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Korea’s Growth Prospects: Overcoming Demographics and COVID-19

by Andrew Swiston

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Korea's Growth Prospects: Overcoming Demographics and COVID-19

Prepared by Andrew Swiston

Authorized for distribution by Andreas Bauer

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Abstract[1]

Korea's economy has leaped to high-income status thanks to several decades of sustained high growth. However, population aging and shifts in global demand provide headwinds for future growth and Korea now faces the effects of COVID-19 on economic activity. This paper asseses the expected drag on potential growth from these factors and discusses policies that could provide offsetting upward momentum by facilitating structural transformation. We find that potential output growth slowed to about 2½ percent before the COVID-19 pandemic and would have fallen to 2 percent by 2030, mainly due to demographic factors. Moreover, there is a possibility of scarring from the COVID-19 shock as adjustment frictions from structural rigidities interact with shifts in demand and supply patterns, lowering investment and labor force participation. At the same time, industry-level analysis suggests ample scope to raise productivity, especially in services where productivity gains have lagged. Addressing these rigidities could offset a large proportion of the expected downward pressure on potential output.

JEL Classification Numbers: E22, E24, J24, O11, O47

Keywords: Korea, productivity, demographics, population aging, potential output, potential growth, multivariate filter, accelerator model, structural reform, COVID-19

Author's E-Mail Address: aswiston@imf.org

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Introduction

Korea transitioned rapidly from low-income to high-income status. Beginning in the early 1960's, Korea's economy grew very rapidly, driven by increasingly competitive export-oriented manufacturing, and underpinned by high investment, increasing educational attainment, and a growing working-age population. Several factors came together to foster this investment in both physical and human capital as well as catch-up with the productive frontier, including deeper structural policies in place before the growth takeoff, improvements in institutions, sound macroeconomic policies, and an orientation toward industrialization through export competitiveness. These trends kicked off a virtuous cycle of higher inputs and higher growth, shifting Korea to a high growth-high investment equilibrium, which helps explain the long-lasting nature of Korea's exceptional growth performance.

However, improvements in living standards have slowed in recent years and the country now faces a different set of challenges than the ones it successfully confronted in the past. Growth has softened in the wake of the Asian financial crisis (AFC) and global financial crisis (GFC). This can be partly explained by the reduced space for convergence to upper-income economies, but other factors also played a role. Investment weakened after the AFC as the corporate sector worked off the financial imbalances characterizing the pre-AFC boom, and the pace of productivity growth also declined. More recently, demographics—which previously had been favorable to growth—are posing a headwind as the population ages. Meanwhile, shifts in demand patterns are exposing structural weaknesses that were less apparent during the era of high growth.

The COVID-19 pandemic adds to the headwinds on potential output. While the economy is in the early stages of its recovery any assessment of the long-term impact is tentative. Yet given the heterogeneous effects of the shock across sectors and experience in previous recessions—both in Korea and globally—as well as the structural rigidities characterizing the Korean economy, there will likely be forces pushing toward scarring (a permanent loss in potential output) through lasting reductions in physical and human capital accumulation, which could also weigh on productivity growth.

This paper assesses prospects for Korea's potential growth in this context and projects a further slowing. Factor accumulation—investment in physical and human capital, and mobilization of labor inputs—has played a primary role in Korea's stellar economic growth, with some contribution also from total factor productivity (TFP). However, pre-COVID potential growth had already decelerated to about 2½ percent and further slowing was projected driven primarily by an aging and shrinking population, which feeds back into lower investment. The features of the COVID-19 shock and Korea's product and labor market rigidities could interact to further weigh on potential output. The results suggest that the COVID-19 shock could lower potential output in the medium term by about three percent, albeit with a wide range of uncertainty.

The expected downward pressure on potential growth highlights the urgency of structural reforms that can provide some compensating upward momentum. An industry-level assessment finds that while TFP has converged toward advanced economies—especially in manufacturing—in most industries there remains significant scope for convergence. While there is a high degree of heterogeneity, the level of TFP in services is especially low. Given the link established in the existing literature between product and labor market flexibility and TFP in services, this adds to the urgency of relaxing existing product and labor market rigidities, as well as ensuring the competitive landscape facilitates investment and activity in sectors likely to be dynamic post-COVID. An illustrative scenario shows sizable possible gains from structural reforms—sufficient to raise medium-term potential growth by about half a percent per year.

Subsequent sections examine these issues. First, a detailed analysis on the impact of demographics on labor force participation is conducted. This and a projection for private investment are used as inputs into two models to estimate a baseline path for potential output pre-COVID, demonstrating the headwinds to growth that were already in place before the shock. Then, the impact of COVID-19 on potential output is examined, with a scenario elaborated drawing on Korea's performance after past downturns. Finally, policies to promote structural transformation are discussed, along with an illustrative scenario to provide a broad order of magnitude of the potential impact of such reforms on potential output.

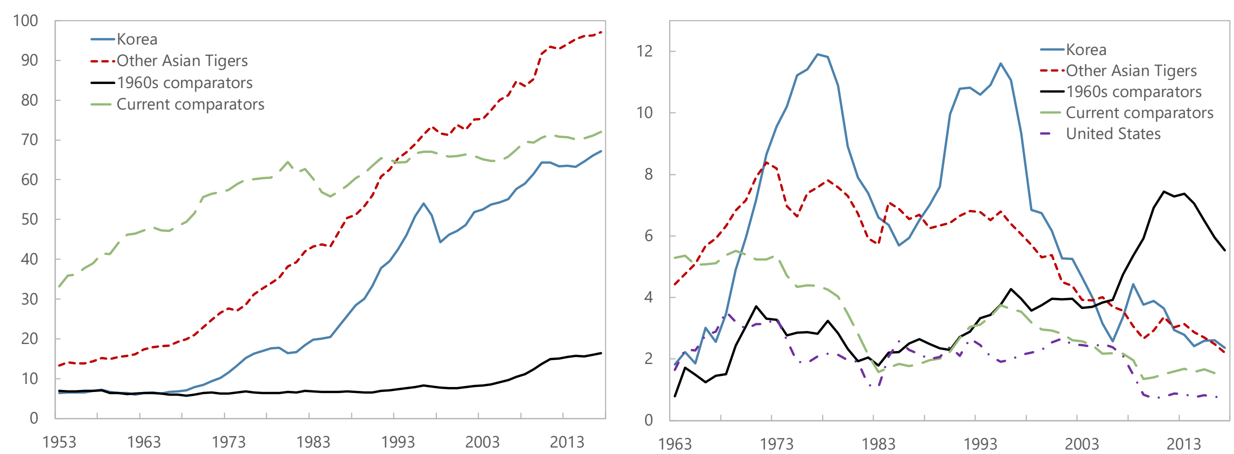
Korea's Convergence to High-Income Status

In recent decades Korea has converged to high-income status but growth has slowed. In the early 1960's, Korea's income per capita was less than 10 percent of that in the United States, which is taken as the reference economy. Per-capita income growth then exceeded 10 percent per year for some 10-year periods—nearly unparalleled in the historical experience (Figure 1). While growth slackened after the AFC, it remained in line with that of other Asian Tigers, raising Korea's per capita income level to two-thirds of U.S. income.[2] However, the pace of growth has continued to slow, nearing that of advanced economy comparators.[3]

Figure 1. Historical Growth Performance

Real Income Levels Relative to United States
(PPP GDP per capita in 2011 U.S. dollars as percent of United States)

Real Income Growth Relative to Comparators
(10-year average percent change, PPP GDP per capita in 2011 U.S. dollars)

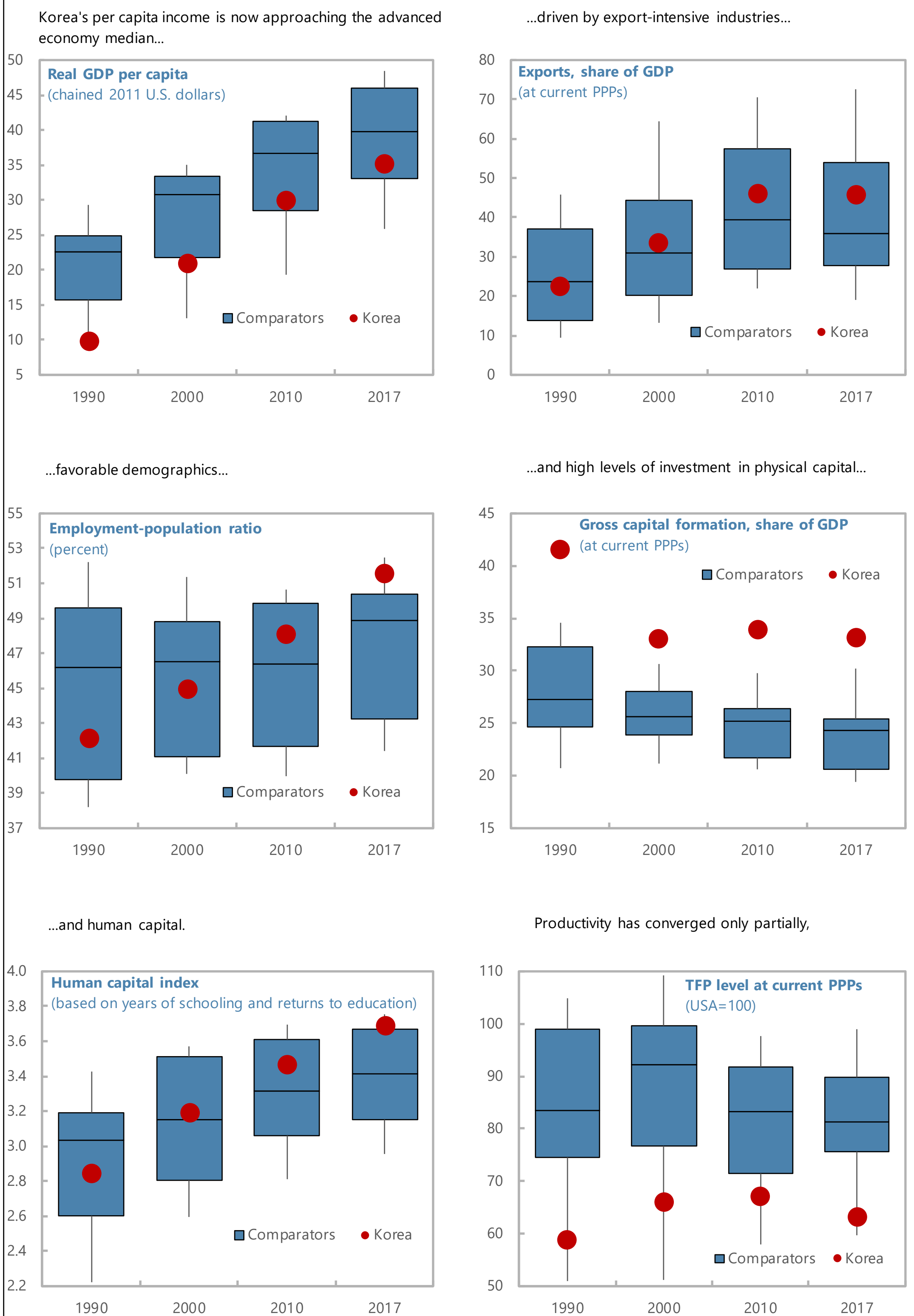


Sources: Penn World Table; and IMF staff calculations.
Note: See Appendix for list of comparators.

[2] For greater detail on the factors driving Korea's rapid economic development, see Cole and Park (1983), Frank and others (1975), Krueger (1977), Westphal and Kim (1977), Hong (1979), and Haggard and others (1990). For a more recent overview, see Young (2019).

[3] Two groups were formed to illustrate Korea's performance relative to economies that were comparable in the 1960s and those that are comparable currently. Comparators are chosen based on per capita income and size. See the Appendix for a list of comparators and description of selection criteria.

Figure 2. Comparison of Growth Drivers with Other Advanced Economies



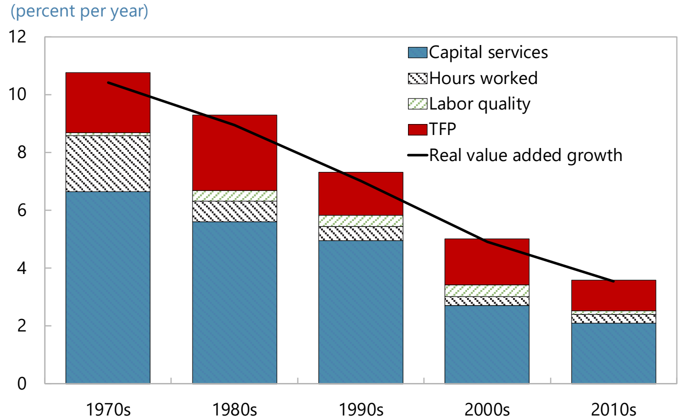
Sources: Penn World Table; and IMF staff calculations.
Notes: Plots show Korea against median, 1st and 3rd quartiles, and 10th and 90th percentiles of a group up to 20 comparators (where data is available). See Appendix for list of comparators.

This has been achieved through heavier reliance on accumulation of physical and human capital and at lower levels of productivity than comparators. Figure 2 summarizes Korea's standing against 20 comparator economies with similar per-capita incomes in recent decades, which permits a view of its convergence to high-income status. It shows Korea's relatively heavy reliance on factor accumulation—especially investment in physical capital—during the convergence process, as emphasized by Young (1995). However, TFP has also contributed, as argued by Klenow and Rodriguez-Clare (1997).

All factors of production have contributed to both Korea's rapid growth and its slowdown. Capital services have been the main contributor to growth, with the pace slowing over time in parallel with the overall economy (Figure 3). During the 1970s, the rising working-age population helped drive a sharp increase in hours worked. Since then, hours worked have increased slowly, with a decline in hours per worker offsetting a large proportion of the increase in employment. Rising education levels led to higher contributions of labor quality in the 1980s through the 2000s. TFP growth was at its strongest in the 1970s and 1980s before slowing subsequently.

Figure 3. Contributions to Growth, Total Economy

(percent per year)

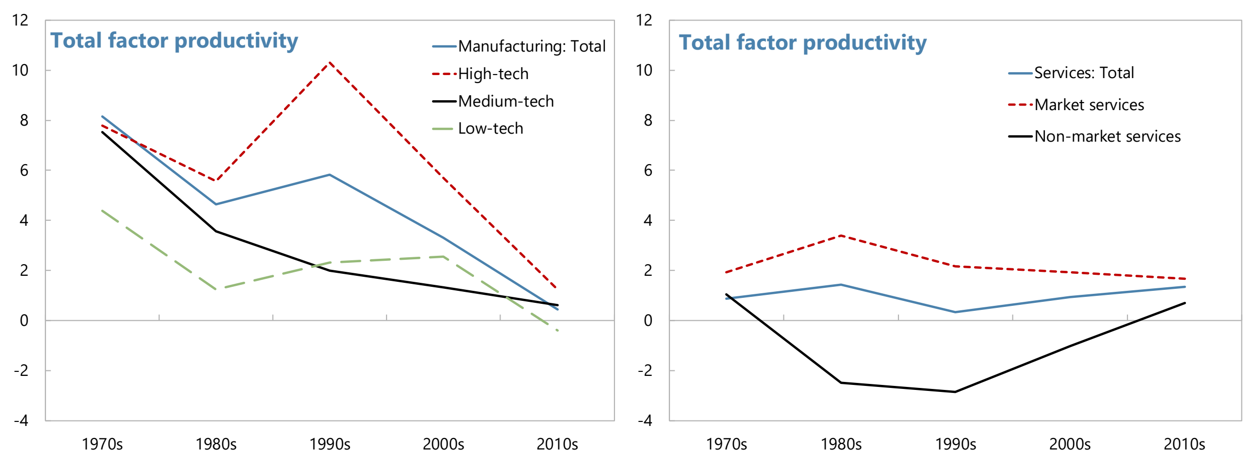


Sources: IMF staff calculations.

Productivity performance has varied greatly across industries. TFP growth in export-oriented manufacturing was a key driver in Korea's rapid economic growth, with manufacturing TFP growth averaging 6 percent per year in the 1970s-1990s. This was driven by high-tech industries that were generally export-oriented, with slower TFP growth in other manufacturing industries (Figure 4).[4]

Figure 4. Total Factor Productivity Growth by Sector

(Annual Percent Change)



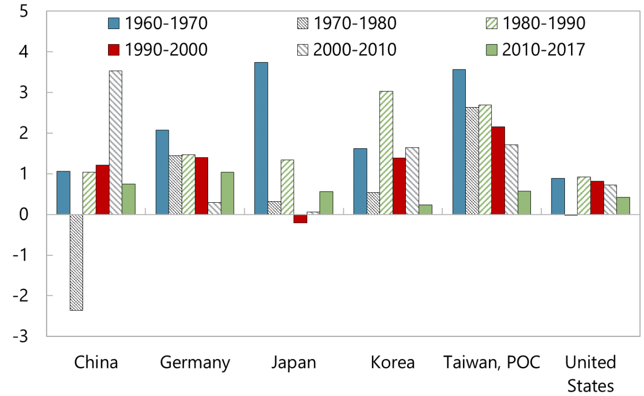
Sources: IMF staff calculations.

[4] This analysis uses data on value added and the factors of production for 35 industries, which are aggregated into six sectors: high-tech, medium-tech, and low-tech manufacturing; other goods; market services; and non-market services. The other goods sector includes agriculture where it is not shown separately. This breakdown follows Inklaar and Timmer (2014) to facilitate international comparisons. See the Appendix for full details.

TFP growth in the other goods sectors was negligible and positive but slow in services. By contrast, the contribution of capital deepening to growth varied less across sectors. while hours worked have increased more in services than other sectors, as services began to play a larger role in the economy commensurate with Korea's rising income levels.

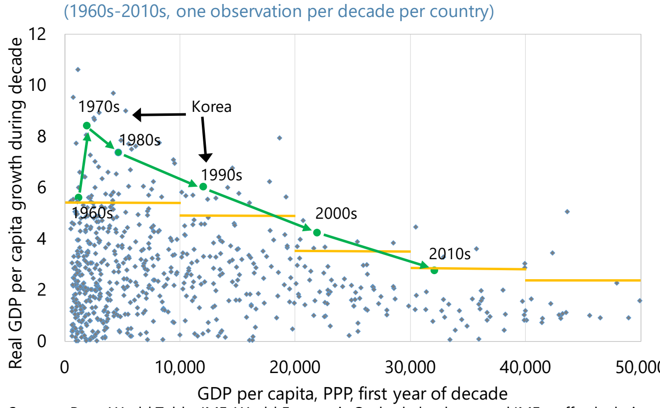
More recently, convergence has slowed, with slower productivity growth being a major driver. The level of TFP has stagnated since the early 2000s at less than two-thirds the U.S. level, with TFP growth since 2010 at its slowest pace since the growth takeoff began (Figure 5). As noted, with Korea having closed a significant proportion of the income gap with other advanced economies, there is less room overall for convergence going forward (Figure 6). Also, since Korea's growth performance over several decades was exceptional even for its income level, a degree of mean reversion may be in store. Indeed, reversion from the outsized growth in the 1970s and 1980s explains two to three percentage points of the slowdown in growth in recent decades and could be a further headwind going forward, as Korea's growth in the 2010's was still at the top 10th percentile for countries of its income level.

Figure 5. TFP Growth by Country
(annual percent change per year)



Sources: Penn World Table; and IMF staff calculations.

Figure 6. Convergence in Real Incomes
(1960s-2010s, one observation per decade per country)



Sources: Penn World Table; IMF, World Economic Outlook database; and IMF staff calculations.
Note: Yellow lines indicate top 10 percentile GDP growth rate within each income group.

This illustrates how the key growth challenge has shifted from accumulation of physical and human capital to raising productivity by facilitating structural transformation. In coming decades, both the total population and the working-age share are set to decline rapidly, which will weigh on growth in labor inputs. As a small, open economy following an export-led growth model, shifts in external demand have played a major role in Korea's economic development and now pose a challenge for transformation. With capital-intensive manufacturing having moved closer to the technological frontier this raises the importance of rebalancing the economy toward new sources of growth, including in sectors whose performance has lagged to date. This may require a shift from prioritizing capital accumulation toward addressing long-standing structural rigidities, which would lift productivity growth in sectors where it is furthest behind.

While the initial effects have been mild compared to other economies, Korea also faces the challenge of recovering from the sizable economic disruption posed by COVID-19. Actual output contracted by over four percent in the first half of 2020, with employment declining by over three percent by early 2021. These effects were uneven across sectors, with a greater impact on those more exposed to person-to-person contact, and the effects occurring despite a comprehensive set of fiscal, monetary, and financial measures enacted by the authorities. The size of the shock, and its reshaping of demand patterns and supply chains, suggest the possibility of long-term effects.

Baseline Pre-Covid Potential Output Estimates

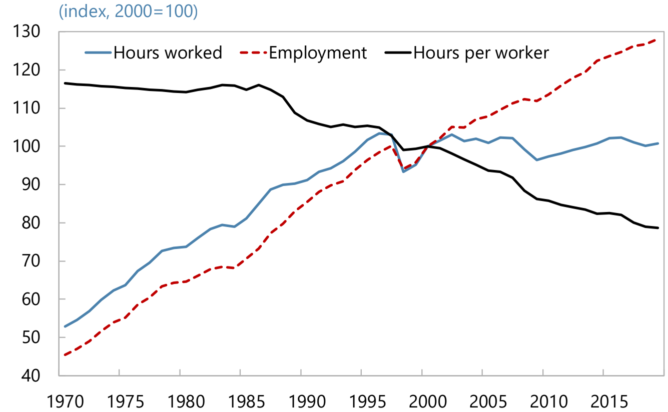
To gauge underlying prospects, potential growth is estimated based on the fundamental determinants as they existed before the COVID-19 shock. This analysis serves as a pre-COVID baseline scenario to be used in discussing the possible impact of the COVID-19 shock. Forward-looking estimates for labor inputs and investment, taking account of demographic shifts, are first provided as building blocks. It allows ongoing trends—especially the reversal of Korea's demographic dividend—to be incorporated without being confounded by the impact of COVID-19. The paper also estimates economy-wide capacity utilization and adjusts for its effects on capital services inputs in estimating potential output. Two approaches are then used to estimate and project overall potential output—a production function model and a multivariate filter (MVF).

Demographics

Demographic factors are one of the key challenges facing Korea, as they will act as a drag on growth by reducing the contribution of labor inputs compared to previous decades. The contribution from a growing working-age population outweighed that of the steady reduction in hours per worker to keep aggregate hours worked increasing until the late 1990s. Subsequently, total hours worked has been broadly flat (Figure 7). Looking to the future, several factors will contribute to slower growth in potential labor inputs (Figure 8). The shrinking population and increase in the share of the elderly will weigh on growth in the number of workers. Hours per worker remain above comparators, and with international evidence that this is well explained by demographic factors and by rising average wages over time, a continued decline in hours per worker in Korea seems probable (Bick and others, 2018). Labor quality as measured by educational attainment is now relatively high, suggesting little scope for further large increases, in line with the forecast in Barro and Lee (2013). By contrast, the female labor force participation rate remains below average, presenting one area for possible increases in labor utilization.[5]

Figure 7. Measures of Labor Utilization

(index, 2000=100)



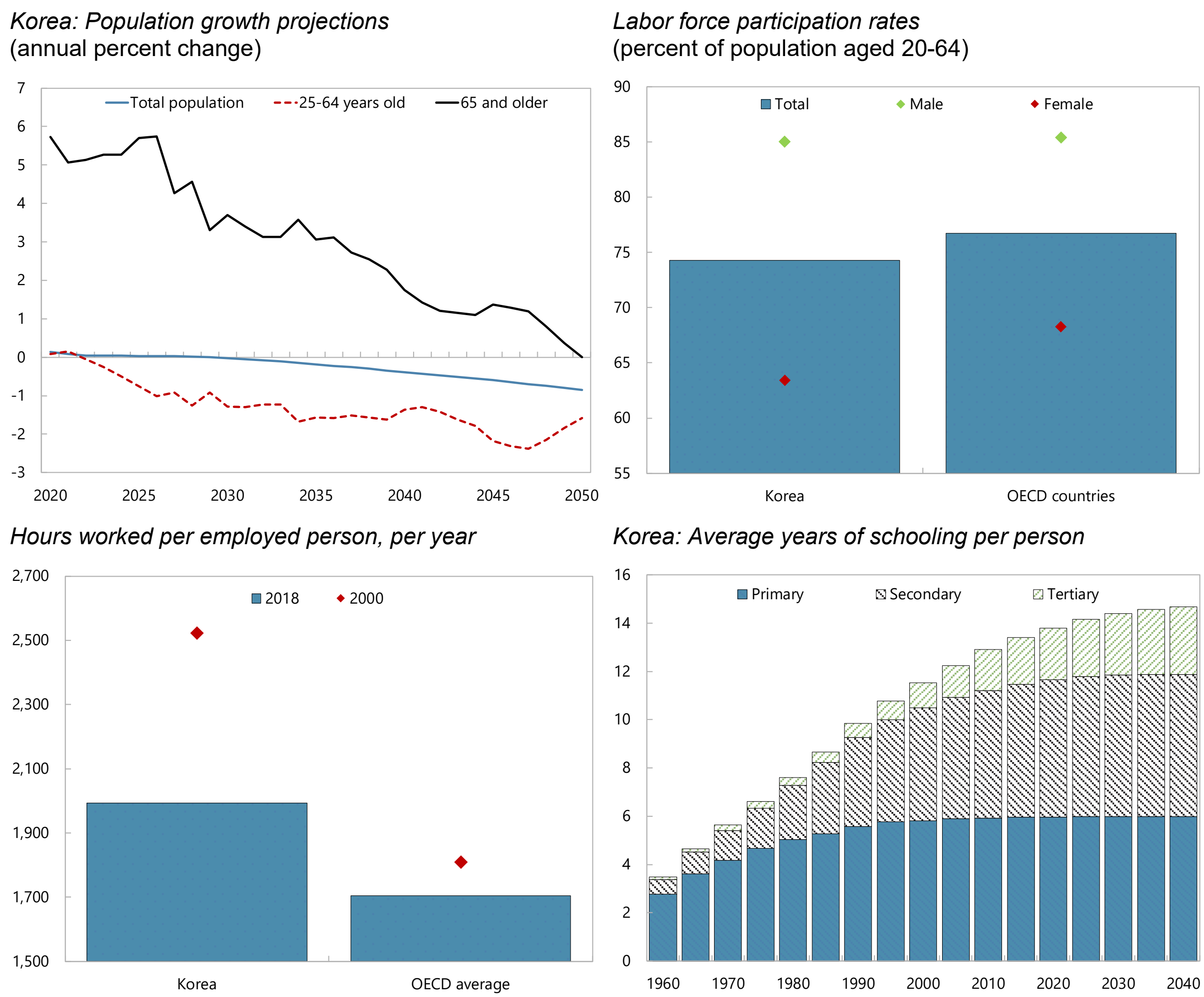
Sources: OECD; National Sources; Haver Analytics; and IMF staff calculations.

Projections of labor force participation in Korea differ substantially depending on assumptions for detailed age-gender groups, illustrating the importance of using disaggregated data in potential

[5] Meanwhile, the impact of demographics on productivity is a subject of debate with some finding a significant negative impact of aging on productivity (e.g., Aiyar and others, 2016; Maestas and others, 2016) and others no impact or a positive one (e.g., Acemoglu and Restrepo, 2017). The review in Cuaresma and others (2016), focusing on Europe, suggests the effects may differ by firm, occupation, and other factors. The direction and magnitude of this effect in Korea are left for further research.

output projections. This paper uses the so-called "cohort approach," which relies on labor force entry and exit rates by age and gender cohort.[6] This differs from assuming constant participation rates by age-gender category because the participation rate of each age-gender cohort has differed over time due to other factors—for example, higher levels of educational attainment are associated with a greater propensity for labor force participation. Figure 9 illustrates these differences for Korea. For females, labor force participation of 20-34 year-olds has risen substantially over time, and there are also increases for those older than 45. For males, participation has fallen for those under 30 years old and risen for those 55 and older. These trends have important implications for aggregate participation projections given the shifts in the age structure of the population shown above.

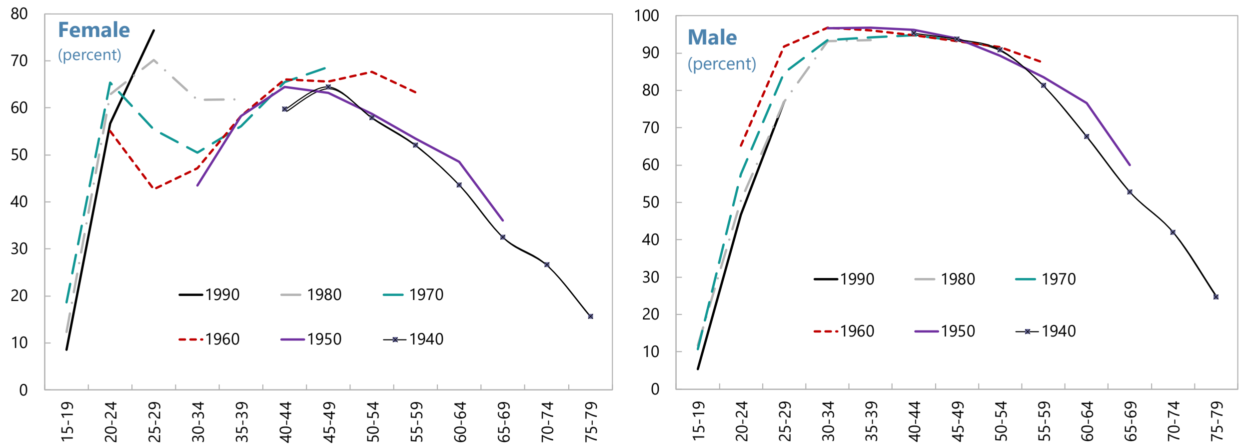
Figure 8. Outlook for Labor Inputs



Sources: Statistics Korea; OECD; and Barro and Lee (2013).

[6] See Cavalleri and Guillemette (2017) for more details.

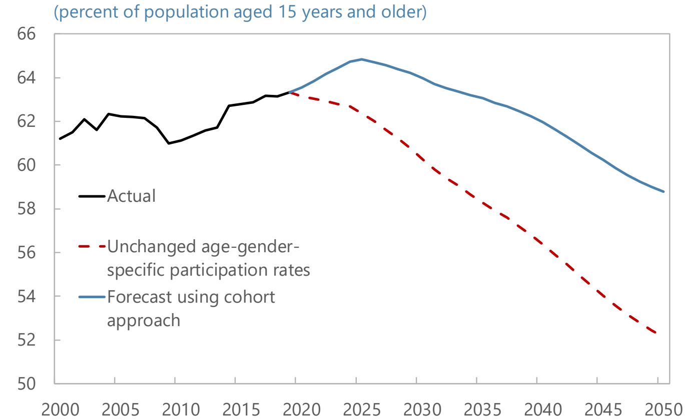
Figure 9. Labor Force Participation Rates by Age Cohort



Sources: Statistics Korea; OECD; Haver Analytics; and IMF staff calculations.

The projections show a decline in labor force participation driven by demographic factors, albeit the magnitude is much smaller using the cohort approach. Even with a relatively conservative assumption about the participation of future cohorts, the cohort approach leads to a substantially higher aggregate labor force participation rate than a forecast using constant age-gender participation rates. Aggregate labor force participation is projected to increase through 2025 driven by still-rising educational attainment and the increasing propensity of younger female cohorts to participate (Figure 10). After 2025 aggregate participation is projected to decrease steadily, though the uncertainty surrounding the projection increases at longer projection horizons. The shift toward a more elderly population with lower propensities to participate predominates, and the pace of increase in educational attainment is projected to level off. These factors outweigh an increase in projected within-group participation rates of some age-gender categories—principally females and the elderly—driven by the tendency for high persistence in labor force participation of individual cohorts. Also, the leveling off in participation is in part by assumption, as the propensity to participate (excluding educational effects) of cohorts that have yet to enter the labor force is held constant at that of the most recent cohorts.

Figure 10. Aggregate Labor Force Participation Rate
(percent of population aged 15 years and older)



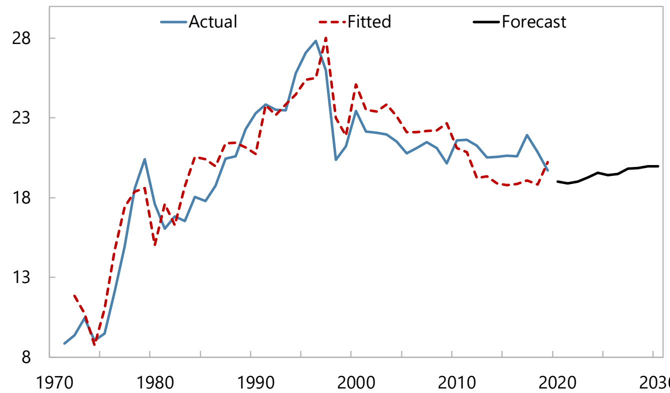
Sources: Statistics Korea; Haver Analytics; and IMF staff calculations.

Investment

Given the large contribution of investment and capital accumulation to Korea's growth, an accurate forward-looking assessment of capital accumulation is another element critical for projecting potential output. Aggregate private investment is estimated using an expanded accelerator model linking the investment-capital ratio to the lagged output growth-capital stock ratio, as an empirical representation aiming to capture the costs of the capital stock deviating from its desired level, which leads to the spreading out over time of adjustments through new investment (Oliner et al, 1995; IMF, 2015a). The modified version used here adds expected growth over the next five years to capture macroeconomic factors in a more forward-looking manner.[7] The model also includes lagged government investment, which for both Korea and advanced economies more generally has been found to be a complement to private investment (Han, 2017; IMF, 2014). The model is estimated on private non-residential investment, which was responsible for most of the acceleration in investment that occurred during Korea's growth takeoff. It should also be the most informative for growth prospects since it is most directly related to the stock of capital used to produce future output.

The accelerator model finds that aggregate macro factors can broadly explain the evolution of private non-residential investment over time. The estimation extends back to 1970 when data on the capital stock begins, and the results explain well the increase in investment in the 1970s-1990s, the drop immediately after the AFC, and the more gradual decline since then (Figure 11).[8]

Figure 11. Private Non-Residential Investment
(percent of GDP)



Sources: National sources; Haver Analytics; and IMF staff calculations.

The model forecast suggests private non-residential investment is likely to be steady over the next decade albeit slightly below previous levels. Estimates suggest non-residential private investment of about 19-20 percent of GDP over the next decade, slightly below recent levels (Figure 11). However, given that the capital-output ratio is higher now than in the past, this level of investment implies a slower rate of growth in the capital stock, which would also serve as a headwind for potential growth. Expected future growth is the main factor weighing on the model projection in the next decade, which is consistent with the projected slowdown in labor inputs described above.

Capacity Utilization

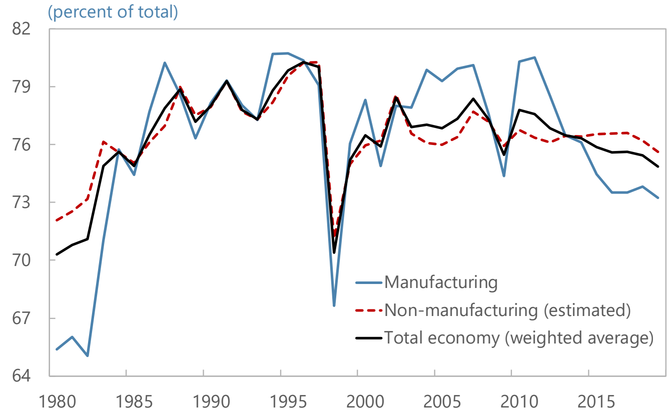
This paper incorporates information on capacity utilization as an indicator of capital services inputs. Capacity utilization rates are closely related to the concept of the output gap, which implies that given data on actual output, capacity utilization could provide useful information about the decomposition of output fluctuations between their cyclical and trend components. However, capacity utilization data only covers the manufacturing sector. As a first step in estimating economy-wide capacity utilization, the

[7] This is calculated using a one-sided H-P filter using only data on output available up to each period to forecast growth over the next five years. While this approach has its shortcomings, it avoids using information that would have been unavailable at the time the expectations were formed.

[8] Estimation results are in the Appendix. The fitted and actual investment-capital ratio have declined, but with the capital-output ratio trending higher over time, investment-GDP has been steady after the drop following the AFC, albeit from exceptionally high levels in the period immediately preceding the crisis.

relationship between manufacturing-sector GDP and capacity utilization was estimated.[9] The parameters were then applied to non-manufacturing data to derive a measure of non-manufacturing capacity utilization. Implicitly this assumes that short-term costs of adjusting the capital stock are broadly similar across sectors. Capacity utilization for manufacturing and non-manufacturing industries was then weighted by the capital stock to calculate an estimate for economy-wide capacity utilization.

Figure 12. Capacity Utilization
(percent of total)



Sources: National sources; Haver Analytics; and IMF staff calculations.

Capacity utilization has differed substantially across sectors and over time. Figure 12 shows the data for manufacturing and estimated series for non-manufacturing sectors and the total economy. Manufacturing capacity utilization was substantially above that in non-manufacturing sectors from 2004-2007 and again in 2010-11 before more recently falling substantially below non-manufacturing capacity utilization. The aggregate measure increased during most of the 1980s and 1990s, peaking immediately before the sharp decline brought about by the AFC. It remained steadier during the GFC, but by 2019 had dipped to its lowest levels since the AFC.

Capacity utilization data helps to more precisely estimate the contributions of capital and TFP to output fluctuations. Typically, the growth accounting literature ascribes cyclical fluctuations in economic activity to either labor utilization through measured employment and hours, or to TFP. By contrast, estimates of capital services are rarely adjusted for the degree of capital utilization—an approach differing from that applied to labor—due to lack of data.[10] This could lead to mismeasurements in estimates of trend TFP, and thus trend growth. This paper adjusts estimates of capital services by the rate of capacity utilization estimated above, which has not previously been performed for Korea. This permits a more accurate estimation of TFP, as fluctuations in capacity utilization are included as contributions of capital services to output, just as fluctuations in hours would be accounted for as contributions of labor inputs.

Potential Output Models and Pre-COVID Results

The above projections of labor inputs and investment are built into baseline projections of potential output. The methodology is as follows, with additional details in the Appendix:

- **Production function:** This approach decomposes output into the contributions from each factor of production—capital, labor, and TFP—relying on assumptions regarding income shares and using an H-P filter to estimate the trend for each factor. The decomposition incorporates detailed information on labor inputs—most critically the participation rate estimated above, but also hours per worker and

[9] Estimation results are in the Appendix.

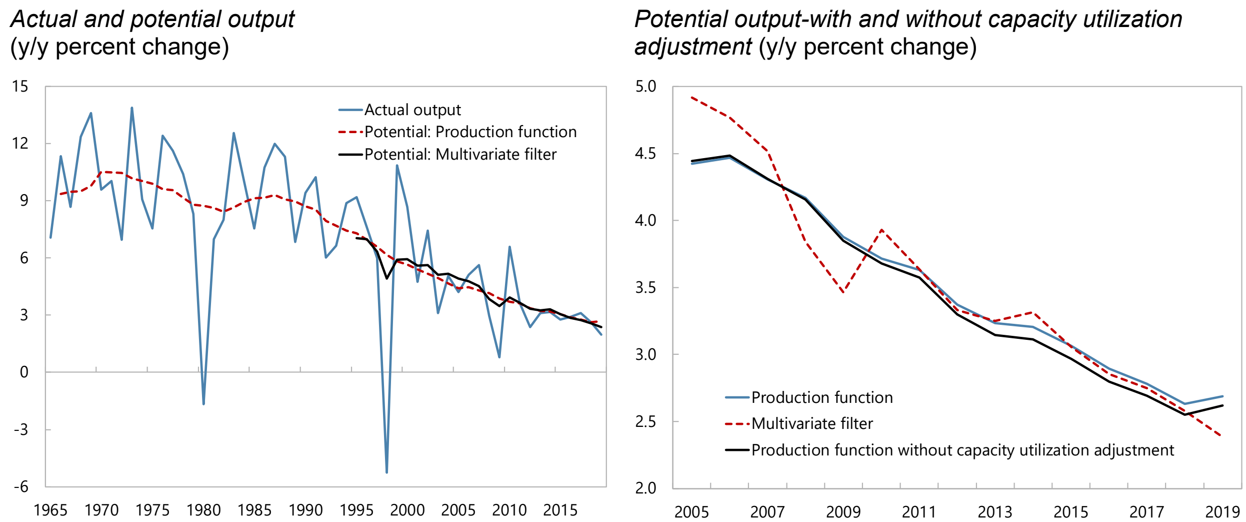
[10] Basu and others (2006) derive cyclically-adjusted TFP using measured hours per worker as a proxy for the unobserved intensity of utilization of all factors of production, including worker effort. This assumes a strong positive correlation between hours per worker and intensity of utilization of each factor, which may not hold if, for example, there are government regulations or firm-level agreements constraining hours per worker.

labor quality. This provides an accurate assessment of the historical contributions of labor inputs and, given the information available about their path in the future, facilitates a more accurate forecast than if recent trends in overall labor input were extrapolated. Estimates of capital services are adjusted for the capacity utilization rates estimated above. To alleviate end-of-sample problems, the factors of production were filtered using both historical and forecast values, with the forecasts as they existed in January 2020, before incorporating any impact from the COVID-19 pandemic.

- **Multivariate filter (MVF).** The MVF uses a Kalman filter, which relies on observable factors to estimate potential output, which is unobserved. The MVF conditions the estimates on economic relationships—Okun's law and the Phillips curve—thus allowing developments in unemployment and inflation to help identify potential output.[11] The MVF used here also adds Consensus Forecasts of real GDP and inflation as observable factors. For the MVF, including capacity utilization as estimated above adds an observable factor that helps explain the behavior of unobserved potential output.

To appropriately account for demographic trends these approaches both utilize the long-term forecast for labor force participation described above. The labor force participation rate is projected using the cohort approach presented previously, using population projections from Statistics Korea. For the production function, educational attainment is projected using Barro and Lee (2013) and hours per worker are assumed to continue on recent trends, in line with the results in Bick and others (2018).

Figure 13. Potential Output: Comparison of Approaches



Sources: National sources; and IMF staff calculations.

Taking into account the methodological improvements on labor force participation and the inputs of capital services and the projected path of investment, the production function and MVF both find that potential output growth recently declined to the mid-2 percent range. The results of the two approaches broadly coincide, showing a deceleration in potential growth from around 7 percent in the mid-1990s, when estimates from the MVF approach are first available (Figure 13). The pre-COVID estimate for 2019 was a quarter-point higher under the production function approach than using the

[11] If the relationships of unemployment and inflation with output are weak historically, then the MVF estimates would tend toward those of the production function.

MVF—2.7 versus 2.4. These results are in line with a recent Bank of Korea study which estimated potential growth at 2.5-2.6 percent for 2019-20, pre-COVID (Kwon and others, 2019) and slightly lower than pre-COVID estimates from the OECD. The right-hand panel of Figure 13 shows the results of the production function approach both with and without the adjustment for capacity utilization along with the MVF results, to illustrate the adjustment's effects. The broad tendencies of the estimates are similar, with the MVF results more variable year-to-year than those of the production function. The estimate without adjusting for capacity utilization yields lower potential growth since 2012 since it does not adjust for the recent decline of capacity utilization to below its long-term average, resulting in a lower estimate for potential TFP growth during that period.

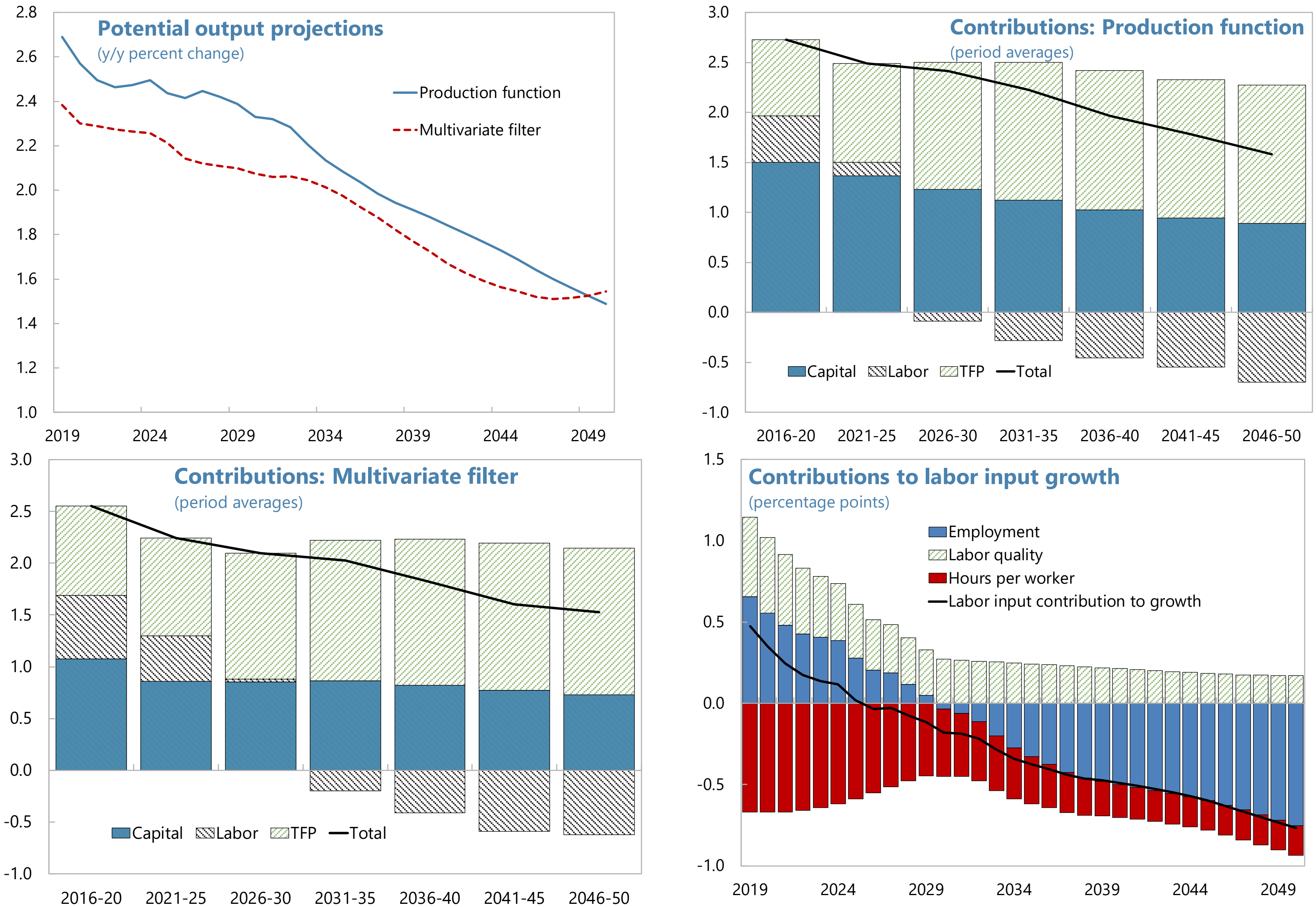
Even before the COVID-19 shock both approaches pointed to a continued gradual decline in potential growth in the years ahead, with demographic factors playing a key role (Figure 14). Pre-COVID potential growth was estimated at about 2.2-2.4 percent in the 2020's before declining to reach about 2 percent per year in the 2030's and about 1.5 percent per year by 2050.[12] This is in line with some other studies (e.g., OECD, 2018a; Zoli and others, 2018), though more optimistic than in Kwon (2017), which estimates a more rapid slowdown due to a sharper decline in labor inputs projected beginning in the 2020s. Figure 14 shows that the contributions by factor of production have some modest differences across the two models but generally follow similar paths over time. The long-term assumption regarding TFP is a key factor, as in both approaches it affects potential growth both directly and through its influence on investment and thus growth in the capital stock. The assumption employed here is that TFP growth returns to its average 2000-19 pace, which implies some recovery relative to 2016-19 but is close to the assumptions in the other studies cited. The lower-right panel of Figure 14 shows the decomposition of projected labor inputs from the production function approach, illustrating that the negative estimated contribution is driven primarily by the declining working-age population and the assumed trend decline in hours per worker. The contribution of labor quality is projected to be positive but smaller than in the past given the slowing pace of improvement in levels of educational attainment.

The COVID-19 Shock and Potential Output

This section discusses how the COVID-19 shock could affect potential output. It shows the extent to which the episode has initially been characterized by reallocation across industries, especially within the services sector. It then estimates the effects of previous large shocks on potential growth, using this as a benchmark for a scenario for the possible effects of COVID-19. The results suggest a meaningful negative impact. However, as this episode is unique, with its full effects yet to be experienced, this is necessarily a preliminary and incomplete assessment. The estimates are thus complemented with a qualitative discussion of some of the key mechanisms likely to be at work in the post-COVID context.

[12] The potential growth estimate not adjusted for capacity utilization gives a slightly lower result for the near term as it does not factor in the return of capacity utilization to typical historical levels but does not affect estimates beyond the next five years.

Figure 14. Pre-COVID Potential Output Projections



Sources: National sources; Haver Analytics; OECD; Penn World Table; and IMF staff calculations.

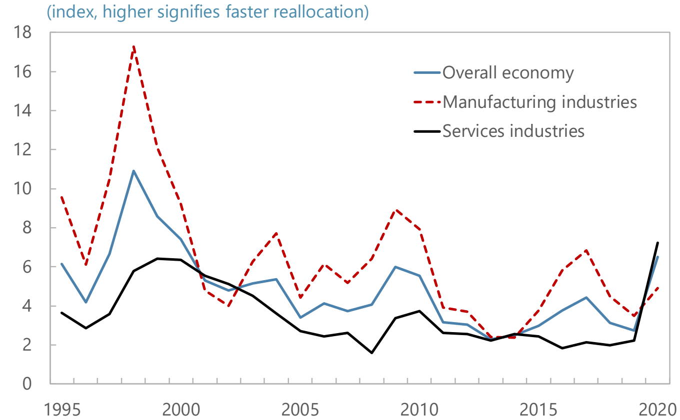
The effects of COVID-19 on economic activity have been heterogeneous across industries, raising the possibility of persistent structural implications. Reallocation was assessed using the measure developed by Lilien (1982), applied to *X*, real GDP, in the following equation:[13]

$$Reallocation_t = \left[\sum_{i=1}^{n} w_i \left(\frac{\ln(x_{i,t}) - \ln(x_{i,t-1})}{\ln(X_t) - \ln(X_{t-1})}\right)^2\right]^{1/2}$$

where *w* is the weight of industry *i* in real GDP. In qualitative terms, this measures the degree to which growth rates in sectoral economic activity diverge from growth in the overall economy, capturing the speed at which the structure of the economy is changing. Figure 15 shows results for the total economy, as well as separate calculations for detailed industries within manufacturing and within services. The overall degree of reallocation during COVID-19 is higher than during the GFC, surpassed only by that during the AFC. A distinctive feature of the COVID-19 shock has been that it has prompted new highs in reallocation within services, unlike during the AFC when manufacturing was more affected. Also, Figure 16 shows that the initial effects on economic activity were greatest in relatively low-wage industries, in which adaptability to abrupt structural transformation may be lower. Overall, while the size of the recession in 2020 was smaller than previous ones in Korea, aspects of it imply it could drive a relatively substantial degree of structural transformation in the economy.

Figure 15. Reallocation Across Sectors

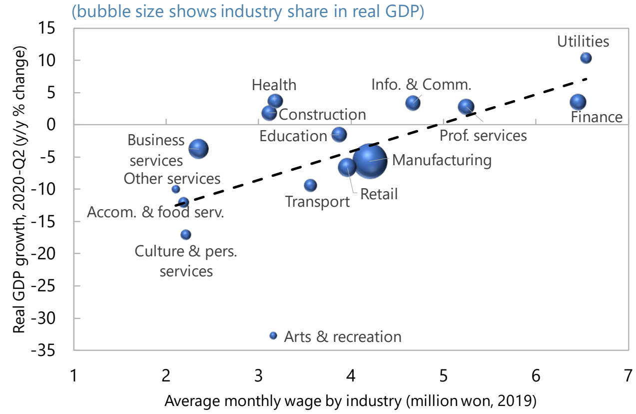
(index, higher signifies faster reallocation)



Source: IMF staff calculations.

Figure 16. COVID-19 Impact by Industry Wage Level

(bubble size shows industry share in real GDP)



Sources: National sources; Haver Analytics; and IMF staff calculations.

Estimates from previous recessions in Korea suggest COVID-19 could reduce potential output through lower investment and labor force participation. Local projections were used to assess econometrically the effects of previous recessions on potential output.[14] Potential output fell in the immediate aftermath of recessions and remained below the pre-recession level even in the medium term. This likely reflects the adjustment of inputs to their new steady-state values, as most of the impact on potential was through lower investment and labor force participation rates while post-recession TFP tended to be resilient (see Appendix).

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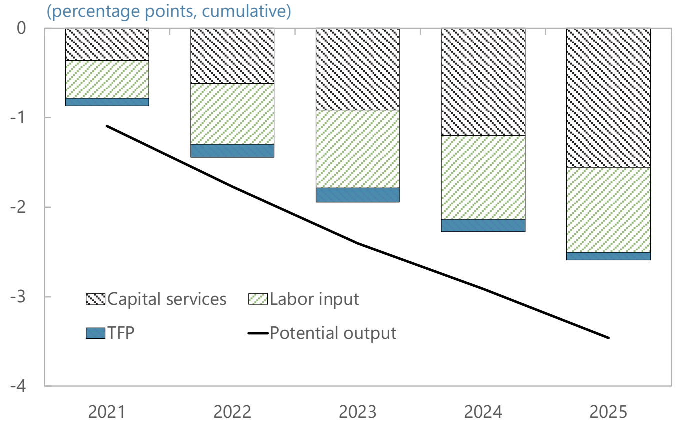
[13] Lilien's original analysis was on employment. Bannister and others (2020) apply the measure to both employment and equity markets.

[14] A description of the methodology and detailed results are in the Appendix.

Applying these results to gauge the impact on potential of the COVID-19 shock suggests that it could lower the level of output by about 3 percent (Figure 17). Using the impact on headline output estimated directly yields a response of 3.5 percent, while aggregating estimated responses across factors of production yields a response of 2.5 percent. There is uncertainty surrounding the above estimates, as the standard errors encompass an impact of between 1½ and 5 percent. The effects on the growth rate of potential output are largest in the immediate aftermath of the shock, with a slow normalization back toward the previous potential growth rate. This is principally due to lower investment rates over the medium term and thus slower capital accumulation, and secondarily to lower labor force participation.

Figure 17. COVID-19 Impact on Potential Output
(percentage points, cumulative)



Source: IMF staff calculations.

While these estimates provide a useful guidepost, they have to be interpreted with caution given the unique factors operating during this episode that will influence the impact on potential. These include: 1) the synchronized, global nature of the shock which may suggest a larger impact as potential in other economies is also affected; 2) the large policy response in Korea which may buffer the medium-term impact; 3) the sudden stop in cash flows for many firms due to shutdowns early in the outbreak; and 4) deeper structural shifts in the organization of supply chains and in demand across sectors. These latter two factors could lead to scarring through destruction of firms and worker-firm relationships, mismatch of workers' skills with available employment opportunities, and uncertainty and worsening in balance sheets that together constrain investment. These transmission channels are especially relevant for Korea given the large proportion of SME debt on which firms cash flows do not cover debt service, and Korea's product and labor market rigidities, discussed below, which may place frictions on the adjustment of supply toward new sectoral patterns of demand. On the other hand, the transmission through investment may be smaller than after the AFC, in which a financial system crisis factored significantly. There could also be some positive effects, as Korea has great potential to capitalize on the shift toward the digitalization of economic activity, as covered in the next section. The size and speed of the ongoing recovery will also influence assessment of the degree to which the effects are temporary or longer-lasting.

Prospects for Structural Transformation

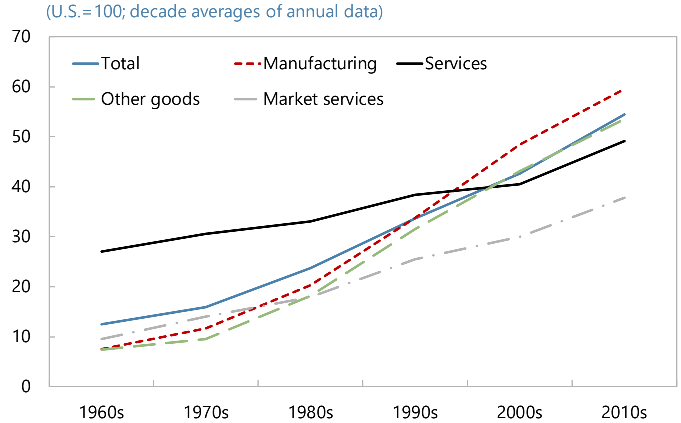
Given the headwinds posed by the shrinking working-age population and the likely impact of the COVID-19 shock, a critical challenge for Korea is to boost potential growth through facilitating structural transformation. This section measures labor productivity relative to the frontier at the level of detailed industries to assess the scope for convergence. It then discusses existing barriers constraining growth and convergence and identifies reforms to promote structural transformation. Finally, it provides a high-level illustrative scenario to quantify the possible gains from the suggested reforms.

Sector-Level Productivity and Convergence

To assess the remaining scope for convergence, labor productivity is compared at the industry level. This comparison uses the industry-level breakdown underlying the above discussion on the sectoral drivers of growth, with details in the Appendix. This comparison relies on the estimates of the levels of relative labor productivity for 2005 in Inklaar and Timmer (2014). These levels are then spliced forward and backward by the rates of labor productivity growth by industry in both Korea and the United States, which as in many studies is used as a benchmark for the frontier. While estimates of relative productivity at the level of the overall economy are available, e.g. from the Penn World Table, this is the first update past 2005 of industry-level comparisons for Korea.

While the Korean economy is in aggregate much closer to the productivity frontier than when it began its rapid growth, for all sectors there remains opportunity to converge. Results for broad sectors are shown in Figure 18. For the overall economy, labor productivity relative to the United States has converged steadily, from 13 percent on average in the 1960s to about 55 percent in the 2010s. All sectors converged to some degree, albeit with differences in the pace. In line with cross-country patterns (Rodrik, 2013), convergence has been strongest in manufacturing, with labor productivity in the 2010s reaching about 60 percent of the U.S. level, from 7 percent in the 1960s. Services have converged at a slower pace, reaching 49 percent of the U.S. level in the 2010s, from 27 percent in the 1960s.

Figure 18. Labor Productivity Relative to United States
(U.S.=100; decade averages of annual data)



Source: IMF staff calculations.

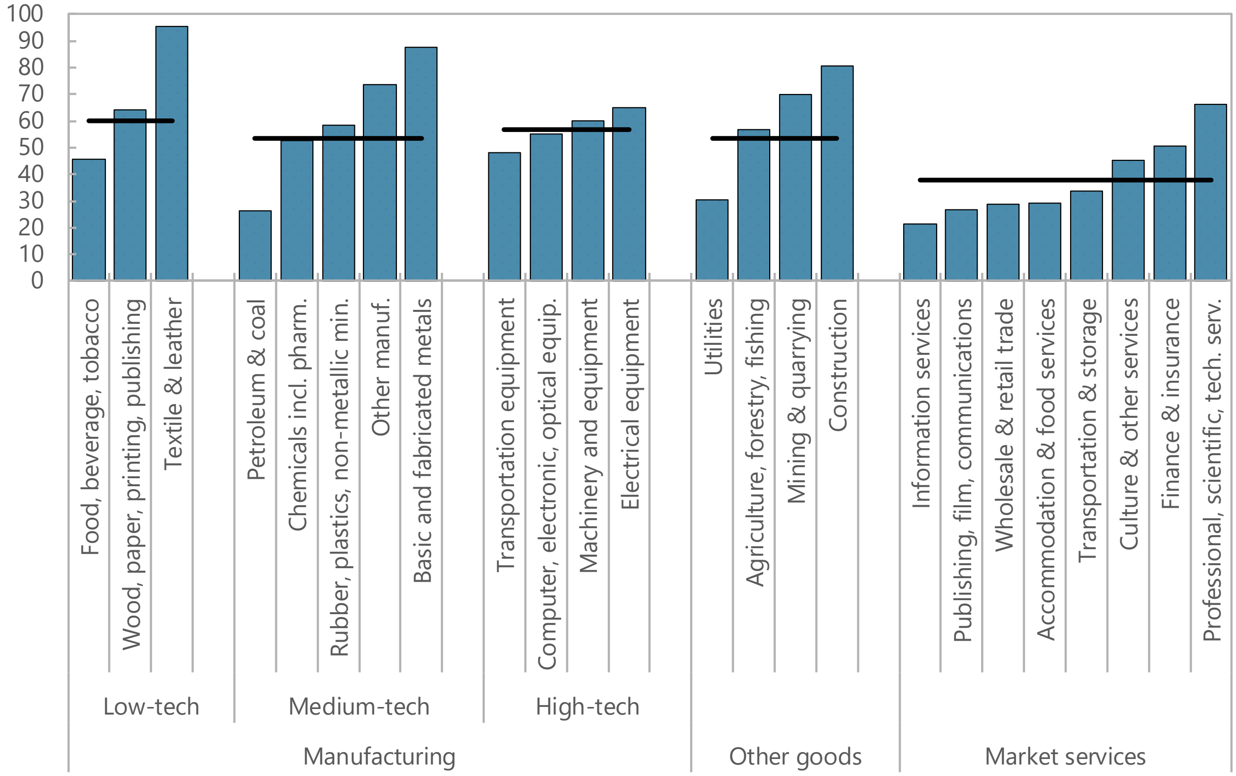
Within each sector there is wide variation in relative labor productivity at the detailed industry level. For manufacturing, the high-, medium-, and low-tech sub-sectors all display similar labor productivity trends relative to their counterpart U.S. sub-sector.[15] However, at the industry level, labor productivity ranges from below 50 percent of U.S. productivity in manufacturing of food and beverages as well as petroleum and coal products to over 80 percent in textile and leather manufacturing and production of basic and fabricated metals (Figure 19).

Productivity growth in the services sector has lagged, leaving greater room for convergence. Services industries typically have the largest share of low-skilled labor, which explains the relatively high initial level of relative labor productivity. However, the slower pace of convergence suggests room for improving growth in these sectors, especially in market services in which labor productivity is less than 40 percent of that in the United States. This is driven by relative productivity of 30 percent of the U.S. level or less in several industries: wholesale and retail; transportation and storage; accommodation and food services; publishing and communications; and information services. Labor productivity is closer to the U.S. level in finance and insurance and in professional, scientific, and technical services.

[15] Productivity growth has been higher within high-tech manufacturing, but the degree of convergence has been comparable to medium- and low-tech manufacturing due to rapid productivity growth in U.S. high-tech manufacturing.

Figure 19. Korea: Labor Productivity Relative to United States

(U.S.=100; average 2010-19; lines show sector averages)



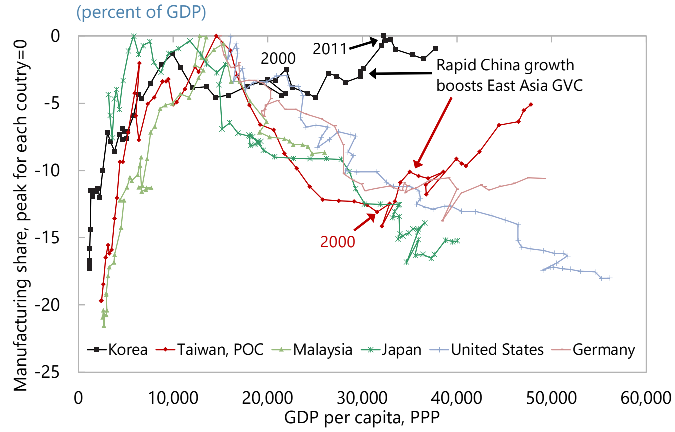
Source: IMF staff calculations.

Shifting Demand and Constraints on Rebalancing

The relatively more productive manufacturing sector continues to be relied upon as a primary driver of growth, principally through exports. External demand acted as a tailwind over the past few decades, a period when global trade in manufactured goods was growing rapidly. Figure 20 illustrates Korea's relatively high reliance on manufacturing given its income level, plotting for various economies manufacturing's share of output against per capita real incomes. Most economies have experienced a pattern of de-industrialization as they grow richer, but this process has halted and reversed in Korea since 2000, as it reaped the benefits of China's integration to the global economy, supplying high-value manufactured tech inputs to China's assembly industries and other products to meet China's rapidly-growing demand. Taiwan POC, which is also shown, experienced the same pattern.

Figure 20. Manufacturing Share of Economy

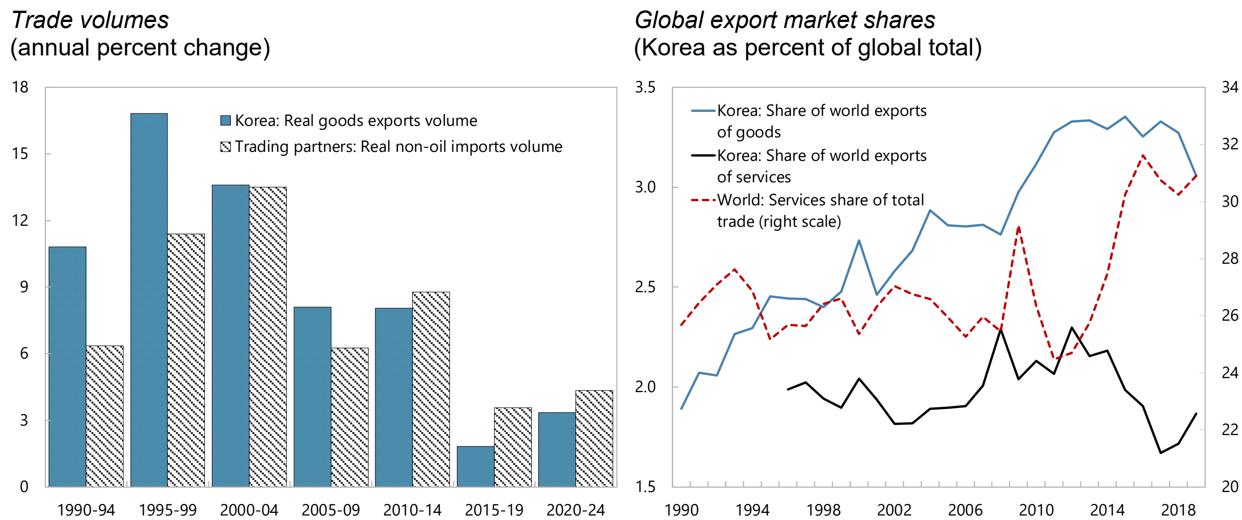
(percent of GDP)



Sources: World Bank, WDI; Penn World Table; and IMF staff calculations.

However, shifts in global economic activity are likely to intensify post-COVID. Figure 21 illustrates two trends already in motion before COVID-19. Overall growth in global trade has fallen, reflected in slowing import growth in Korea's trading partners. Global demand has also shifted toward services, in which Korea's market share is lower. Both these trends were already likely to persist and could accelerate owing to the pandemic, as producers seek more localized supply chains and economic activity becomes more digitalized. By contrast, the trend toward digitalization of activity does favor Korea's relatively tech-intensive composition of exports.

Figure 21. Shifting Patterns of Global Demand



Sources: IMF, World Economic Outlook database; Bank of Korea; Haver Analytics; and IMF staff calculations.
Note: In left-hand panel, 2020-24 is pre-COVID World Economic Outlook projection.

These developments, in conjunction with the COVID-driven reallocation shock highlighted above, underscore the need for the economy to rebalance toward new growth drivers, especially services. With the contribution from some traditional manufacturing sectors likely to fade, new, more diversified growth drivers are needed. Given the relatively low productivity in the services sector, the likely shift of external and domestic demand toward services, and its relatively higher labor intensity, a rebalancing toward services could contribute to higher growth in both output and employment.

Korea also has great potential to capitalize on the shift toward the digitalization of economic activity. Some of Korea's strengths are presented in the upper panels of Figure 22. The upper-left panel displays some pillars of the Global Competitiveness Index (GCI) produced by the World Economic Forum (2019).[16] The Korean economy ranks first in the world in Information and Communication Technology (ICT) adoption, with a well-developed high-tech industry, strong digital infrastructure, and high rates of digital penetration, albeit with a large generational gap (OECD, 2020). The upper-right panel shows Korea's strong ranking in the innovation pillar, especially in research and development and commercialization of innovation. Infrastructure is also a strength, and while the rankings are lower Korea is in the top quintile of countries for business dynamism, institutions, and skills of its human capital.

[16] For the effects of these areas on growth or productivity, for infrastructure see: Dabla Norris and others (2015); and IMF (2014); for ICT: Adarov and Stehrer (2019); and Dabla Norris and others (2015); for institutions: Bakker and others (2020); for business dynamism: Broughel and Hahn (2020); and for human capital: Aiyar and Feyrer (2002); and Bakker and others (2020).

Figure 22. Structural Drivers of Productivity

Sources: World Economic Forum; OECD; Statistics Korea; and IMF staff calculations.
1/ Higher score signifies greater competitiveness.
2/ Median male minus median female wage for full-time employees and self-employed.

However, there are rigidities in product markets—especially regarding the service sector—and in labor markets.[17] Korea's product market regulation is restrictive relative to the OECD average, driven by restrictive regulation of the communication sector and of professional services (Vitale and others, 2020). The GCI also points to high costs to start a business, shortcomings in competition due to market dominance and the distortive effect of taxes and subsidies, and relatively high and complex tariff and non-tariff barriers (World Economic Forum, 2019). The main labor market rigidities are in the flexibility of wage determination, hiring and firing flexibility, redundancy costs, and labor-employer cooperation, while the degree of meritocracy and incentivization is relatively competitive (World Economic Forum, 2019).

The capacities of youth, women, and the elderly could also be more fully utilized.[18] Korea's labor market is characterized by dualism between so-called "regular" employment in well-compensated jobs with strong protections and benefits, and "non-regular" (temporary or fixed-term) employment of defined duration and lower compensation and benefits. This tends to limit employment among youth and women who may be reluctant to accept non-regular employment, leading them to remain outside the labor force in either education or family-raising status. Female labor force participation is also constrained by the difficulty in entering and exiting regular employment and by the high work hours associated with those jobs. This contributes to the high proportion of female employment in non-regular positions or as unpaid workers in family businesses, and to the substantially lower wages for females than for males. Despite the generally high level of educational attainment, skills mismatch has been cited as limiting the availability of workers with the skills required for available jobs, pointing to the need for improved vocational training and coordination between the education system and employers. Finally, the seniority-based wage system and mandatory retirement ages weigh heavily on the labor force participation of the elderly.

The government has formulated a Korean New Deal (KND) aiming to help adapt to post-COVID trends by facilitating structural transformation. The KND is a five-year development strategy that seeks to support the transformation toward a more digital and green economy by 1) strengthening digital capacity, 2) accelerating the transition toward a low-carbon economy, and 3) pursuing an overarching strategy of strengthening the social safety net (Government of the Republic of Korea, 2020). Within these three pillars, the government plans 28 projects in nine key areas with estimated government funding of KRW 114.1 trillion through 2025, or about 1 percent of GDP per year (Table 1). The KND could reinvigorate growth through multiple channels. Through these projects, the government expects to mobilize large-scale private investment by creating new markets, stimulating private demand, and improving regulations. The focus on broadening ICT use throughout the economy could also raise productivity, as ICT-intensive industries in Korea have historically experienced relatively fast productivity growth, in line with cross-country experience (Adler and others, 2017; Dabla-Norris and others, 2015). Finally, strengthening training and other investments in human resources could raise labor force participation and help the benefits of growth to be shared more broadly.

[17] For the effects of these rigidities on growth or productivity, for service sector regulation see: Bambalaite and others (2020); and Barone and Cingano (2011); for product markets: Bouis and others (2016); Bourlès and others (2013); Cette and others (2017); Duval and Furceri (2018); and Gal and Hijzen (2016); and for labor markets: Adler and others (2017); Alesina and others (2018); and Bassannini and others (2009).

[18] This discussion draws from several recent OECD reports (OECD 2018b, 2019a, 2019b, 2019c, and 2020). See also Schauer (2018) on labor market duality and Zoli (2019) on training and other active labor market programs.

Table 1. Overview of Korean New Deal

Pillar	Key areas of focus
Digital new deal	1. Stronger integration of data, networks, and artificial intelligence throughout the economy 2. Digitalization of educational infrastructure 3. Fostering 'untact' (contactless) industries 4. Digitalization of Social Overhead Capital (public infrastructure)
Green new deal	5. Green transition of existing infrastructure 6. Low-carbon and decentralized energy 7. Innovation in the green industry
Stronger safety net	8. Employment and social safety net measures 9. Investment in human resources

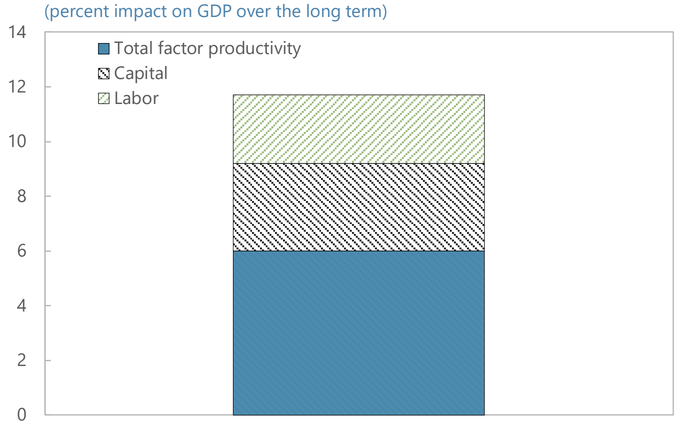
Source: Government of the Republic of Korea (2020).

A Reform Scenario

Demographic headwinds and the drag of COVID-19 on potential output heighten the urgency of reforms to facilitate reallocation of resources toward fast-growing sectors and increase labor utilization. Two sets of existing quantitative estimates are used to build a scenario illustrating the possible impact of reforms in these areas—Kim and Loayza (2019) on the drivers of productivity covering five factors: innovation, infrastructure, education, labor markets, and institutions—and Dao and others (2014) on reforms affecting labor force participation and employment rates in Korea. These reforms remain relevant given the likely post-pandemic shift to services, labor flexibility, and digitalization of economic activity. Given the broad scope of reforms encompassed by the Kim and Loayza (2019) model, the reform scenario assumes that for each indicator entering the model, measures are implemented to gradually raise the indicator to the 75th percentile of OECD countries for variables where Korea lagged this benchmark (where Korea exceeded this benchmark, its standing was assumed to remain unchanged). As in Dao and others (2014), labor market reforms are assumed to close one third of the gap between female and male labor force participation rates and raise youth employment rates by ten percentage points. The scenario focuses on the long-term impact since it consists of several reforms whose implementation and effects would occur on different timetables. Further details on how the scenario was constructed are in the Appendix.

Structural reforms could yield sizable gains. According to the model estimates, once the effects are fully realized, potential output would be about 12 percent higher than in the baseline (Figure 23). This would lift income per capita from around two-thirds of the U.S. level currently to roughly 80 percent. The assumed reforms to raise productivity account for about eight percentage points of the total impact—six percentage points directly and the rest through higher investment and capital stock—with the labor market reforms explaining the rest. The impact via

Figure 23. Impact of Illustrative Reform Scenario
(percent impact on GDP over the long term)



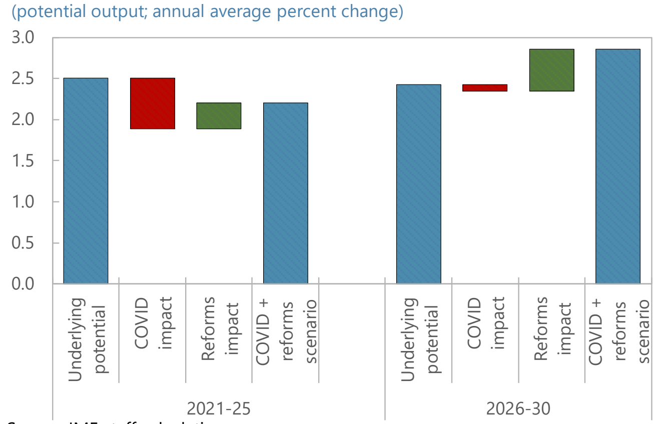
Source: IMF staff calculations.

productivity-enhancing reforms is broadly balanced among the areas covered by the model, with the largest contribution coming from institutions, which includes a measure of regulatory quality. As discussed in Kim (2016), this index embodies the main aspects of the product market regulations mentioned earlier. While the specific effects would depend on the timing of reform implementation, the peak impact of these reforms on potential growth is over half a percentage point per year. These results are broadly in line with those of other studies focusing on similar areas for reform, as shown in Table 2, with a large share of the variation between studies explained by differences in the methodology, variables, time horizon, and scenario assumptions regarding the breadth of reforms and stringency of the benchmark. Overall, these estimates confirm the sizable potential gains from product and labor market reforms, among others.

Table 2. Estimates of Long-Term Impact of Reforms on Korea's GDP

Study	Impact	Main areas for reform	Explanatory comments
This paper	12 percent	Product markets, education, innovation, labor market	Long-term impact; Korea assumed to reach 75th percentile of OECD; impact of reforms assessed using Kim and Loayza (2019) and Dao and others (2014)
Bouis and Duval (2011)	10 percent	Product markets; employment protection; benefit, tax, and retirement schemes	Impact at 10-year horizon; Korea assumed to reach top-3 average OECD
OECD (2018a)	20 percent	Product markets, labor markets, training programs, family and maternity benefits, labor tax wedges	Impact at 40-year horizon; Korea assumed to reach top-5 average OECD
Jain-Chandra and Zhang (2014)	4.7 percent	Employment protection and network sector regulations	Impact on productivity only, at 10-year horizon; Korea assumed to reach top-3 average OECD
Zoli and others (2018)	6-7 percent	Product markets, labor markets, training programs, childcare benefits	Long-term impact; Korea assumed to reach top-3 average OECD in labor and product markets; also assumes shift to consumption taxes from capital and income taxes

Figure 24. Medium-Term Potential Growth Scenarios
(potential output; annual average percent change)



Source: IMF staff calculations.

However, structural reforms would take time to offset the drag of COVID-19 on potential output. The above scenario measures the estimated long-term impact on output, assuming these measures begin to be implemented in the near term. As noted above, such reforms may in many cases take several years to be fully implemented and their effects could take several more years to materialize, explaining the decision to evaluate the estimated impact over a long horizon. Under a scenario encompassing both the COVID-19 shock and assuming implementation of reforms begins promptly, the economy could return to roughly the pre-COVID path of potential output by 2030, though this estimate is subject to both the uncertainty surrounding the impact of the COVID shock and that of the effects of structural reforms (Figure 24). Overall, the scenario illustrates the likely difficulty in avoiding a slowdown in potential growth in the next few years, as the cumulative impact of reforms would only offset that of the COVID-19 shock after several years. It also highlights the desirability of early reform implementation to avoid a more protracted return to the pre-COVID 19 path of potential output.

Conclusions

After a long period of very rapid expansion, Korea's potential growth has slowed, and the challenges of further increasing living standards have evolved. Potential growth has decelerated from about 7 percent in the mid-1990s to about 2½ presently, with contributions from all factors of production decreasing. These results are similar across both a production function model and multivariate filter and are in line with other studies. Several factors have played a role in this decline of trend growth—slower labor force growth due to demographics, lower investment, convergence to high-income status, shifts in external demand, and long-standing structural rigidities that have become more binding now that the economy has moved closer to the frontier in other respects. Looking forward, demographics pose a continued obstacle to growth, as the working-age population begins falling and educational attainment levels off. This slower pace of growth in labor inputs is also likely to weigh on investment and growth in the capital stock. Ongoing shifts in the composition of global economic activity are another challenge, as growth in merchandise trade slows and service sectors rise in importance.

The COVID-19 shock poses another obstacle to raising growth, as there are risks it could lower medium-term output by reducing investment and labor force participation. The COVID-19 shock has been smaller than previous recessions in Korea but has represented a relatively large reallocation shock—to this point on par with that experienced in the Asian Financial Crisis, and more concentrated in the labor-intensive services sectors. Previous recessions have had substantial negative effects on medium-term output both in Korea and globally. This suggests that while the proactive economic policy response has buffered the initial impact, the COVID-19 pandemic could reduce potential output by 2.5-3.5 percent, mainly through lower investment and labor force participation. However, these conclusions are tentative given the unique nature of the shock and that its full magnitude is not yet known. Also, policies could play a role in reducing long-term scarring by facilitating restructuring and transformation. Indeed, the Korean New Deal takes steps to help address these issues.

These findings underscore the urgency of reforms to boost labor force participation, productivity, and investment, which have become even more critical in the wake of COVID-19. The export-oriented manufacturing sector has achieved notably high productivity growth, yet there remains scope for convergence to frontier levels of productivity in all industries, especially in the service sector. An illustrative scenario finds significant room to boost growth through competition-enhancing reforms to product markets and reforms to labor markets to increase labor inputs through increasing flexibility, improving training and worker matching, and reducing disincentives for participation. With the pandemic accelerating shifts toward digitalization of economic activity, new growth sectors, and flexibility in work arrangements, Korea's longstanding needs for product and labor market reforms remain key priorities. The effects of such reforms would occur only gradually, underscoring the importance of prompt implementation for buffering any slowdown in potential growth caused by COVID-19.

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Appendix. Methodology and Detailed Estimation Results

Comparator Countries

1960s comparators: Comparators were identified for the period immediately preceding takeoff using the following criteria:

- PPP GDP per capita between 50 percent and 200 percent of Korea's level at the time, to allow for a wide range of possible comparators who could potentially have experienced a similar growth takeoff. A five-year average was used, in case of noise in the data due to cyclical factors or measurement.
- Population greater than 5 million, as growth drivers of smaller economies could be different.

This results in a list of 20 economies with a wide range of diversity both geographically and in terms of economic structure at the time of Korea's takeoff: Burkina Faso, Bangladesh, Brazil, China, Cameroon, Egypt, Indonesia, India, Kenya, Morocco, Madagascar, Mali, Nepal, Pakistan, Philippines, Romania, Thailand, Taiwan POC, Tanzania, and Uganda.

Current comparators: The same population criterion was used. The income criterion was narrowed to include only economies with PPP GDP per capita between 66% and 150% of Korea's during the 2010s, which resulted in a set of 20 economies with a wide range of incomes and diverse economic structures: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, France, Germany, Hungary, Israel, Italy, Japan, Malaysia, Poland, Portugal, Spain, Sweden, Taiwan POC, United Kingdom, United States.

Industry-Level Growth Decomposition and Productivity Comparisons

Data sources: *Korea:* Asia KLEMS database; Bank of Korea; Haver Analytics; Korea Productivity Center; Statistics Korea. *United States:* Bureau of Economic Analysis; Bureau of Labor Statistics; Haver Analytics; and KLEMS database. For Korea, growth decomposition data is available for the 35 industries in the third column of Table A1 from 1970 to 2017, and labor productivity is available through 2019 (extending back to 1963 for broad sectors). The data is consolidated to 29 industries in the comparison of labor productivity relative to the United States to match the industry breakdown in the U.S. data.

Relative productivity: Korea's level of labor productivity vis-à-vis the United States for 2005 uses Inklaar and Timmer (2014), which estimated productivity levels for broad sectors, adjusted for international prices. Industry-level relative productivity y_i^{rel} was estimated by scaling each industry's productivity (y_i) by that of its broad sector (y_s) according to equation A.1:

$$y_i^{rel} = y_s^{rel} * y_i \ / y_s \qquad \text{(A.1)}$$

Where y_s^{rel} is the productivity of Korean sector *s* relative to the United States, as estimated by Inklaar and Timmer (2014). This yields industry-specific relative productivity levels for 2005. For other years, this level is spliced forward and backward using Korean and U.S. productivity growth rates for the respective detailed industries.

Table A1. Industry Categorization

Broad sector	Sector	Industry	Comparison with United States
Manufacturing	High-tech	1. Computer, electronic, optical 2. Electrical equipment 3. Machinery & equipment 4. Automobiles & parts 5. Other transportation equipment	1. Computer, electronic, optical 2. Electrical equipment 3. Machinery & equipment *4. Transportation equipment*
	Medium-tech	1. Coke & refined petroleum 2. Chemicals & products 3. Pharmaceuticals & medicine 4. Rubber & plastics 5. Non-metallic minerals 6. Basic metals 7. Fabricated metals 8. Other manufacturing	1. Coke & refined petroleum *2. Chemicals & products; pharmaceuticals & medicine* *3. Rubber & plastics; non-metallic minerals* *4. Basic metals & fabricated metals* 5. Other manufacturing
	Low-tech	1. Food & beverages 2. Textiles, apparel, leather 3. Wood, paper, printing	1. Food & beverages 2. Textiles, apparel, leather 3. Wood, paper, printing
Other goods	Other goods	1. Agriculture, forestry, fishing[19] 2. Construction 3. Mining & quarrying 4. Electric, gas, steam, a/c supply 5. Water, waste, recycling	1. Agriculture, forestry, fishing 2. Construction 3. Mining & quarrying 4. Electric, gas, steam, a/c supply 5. Water, waste, recycling
Services	Market services	1. Wholesale & retail trade 2. Accommodation & food services 3. Transportation & storage 4. Finance & insurance 5. Publishing, film, broadcasting 6. Information services 7. Communication 8. Professional, scientific, technical 9. Business support services 10. Culture & other services	1. Wholesale & retail trade 2. Accommodation & food services 3. Transportation & storage 4. Finance & insurance *5. Publishing, film, broadcasting, & communication* 6. Information services 7. *Professional, scientific, technical, & business support services* 8. Culture & other services
	Non-market services	1. Public administration & defense 2. Educational services 3. Health & social work 4. Real estate & rent	1. Public administration & defense 2. Educational services 3. Health & social work 4. Real estate & rent

Note: Italics show industries for which Korean industry-level data has been combined for comparison.

Accelerator Model

The estimation framework builds on the accelerator model estimated in Oliner, Rudebusch, and Sichel (1995):

$$I_t = \alpha + \sum_{i=0}^{N} \beta_i \, \Delta K^*_{t-i} + \delta K_{t-1} \tag{A.2}$$

Where I_t is investment, ΔK^*_{t-i} is the change in the desired capital stock, and δK_{t-1} is depreciation of existing capital. Assuming the change in output growth is proportional to the change in the desired capital

[19] The agriculture, forestry, and fishing industry is sometimes shown separately given its importance in the economy at the beginning of the sample period.

stock, dividing each term in equation A.2 by the lagged capital stock, and dropping the contemporaneous output-capital stock term to minimize endogeneity, the estimation equation is:

$$\frac{I_t}{K_{t-1}} = \delta + \alpha/K_{t-1} \quad + \sum_{i=1}^{N} \beta_i \frac{\Delta Y_{t-i}}{K_{t-i+1}} + y_{t-1}^{e} + \frac{IG_{t-1}}{K_{t-2}} \tag{A.3}$$

Where y_{t-1}^{e} is expected real GDP growth, extrapolated from the trend obtained using a one-side H-P filter and IG_{t-1} is lagged government investment. Both the dependent variable and the capital stock include only private non-residential investment or capital. The model is estimated on annual data since historical data on the capital stock and government investment are available only at the annual frequency. The first two lags of the ratio of the change in output to the lagged capital stock are included, as additional lags were rejected by standard tests. Estimation results are shown in Table A2.

Table A2. Accelerator Model Results

Dependent Variable: Private non-residential investment (ratio to private non-residential capital stock)

Variable	Coefficient	Standard error	t-Statistic	Probability
Constant	55.88	7.48	7.47	0.00
Private non-residential capital stock, inverse (lagged)	-848.13	130.89	-6.48	0.00
Output growth, ratio to private non-residential capital stock (first lag)	0.11	0.07	1.63	0.11
Output growth, ratio to private non-residential capital stock (second lag)	0.09	0.09	0.98	0.33
Expected real GDP growth, extrapolated from one-sided H-P filter (first lag)	1.81	0.52	3.50	0.00
Government investment to private non-residential capital stock (first lag)	2.21	0.28	7.77	0.00
Adjusted R-squared	0.88			
Durbin-Watson stat	1.26			
Observations	47			

Source: IMF staff calculations.
Note: Standard errors are heteroskedasticity- and autocorrelation-robust.

Economy-Wide Capacity Utilization

Data on capacity utilization in manufacturing is linked with real value added in the sector. Capacity utilization in sector *i* is theoretically proportionate to actual output as a percent of potential:

$$CU_i = \alpha + \beta(y_i - y_i^*) + \Delta y_i \tag{A.4}$$

Where $y_i - y_i^*$ is the cyclical component of output in sector *i* and time subscripts have been dropped for simplicity. Actual growth in real value added is also included in equation A.4 to account for the possibility of sluggish adjustment of capacity to shifts in activity. The cyclical component output is estimated using the H-P filter with a lambda of 100. This equation is estimated using quantile regression, given the relatively skewed distribution of capacity utilization, as the series is punctuated by sharp drops from the historical norm during recessions but no such spikes above the norm during periods of expansion (see Figure 15 in the main text). Table A3 shows the results, using annual data in order to align with the frequency of the capital stock data and production function model. These parameters are applied to data on non-manufacturing value added to derive an estimate for non-manufacturing capacity utilization. Total economy capacity utilization is then calculated using the actual manufacturing and estimated non-manufacturing figures, weighted by each sector’s share in the total capital stock.

Table A3. Manufacturing Capacity Utilization Results

Dependent Variable: Capacity utilization in manufacturing (percent of total)
Method: Quantile Regression (Median)

Variable	Coefficient	Standard error	t-Statistic	Probability
Constant	76.09	1.05	72.55	0.00
Real value added in manufacturing, log difference	13.23	11.27	1.17	0.25
Cyclical component of real value added in manufacturing	0.81	0.20	4.02	0.00
Mean dependent variable	76.22			
Quantile dependent variable	77.60			
Adjusted R-squared	0.38			
Observations	40			

Source: IMF staff calculations.
Note: Huber sandwich standard errors.

Production Function and Multivariate Filter Models

Production function: A Cobb-Douglas production function is assumed such that

$$Y \;=\; A \;\; K^{(1-a)}\, L^{a} \tag{A.5}$$

Where *Y* is output, *A* is total factor productivity, *K* is capital services, *L* is labor inputs, and α is the labor share of national income.[20] Data on capital services assuming a constant capacity utilization rate comes from the OECD. This estimate is then adjusted for the capacity utilization rate as described in the main text and previous section of the Appendix. Labor inputs include the estimate of labor quality provided by version 9.1 of the Penn World Table and data on hours worked from the OECD. Historical total factor productivity is estimated as a residual from equation A.5.

Long-term projections of real GDP are formulated using the following assumptions:

- *Capital services:* Gross fixed capital formation is projected using the results of the accelerator model discussed above, yielding a broadly stable ratio of investment as a share of GDP. The capital depreciation rate is assumed to follow recent trends. Capacity utilization is assumed to return to its historical norm by 2025, as all cyclical factors are assumed to have normalized by that time.

- *Labor inputs:* Population projections by age and gender are from Statistics Korea. The labor force participation rate is projected using the cohort approach as described in the main text. The employment rate is assumed to return to its historical norm by 2025. Hours per worker are extrapolated from recent trends. The change in labor quality is estimated combining the projections of educational attainment in Barro and Lee (2013) with the above population and labor force participation projections.

- *Total factor productivity:* Productivity growth is assumed to gradually return to its 2000-2019 average of 1.4 percent. This would imply modest convergence of productivity relative to the United States from

[20] Both approaches assume a labor share of 0.61, which matches that of a recent Bank of Korea study (Kwon et al, 2019) that calculates the share using national accounts data.

63 percent of the U.S. level currently to 72 percent in 2050, assuming U.S. productivity growth in line with its 2000-2019 average of 0.8 percent.

The trend value for each concept is then estimated by applying the Hodrick-Prescott filter (with a lambda of 100) on the historical data and projections together, to alleviate end-of-sample issues with filtering methods. Potential output is then calculated as the sum of the trend of each component according to equation A.5.

Multivariate filter (MVF): The MVF expands on the production function framework by adding theoretical structure that aids in estimating the unobserved concept of potential output by linking it to relationships among observed variables—see Blagrave and others (2015) and Alichi and others (2017). Specifically, the MVF includes Phillips curve and Okun's law relationships which help identify potential output through the behavior of inflation and the unemployment rate.

Consensus Forecasts for real GDP and inflation are also included, which helps improve the accuracy of the estimates at the end of the historical sample and beginning of the forecast sample (Blagrave and others, 2015). Capacity utilization as estimated above is also included as an observable variable.

As in Alichi (2015), this version of the MVF also includes a more detailed labor supply block, incorporating the working-age population and labor force participation rate. See Alichi (2015) for the equations specifying the model structure.

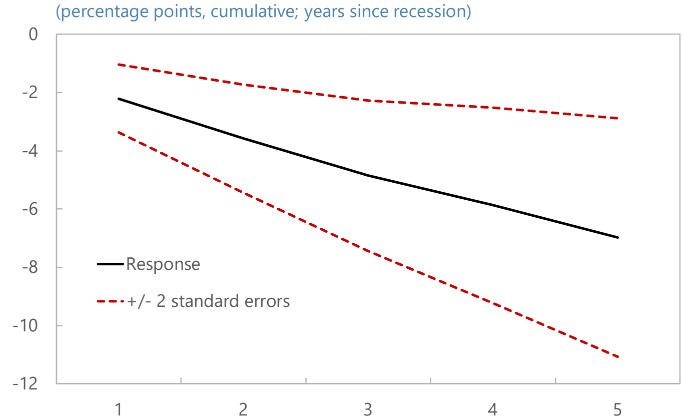
Long-term assumptions regarding the evolution of capital, labor inputs, and productivity are the same as in the production function approach (with the exception of labor quality and hours per worker, which are not part of this model), and provide the steady-state values for the model, which is solved using Bayesian Maximum Likelihood techniques.

Local Projections Estimates of Impact of Previous Recessions on Potential Output

The impact of recessions on potential output in Korea is assessed econometrically using the production function model. Recessions—defined as two consecutive quarters of contraction in real GDP—occurred in Korea in 1979-80 and 1997-98. The analysis also includes 2008-9, since there was a large decline in Q4-2008 and growth in Q1-2009 was narrowly positive. A recession variable measuring the growth surprise was estimated in an autoregressive model including the third through fifth lags of real GDP growth. This permits the estimation to account for the magnitude of each recession. The effects of these growth surprises on potential output and each of its components were then estimated out to a five-year horizon using the local projections method of Jordà (2005) and Teulings and Zubanov (2014).

The econometric results show that previous recessions in Korea have had a sizable negative impact on potential output averaging 7 percent over five years (Figure A.1). These effects are largest in the

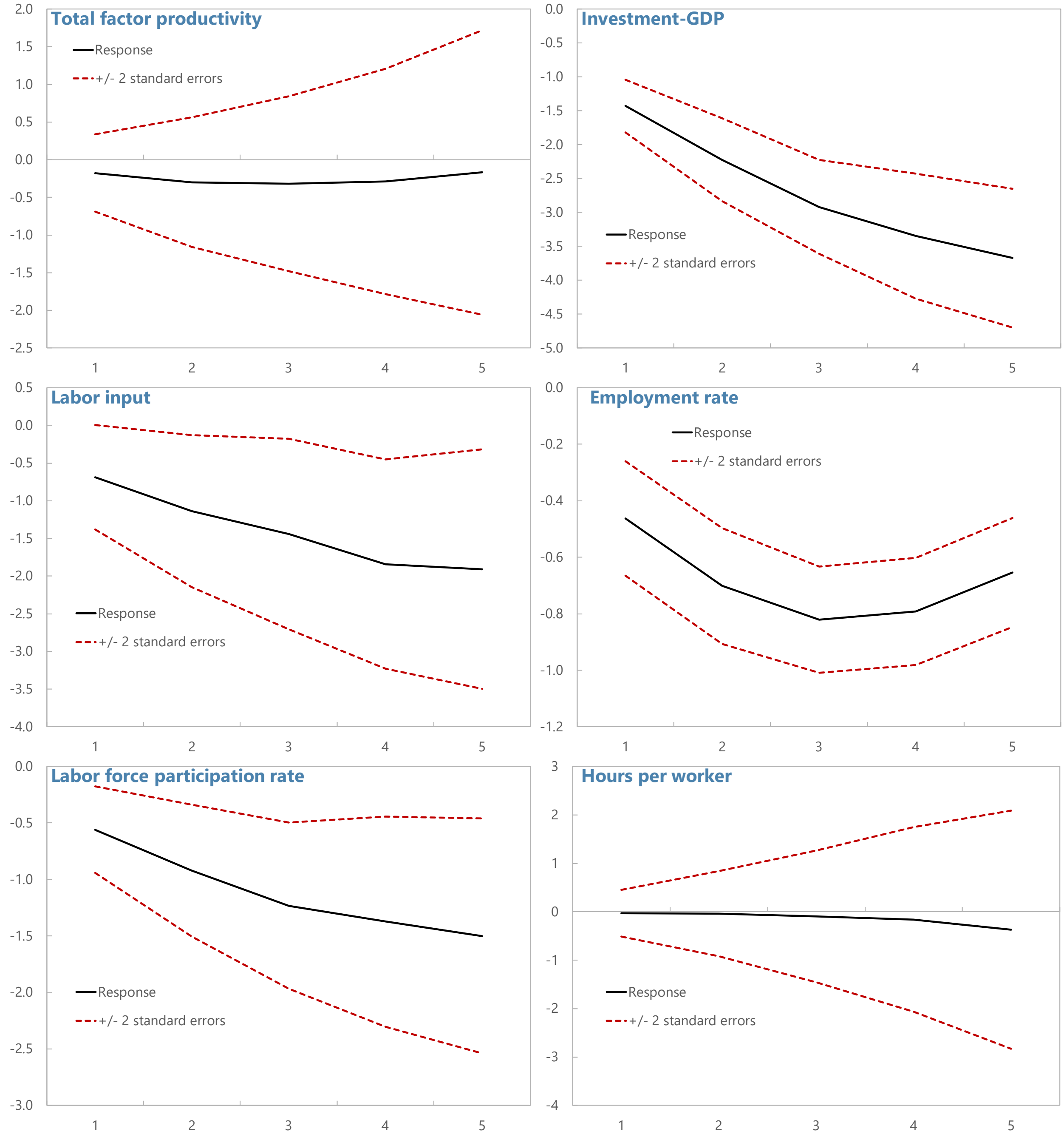
Figure A.1. Impact of Recessions on Potential Output
(percentage points, cumulative; years since recession)



Source: IMF staff calculations.

immediate aftermath of recessions but continue to materialize over time, with potential growth only slowly converging to the rate it would have attained in the absence of the shock. These persistent effects on potential growth likely reflect the prolonged adjustment of inputs to their new steady-state values. While the number of observations is small, these findings confirm the conclusions of the literature that downturns can have long-lasting, potentially permanent, effects on output, for example Cerra and Saxena (2008), Ball (2014), and IMF (2015b).

Figure A.2: Impact of Recessions on Factors of Production
(Percentage Points, Cumulative; Years Since Recession)



Source: IMF staff calculations.

Estimates of the impact on the factors of production find recessions have led to long-lasting reductions in both capital and labor inputs. The literature has found these effects occurring through lower investment, productivity, labor force participation, and employment (see Adler and others, 2017; Dovern and Zuber, 2020; IMF, 2015b; and Oulton and Sebastiá-Barriel, 2017). Korea has also experienced these patterns in prior downturns to some degree, most notably declines in private investment ratios and labor force participation. Figure A.2 shows the results of using local projections to estimate econometrically the impact on the potential level of the factors of production.

- *Insignificant effects on productivity.* Trend TFP slowed after the 1979-1980 recession but not after 1997-1998 as actual TFP rebounded sharply. TFP was also resilient during the global financial crisis—it was not until a few years later that a trend slowdown in TFP occurred.
- *Sharp reduction in investment and thus slower growth of capital inputs through the medium term.* Investment-GDP ratios fell immediately and remained depressed for several years in the aftermath of Korea's recessions, leading to lower capital inputs—notably after the AFC, as pre-crisis financial imbalances took several years to be resolved. Results not shown are similar for investment-capital ratios, the capital stock, and capital services.
- *Temporary reduction in growth of labor inputs.* Potential employment rates dipped after recessions before recovering in the medium term. Recessions were also found to have long-lasting effects on labor force participation rates. Little impact was found on hours per worker.[21]

Aggregating these factor-level results broadly confirms the magnitude of the impact estimated using headline potential growth. The estimated effects on capital services and labor inputs were scaled by their share of income and added together, along with the contribution of TFP. The cumulative reduction of potential output estimated in this manner is slightly smaller at -5.2 percent, with the majority of this impact in the medium term accounted for by the reduction in capital services. While these results may not generalize to the current episode, they confirm the common finding that large downturns tend to have long-lasting effects on output through scarring or hysteresis effects.

Structural Reforms Scenario

Quantitative estimates of the impact of structural reforms are obtained in two stages. First, the parameters estimated in Kim and Loayza (2019) and Dao and others (2014) are used to quantify the direct impact of assumed reforms on productivity and labor force participation, respectively. These direct effects are then fed into the production function model for potential output estimated earlier. This model then provides an estimate of the feedback from higher productivity and labor participation to output and investment.[22] Given the importance of past labor force participation in the ongoing participation rate of a given cohort, the effects of reforms on participation are applied via the cohort model to incoming cohorts but not to ones already in the labor force, a relatively conservative assumption.

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[21] Two plausible explanations are that 1) the structural decline in hours per worker during the period under analysis could be obscuring the estimated effects of recessions; or 2) labor inputs are adjusted via shedding of part-time workers, with the jobs of full-time workers more protected by Korea's relatively stringent labor market regulations.

[22] Given the aggregate structure of the potential output model and reduced form nature of the empirical estimates of the impact of reforms, no feedback to labor quality, hours worked, or the equilibrium unemployment rate is assumed, though effects through these channels would likely be of smaller magnitude than the ones incorporated here.