35 (0.299; 0.393)
Education (percent secondary)	0.211*** (0.017)	0.010*** (0.001)	0.203*** (0.023)	0.247*** (0.030)	0.211*** (0.025)	0.211** (0.031)	0.187*** (0.016)	0.215*** (0.020)	0.195*** (0.018)	0.221*** (0.022)	0.209 (0.19; 0.236)
Education (percent tertiary)	0.332*** (0.030)	0.016*** (0.001)	0.268*** (0.038)	0.360*** (0.048)	0.332*** (0.042)	0.332*** (0.053)	0.249*** (0.049)	0.332*** (0.035)	0.319*** (0.031)	0.360*** (0.042)	0.333 (0.285; 0.374)
Tax Wedge	-0.129*** (0.029)	-0.002 (0.001)	-0.134*** (0.032)	-0.095*** (0.026)	-0.129*** (0.035)	-0.129*** (0.041)	-0.141 (0.071)	-0.125*** (0.028)	-0.104*** (0.029)	-0.115*** (0.027)	-0.13 (-0.158; -0.104)
Unemployment Replacement Ratio	-0.035 (0.033)	-0.003 (0.002)	-0.036 (0.025)	-0.028 (0.021)	-0.035 (0.026)	-0.035 (0.033)	0.044 (0.095)	-0.040 (0.035)	-0.030 (0.033)	-0.048 (0.034)	-0.034 (-0.047; -0.025)
Public Spending on ALMP	0.039*** (0.006)	0.002*** (0.000)	0.040*** (0.009)	0.038*** (0.008)	0.039*** (0.010)	0.039*** (0.013)	0.022 (0.016)	0.038*** (0.007)	0.046*** (0.007)	0.042*** (0.008)	0.039 (0.031; 0.042)
Restrictiveness of Migrant Integration Policies	-0.462*** (0.049)	-0.019*** (0.002)	-0.464*** (0.056)	-0.330*** (0.063)	-0.462*** (0.060)	-0.462*** (0.082)	-0.449*** (0.083)	-0.470*** (0.052)	-0.436*** (0.047)	-0.496*** (0.057)	-0.463 (-0.491; -0.418)
Union Density	0.153*** (0.044)	0.004** (0.002)	0.165*** (0.033)	0.084** (0.041)	0.153*** (0.036)	0.153*** (0.047)	0.050 (0.094)	0.127** (0.046)	0.156*** (0.042)	0.116** (0.046)	0.151 (0.114; 0.173)
Coordination of Wage Setting	0.701*** (0.219)	0.026** (0.010)	0.675*** (0.164)	0.190 (0.126)	0.701*** (0.177)	0.701*** (0.235)	1.658** (0.444)	0.640** (0.259)	0.687*** (0.219)	0.603** (0.247)	0.707 (0.64; 0.771)
Public Spending on Early Childhood Education and Care	3.708*** (1.210)	0.250*** (0.071)	3.423*** (0.622)	2.151*** (0.799)	3.708*** (0.683)	3.708*** (0.951)	5.855** (2.146)	3.628*** (1.295)	3.670*** (1.177)	3.709*** (1.276)	3.699 (3.122; 4.285)
Share of Part-Time Employment	0.946*** (0.118)	0.045*** (0.006)	0.932*** (0.066)	0.735*** (0.064)	0.946*** (0.073)	0.946*** (0.098)	0.982*** (0.168)	0.943*** (0.126)	1.021*** (0.109)	0.889*** (0.104)	0.956 (0.868; 0.994)
Job-Protected Maternity Leave	0.025*** (0.006)	0.001*** (0.000)	0.026*** (0.007)	0.013 (0.009)	0.025*** (0.008)	0.025*** (0.009)	0.087*** (0.011)	0.024*** (0.006)	0.020*** (0.007)	0.025*** (0.006)	0.024 (0.021; 0.028)
Number of Observations	489	489	489	489	489	489	117	443	511	443	
Countries	23	23	23	23	23	23	23	23	25	23	
R <sup>2</sup>	0.887	0.870	0.971	0.887	0.887	0.887	0.891	0.881	0.879	0.879	

Source: IMF staff calculations.

Note: The table presents results from estimation equation (2.3) with the participation rate of prime-age women (ages 25–54) as the dependent variable on a sample of 23 advanced economies (AEs) during 1980–2011 using annual data. See Annex 2.4 for the construction of the explanatory variables and Annex Table 2.1.2 for the countries in the sample. All specifications include country and year fixed effects. Column (1) reports the baseline estimation results; column (2) reports the results after applying the logistic transformation to the dependent variable; column (3) reports the estimates from a seemingly unrelated regressions (SUR) estimation of a four-equation system (one for each group of workers); column (4) shows the results using the Beck and Katz (1995) estimator; column (5) reports the estimates with heteroskedasticity and autocorrelation consistent (HAC) standard errors, without the correction for cross-sectional dependence; column (6) shows the results with the Newey-West correction for the standard errors; column (7) shows the results based on a sample of five-year averages; column (8) reports the results dropping global financial crisis (GFC) years 2008 and 2009 from the sample; column (9) reports the coefficients when Czech Republic and Slovak Republic, which recently joined AEs, are added to the sample; column (10) shows the results when the lag of the output gap is replaced with the lag of the unemployment rate; and column (11) reports the median coefficient from a distribution of estimates obtained by dropping one country at a time from the sample. Driscoll-Kraay standard errors are reported in parentheses in columns (1), (2), (7)–(10); bootstrapped standard errors are reported in parentheses in column (3); HAC standard errors assuming a panel-dependent correlation structure are reported in column (4); HAC standard errors are reported in parentheses in column (5); and Newey-West corrected standard errors are reported in column (6). Column (11) reports the 10th and 90th percentile of the estimated coefficients in parentheses. ALMP = active labor market programs.

\*  $p < .10$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$ .

**Annex Table 2.4.4. Drivers of Older Workers' (Ages 55 and over) Labor Force Participation Rates: Robustness**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Baseline	Logistic Transformation	SUR	Beck and Katz	HAC Standard Errors	Newey-West Standard Errors	Five-Year Averages	Excluding GFC	Including All AEs	Replacing Output Gap with Unemployment Rate	Dropping One Country at a Time
Lag of Output Gap	-0.006 (0.068)	-0.000 (0.003)	0.009 (0.056)	0.025 (0.037)	-0.006 (0.055)	-0.006 (0.083)	0.178 (0.131)	0.003 (0.078)	0.000 (0.065)	-0.268*** (0.079)	-0.008 (-0.045; 0.014)
Routinization × Relative Price of Investment	0.505* (0.288)	0.009 (0.015)	1.038*** (0.222)	0.198 (0.229)	0.505*** (0.184)	0.505 (0.372)	0.473 (0.298)	0.468 (0.292)	0.742*** (0.241)	0.472 (0.289)	0.503 (0.219; 0.593)
Lag of Trade Openness	-0.059*** (0.009)	-0.002*** (0.000)	-0.066*** (0.013)	-0.012 (0.008)	-0.059*** (0.013)	-0.059*** (0.014)	-0.051*** (0.013)	-0.063*** (0.015)	-0.045*** (0.012)	-0.063*** (0.013)	-0.06 (-0.07; -0.044)
Relative Service Employment	0.009 (0.006)	0.001*** (0.000)	0.007 (0.006)	0.002 (0.004)	0.009 (0.006)	0.009 (0.006)	0.007 (0.006)	0.008 (0.006)	0.005 (0.006)	0.008 (0.006)	0.01 (0.004; 0.014)
Lag of Urbanization	0.194 (0.115)	0.014** (0.007)	-0.056 (0.084)	0.118 (0.092)	0.194*** (0.064)	0.194* (0.114)	0.138 (0.172)	0.225* (0.127)	0.189* (0.111)	0.223* (0.126)	0.194 (0.095; 0.245)
Education (percent secondary)	0.038* (0.021)	0.001 (0.001)	0.019 (0.021)	-0.016 (0.021)	0.038* (0.020)	0.038 (0.027)	0.004 (0.043)	0.037* (0.022)	0.053** (0.020)	0.037* (0.022)	0.036 (0.016; 0.059)
Education (percent tertiary)	0.389*** (0.050)	0.018*** (0.002)	0.321*** (0.059)	0.260*** (0.057)	0.389*** (0.058)	0.389*** (0.093)	0.296** (0.085)	0.384*** (0.053)	0.397*** (0.046)	0.386*** (0.056)	0.387 (0.3; 0.44)
Tax Wedge	-0.263*** (0.037)	-0.012*** (0.002)	-0.185*** (0.035)	-0.062** (0.029)	-0.263*** (0.032)	-0.263*** (0.049)	-0.332*** (0.070)	-0.255*** (0.039)	-0.245*** (0.040)	-0.255*** (0.040)	-0.268 (-0.288; -0.208)
Unemployment Replacement Ratio	-0.081 (0.050)	-0.006** (0.002)	-0.036 (0.029)	-0.039 (0.024)	-0.081*** (0.029)	-0.081* (0.043)	-0.073 (0.052)	-0.051 (0.049)	-0.079 (0.052)	-0.051 (0.047)	-0.08 (-0.088; -0.042)
Public Spending on ALMP	-0.025** (0.009)	-0.001 (0.001)	-0.024** (0.010)	-0.003 (0.008)	-0.025** (0.010)	-0.025** (0.012)	-0.039** (0.012)	-0.026** (0.010)	-0.027*** (0.010)	-0.027*** (0.009)	-0.025 (-0.029; -0.018)
Restrictiveness of Migrant Integration Policies	0.056 (0.088)	0.001 (0.005)	0.131* (0.068)	0.066 (0.058)	0.056 (0.069)	0.056 (0.092)	0.126 (0.132)	0.063 (0.087)	0.108 (0.092)	0.063 (0.084)	0.055 (-0.024; 0.11)
Union Density	-0.115*** (0.032)	-0.006*** (0.002)	-0.126*** (0.036)	-0.118*** (0.031)	-0.115*** (0.032)	-0.115*** (0.038)	-0.077 (0.052)	-0.127*** (0.038)	-0.125*** (0.026)	-0.125*** (0.036)	-0.114 (-0.146; -0.096)
Coordination of Wage Setting	0.040 (0.222)	0.010 (0.011)	-0.016 (0.185)	0.102 (0.078)	0.040 (0.173)	0.040 (0.214)	0.803* (0.363)	0.109 (0.239)	0.106 (0.231)	0.088 (0.246)	0.029 (-0.066; 0.111)
Statutory Retirement Age	0.661*** (0.174)	0.035*** (0.010)	0.677*** (0.196)	0.495** (0.209)	0.661*** (0.204)	0.661** (0.321)	0.505 (0.308)	0.591*** (0.178)	0.943*** (0.204)	0.594*** (0.179)	0.658 (0.456; 0.815)
Public Spending on Old-Age Pension	-0.750*** (0.154)	-0.038*** (0.009)	-0.597*** (0.196)	-0.306** (0.126)	-0.750*** (0.176)	-0.750*** (0.255)	-0.873*** (0.095)	-0.826*** (0.152)	-0.596*** (0.161)	-0.840*** (0.179)	-0.749 (-0.839; -0.566)
Public Spending on Incapacity	-0.421 (0.562)	-0.025 (0.031)	-0.689** (0.348)	-0.008 (0.300)	-0.421 (0.295)	-0.421 (0.404)	-0.659 (0.831)	-0.208 (0.586)	-0.320 (0.570)	-0.203 (0.584)	-0.426 (-0.634; -0.163)
Number of Observations	568	568	489	568	568	568	132	522	589	522	522
Countries	23	23	23	23	23	23	23	23	25	23	23
R <sup>2</sup>	0.686	0.681	0.925	0.686	0.686	0.686	0.737	0.665	0.690	0.666	0.666

Source: IMF staff calculations.

Note: The table presents results from estimation equation (2.3) with the participation rate of older workers (ages 55 and older) as the dependent variable on a sample of 23 advanced economies (AEs) during 1980–2011 using annual data. See Annex 2.4 for the construction of the explanatory variables and Annex Table 2.1.2 for the countries in the sample. All specifications include country and year fixed effects. Column (1) reports the baseline estimation results; column (2) reports the results after applying the logistic transformation to the dependent variable; column (3) reports the estimates from a seemingly unrelated regressions (SUR) estimation of a four-equation system (one for each group of workers); column (4) shows the results using the Beck and Katz (1995) estimator; column (5) reports the estimates with heteroskedasticity and autocorrelation consistent (HAC) standard errors, without the correction for cross-sectional dependence; column (6) shows the results with the Newey-West correction for the standard errors; column (7) shows the results based on a sample of five-year averages; column (8) reports the results dropping global financial crisis (GFC) years 2008 and 2009 from the sample; column (9) reports the coefficients when Czech Republic and Slovak Republic, which recently joined AEs, are added to the sample; column (10) shows the results when the lag of the output gap is replaced with the lag of the unemployment rate; and column (11) reports the median coefficient from a distribution of estimates obtained by dropping one country at a time from the sample. Driscoll-Kraay standard errors are reported in parentheses in columns (1), (2), (7)–(10); bootstrapped standard errors are reported in parentheses in column (3); HAC standard errors assuming a panel-dependent correlation structure are reported in column (4); HAC standard errors are reported in parentheses in column (5); and Newey-West corrected standard errors are reported in column (6). Column (11) reports the 10th and 90th percentile of the estimated coefficients in parentheses. ALMP = active labor market programs.

\* p < .10; \*\* p < .05; \*\*\* p < .01.

Annex Table 2.4.5. Drivers of Aggregate Labor Force Participation Rates: Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Baseline	Logistic Transformation	Beck and Katz	HAC Standard Errors	Newey-West Standard Errors	Five-year Averages	Excluding GFC	Including All AEs	Replacing Output Gap with Unemployment rate	Dropping One Country at a Time
Lag of Output Gap	0.183*** (0.044)	0.008*** (0.002)	0.090*** (0.025)	0.183*** (0.036)	0.183*** (0.042)	0.250** (0.096)	0.193*** (0.045)	0.136*** (0.039)	-0.364*** (0.037)	0.182 (0.143; 0.2)
Routinization x Relative Price of Investment	0.536*** (0.175)	0.022*** (0.007)	0.272** (0.120)	0.536*** (0.118)	0.536*** (0.138)	0.552* (0.247)	0.506*** (0.167)	0.653*** (0.156)	0.548*** (0.153)	0.533 (0.459; 0.61)
Lag of Trade Openness	0.012* (0.007)	0.000 (0.000)	0.003 (0.007)	0.012 (0.009)	0.012 (0.010)	0.016 (0.011)	0.020** (0.008)	0.003 (0.007)	0.004 (0.007)	0.013 (0.003; 0.016)
Relative Service Employment	0.010** (0.004)	0.000** (0.000)	0.002 (0.003)	0.010*** (0.004)	0.010** (0.005)	0.016*** (0.004)	0.010** (0.004)	0.013*** (0.004)	0.016*** (0.004)	0.011 (0.006; 0.012)
Lag of Urbanization	0.249*** (0.047)	0.011*** (0.002)	0.208*** (0.042)	0.249*** (0.039)	0.249*** (0.071)	0.240*** (0.047)	0.260*** (0.056)	0.257*** (0.045)	0.268*** (0.063)	0.25 (0.202; 0.294)
Education (percent secondary)	0.063*** (0.017)	0.003*** (0.001)	0.018 (0.014)	0.063*** (0.015)	0.063*** (0.017)	0.058** (0.017)	0.061*** (0.019)	0.062*** (0.016)	0.066*** (0.017)	0.064 (0.047; 0.074)
Education (percent tertiary)	0.135*** (0.031)	0.006*** (0.001)	0.108*** (0.027)	0.135*** (0.032)	0.135*** (0.035)	0.121** (0.034)	0.115*** (0.029)	0.136*** (0.031)	0.060** (0.026)	0.134 (0.119; 0.158)
Tax Wedge	-0.240*** (0.026)	-0.010*** (0.001)	-0.073*** (0.020)	-0.240*** (0.021)	-0.240*** (0.027)	-0.275*** (0.029)	-0.223*** (0.024)	-0.226*** (0.025)	-0.125*** (0.030)	-0.242 (-0.253; -0.216)
Unemployment Replacement Ratio	-0.078*** (0.025)	-0.003*** (0.001)	-0.032** (0.013)	-0.078*** (0.017)	-0.078*** (0.028)	-0.083* (0.041)	-0.068** (0.025)	-0.076*** (0.024)	-0.069*** (0.023)	-0.076 (-0.085; -0.067)
Public Spending on ALMP	0.031*** (0.007)	0.001*** (0.000)	0.017*** (0.006)	0.031*** (0.006)	0.031*** (0.009)	0.034** (0.013)	0.030*** (0.007)	0.033*** (0.007)	0.015* (0.008)	0.031 (0.024; 0.034)
Restrictiveness of Migrant Integration Policies	-0.207*** (0.049)	-0.008*** (0.002)	-0.084** (0.038)	-0.207*** (0.040)	-0.207*** (0.070)	-0.245*** (0.055)	-0.191*** (0.054)	-0.198*** (0.047)	-0.230*** (0.052)	-0.211 (-0.255; -0.184)
Union Density	-0.015 (0.025)	-0.001 (0.001)	-0.064*** (0.018)	-0.015 (0.021)	-0.015 (0.031)	0.021 (0.024)	-0.030 (0.025)	-0.007 (0.023)	-0.004 (0.022)	-0.016 (-0.033; -0.001)
Coordination of Wage Setting	0.256** (0.120)	0.011** (0.005)	0.020 (0.065)	0.256** (0.112)	0.256* (0.148)	0.289 (0.302)	0.274** (0.108)	0.238* (0.121)	-0.027 (0.115)	0.26 (0.203; 0.312)
Number of Observations	570	570	570	570	570	132	524	592	524	524
Countries	23	23	23	23	23	23	23	25	23	23
R <sup>2</sup>	0.578	0.569	0.983	0.578	0.578	0.596	0.560	0.567	0.602	0.602

Source: IMF staff calculations.

Note: The table presents results from estimation equation (2.3) with the participation rate of all workers (ages 15 and older) as the dependent variable on a sample of 23 advanced economies (AEs) during 1980–2011 using annual data. See Annex 2.4 for the construction of the explanatory variables and Annex Table 2.1.2 for the countries in the sample. All specifications include country and year fixed effects. Column (1) reports the baseline estimation results; column (2) reports the results after applying the logistic transformation to the dependent variable; column (3) shows the results using the Beck and Katz (1995) estimator; column (4) reports the estimates with heteroskedasticity and autocorrelation consistent (HAC) standard errors, without the correction for cross-sectional dependence; column (5) shows the results with the Newey-West correction for the standard errors; column (6) shows the results based on a sample of five-year averages; column (7) reports the results dropping global financial crisis (GFC) years 2008 and 2009 from the sample; column (8) reports the coefficients when Czech Republic and Slovak Republic, which recently joined AEs, are added to the sample; column (9) shows the results when the lag of the output gap is replaced with the lag of the unemployment rate; and column (10) reports the median coefficient from a distribution of estimates obtained by dropping one country at a time from the sample. Driscoll-Kraay standard errors are reported in parentheses in columns (1), (2), (6)–(9); HAC standard errors assuming a panel-dependent correlation structure are reported in column (3); HAC standard errors are reported in parentheses in column (4); and Newey-West corrected standard errors are reported in column (5). Column (10) reports the 10th and 90th percentile of the estimated coefficients in parentheses. ALMP = active labor market programs.  
\*  $p < .10$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$ .

## Annex 2.5. The Role of Individual and Household Characteristics: Micro-Level Analysis

The micro-level analysis relies on the European Union Labour Force Survey for 24 advanced economies during 2000–16. It estimates logit models on a random sample of 10,000 people per country per year. The dependent variable is a dummy variable indicating whether someone is in or out of the labor force.<sup>54</sup>

Explanatory variables include age; gender (for the 55 and older group); and whether the person was born in the country or abroad, whether the person lives in an urban or rural area, and the person's highest level of education completed (lower secondary, upper secondary, or tertiary). The regressions also control for measures of family composition: the number of children; other employed adults in the household; and whether the individual lives in a household of a single adult without children (the baseline category), a single adult with children, or a couple with or without children. Finally, regressions control for the routinization score of an individual's current occupation (if currently employed) or last occupation (if currently unemployed or inactive). Country, region and year fixed effects are included. Results are robust if interacted country-year fixed effects are included instead. Standard errors are clustered at the country-year level.

The baseline specification does not control for income due to data limitations (Annex Table 2.5.1, columns 1–3). However, results are broadly robust to controlling for the income decile of employed individuals and the predicted income decile (based on age, gender, education, location, immigration status, and sector and occupation of last employment) for unemployed or inactive people (for whom income information is not available). Once a (predicted) income decile is included, the effect on women's participation of being part of a couple and having children turns positive, the effect of other employed adults in the household turns negative, and income itself has a negative effect (Annex Table 2.5.1, columns 4–6). This suggests that individuals in upper deciles may be able to afford to drop out of the labor force. The results on vulnerability to routinization and education are very similar to those in the baseline.

<sup>54</sup>Main labor force status is coded as *employed* (if a person has a job or profession, including unpaid work for a family business, apprenticeship, or paid traineeship), *unemployed*, or *out of the labor force* (including people who are students, retired, permanently disabled, in compulsory military service, fulfilling domestic tasks, and otherwise inactive). This coding is assigned based on respondents' answers about their activity during the reference week.

## Annex 2.6. Prospects for Labor Force Participation: Cohort-Based Analysis

The cohort-based analysis relies on Organisation for Economic Co-operation and Development data on participation rates for a balanced sample of 17 advanced economies during 1985–2016. It estimates a system of 11 seemingly unrelated regressions (one for each age group) for each country, and separately for men and women, of the following form:

$$LFP_t^{a,g} = \alpha^{a,g} + \frac{1}{n_g} \sum_{t-g}^T \beta^{a,g} C_{t-g}^a + \lambda^{a,g} X_t + \varepsilon_t^{a,g}, \quad (2.5)$$

in which  $\alpha^{a,g}$  is a gender- and age-specific constant;  $C_{t-g}^a$  is a set of birth cohort- and gender-specific dummy variables, which take the value 1 if the birth cohort  $t-g$  appears in the age group  $g$  in year  $t$ ;  $\beta^{a,g}$  is a gender and birth-year-specific fixed effect (that is, the cohort effect), which is divided by the number of birth cohorts in the age group  $n_g$ ;  $X_t$  is the output gap; and  $\lambda^{a,g}$  is a coefficient on the output gap that varies by gender and age group.<sup>55</sup> Within each gender group and country, the coefficient for each birth cohort  $\beta^{a,g}$  is constrained to be the same across equations. In addition, each birth cohort appears in at least two equations, which implies that the sample covers cohorts born between 1925 and 1994.

A series of tests ensures that the results are broadly robust to the application of a logistic transformation to the dependent variable, replacing the output gap with the unemployment rate, and dropping more birth cohorts at the end of the sample.

Age-group-specific trend labor force participation rates are obtained as the predicted values of the cohort-based model estimates, assuming a zero output gap. The aggregate trend labor force participation rate is calculated as the three-year moving average of the age group's specific trend labor force participation rates multiplied by its population share.

Projected scenarios for trend labor force participation rely on the United Nations World Population Prospects data, under the assumptions of medium fertility and migration flows and policies based on historical trends. Projections assume no effects from new cohorts entering the labor force. Three illustrative scenarios are built on the following assumptions. The first assumes that for people of prime age (25–54), women's participation rates gradually

<sup>55</sup>For example, in 1985, the birth cohort dummy variable for those born between 1970 and 1974 takes the value 1 for the equation of the 15–19 age group.

Annex Table 2.5.1. Determinants of Being in the Labor Force

	(1)	(2)	(3)	(4)	(5)	(6)
	Men, Ages 25–54	Women, Ages 25–54	All, Ages 55+	Men, Ages 25–54	Women, Ages 25–54	All, Ages 55+
Age	1.158*** (0.011)	1.320*** (0.014)	1.396*** (0.113)	1.261*** (0.018)	1.347*** (0.021)	1.356*** (0.151)
Age Squared	0.998*** (0.000)	0.997*** (0.000)	0.998*** (0.001)	0.997*** (0.000)	0.997*** (0.000)	0.998*** (0.001)
Male			1.196*** (0.031)			1.539*** (0.046)
Upper Secondary Education	1.719*** (0.032)	1.709*** (0.033)	1.209*** (0.036)	1.737*** (0.056)	1.855*** (0.060)	1.102** (0.046)
Tertiary Education	2.759*** (0.082)	2.961*** (0.077)	1.594*** (0.059)	2.217*** (0.097)	2.763*** (0.115)	1.240*** (0.063)
Born in Country	1.489*** (0.035)	1.333*** (0.024)	1.091** (0.046)	1.761*** (0.051)	1.520*** (0.050)	1.167** (0.075)
Urban	1.008 (0.019)	1.024* (0.013)	1.019 (0.027)	0.896*** (0.027)	0.864*** (0.022)	0.866*** (0.037)
Number of Children in Household	1.049*** (0.009)	0.816*** (0.007)	0.960* (0.020)	1.094*** (0.012)	0.869*** (0.012)	1.039 (0.035)
One Adult with Children	1.042 (0.059)	0.846*** (0.026)	1.785*** (0.394)	1.045 (0.087)	0.846*** (0.039)	1.217 (0.330)
Couple without Children	1.356*** (0.035)	0.906*** (0.034)	0.842*** (0.025)	1.757*** (0.083)	1.741*** (0.128)	1.161*** (0.051)
Couple with Children	1.726*** (0.052)	0.757*** (0.028)	1.446*** (0.128)	2.141*** (0.114)	1.248*** (0.088)	2.429*** (0.350)
Other Household Structure	0.937** (0.027)	0.868*** (0.030)	0.812*** (0.038)	1.212*** (0.063)	1.334*** (0.092)	1.726*** (0.138)
Other Employed Adult(s) in Household	1.497*** (0.035)	1.152*** (0.038)	1.703*** (0.091)	0.992 (0.043)	0.601*** (0.046)	0.636*** (0.079)
Routinization Score of Occupation	0.825*** (0.011)	0.900*** (0.010)	0.716*** (0.013)	0.467*** (0.012)	0.490*** (0.012)	0.488*** (0.016)
Lagged Output Gap	1.037*** (0.006)	1.023*** (0.004)	1.031*** (0.007)	1.042*** (0.008)	1.030*** (0.008)	1.037*** (0.012)
Predicted Income Decile <sup>1</sup>				0.952*** (0.001)	0.950*** (0.001)	0.952*** (0.002)
Number of Observations	491,820	474,240	86,441	474,434	443,687	63,982

Source: IMF staff calculations.

Note: Logit regressions based on a random sample of 10,000 respondents per country per year of 19 countries, exponentiated coefficients. All specifications include country, region, and year fixed effects. The base category for education is “up to lower secondary education.” For family composition the base category is “one adult without children.” Standard errors clustered at the country-year level.

\* $p < .10$ ; \*\* $p < .05$ ; \*\*\* $p < .01$ .

<sup>1</sup>Predicted income decile uses the actual income decile for those currently employed and predicts the income decile for those currently unemployed/inactive using age, gender, education, migration status, location, sector, and occupation; and country, region, and year fixed effects.

converge to those of men over the next 20 years. The second scenario assumes that the participation rate of those ages 55–59 converges to the rate of the 50–54 age group over the next 20 years and that the rate for the 60–64 age group becomes the same as for the 50–54 age group over the next 40 years. The third scenario assumes that policies converge to the best possible levels, defined as the 90th (or 10th) percentile of the level observed among advanced economies, over the next 20 years. The impact is then simulated using the coefficients estimated in the cross-country empirical model.

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