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Productivity and Product Markets in Korea

Evidence from Advanced Economies

Andrew Swiston and Stella Tam

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Productivity and Product Markets in Korea: Evidence from Advanced Economies

Prepared by Andrew Swiston and Stella Tam*

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ABSTRACT: This paper constructs an industry-level dataset of productivity across advanced economies, showing that Korea's labor productivity and total factor productivity levels are below the median of other advanced economies. We identify sizable industry-level productivity gaps in Korea with respect to the global frontier, especially in market-oriented services. Using the OECD's Product Market Regulation (PMR) Indicators, we show that tighter PMRs slow industry-level productivity growth, and these effects occur across all areas of PMRs—state control, barriers to entrepreneurship, and barriers to trade and investment—and through several detailed indicators. These effects are transmitted through higher product prices and unit labor costs of industries exposed to regulation. The results confirm the potential for Korea to boost overall productivity and growth through PMR reforms, especially by lowering barriers in service and network sectors, reducing restrictions applying to trade and investment, and evaluating the scope of government involvement in the economy.

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

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Introduction

The regulatory environment has long been considered, by many analysts, as a key factor in keeping Korea's economy-wide productivity at a relatively low level for a country with its per capita income (McKinsey, 1998; OECD 2014, 2016). These studies and other analysts have identified regulations as a constraint on faster growth, especially in the service sector (Jones, 2009; Jain-Chandra and Zhang, 2014; Jones and Lee, 2016).

While Korea's growth performance was exceptional for decades, the rate of growth has slowed substantially in recent years. Beginning from low income levels in the 1950's and early 1960's, Korea converged to advanced economy income levels by about 2000 (Radelet and others, 2001; Young, 2019). However, the economy's trend growth rate has been in a long decline dating from well before the Covid-19 pandemic (Cho and Kwon, 2017; Kwon and others, 2019; Zoli and others, 2018).

In terms of the proximate determinants of growth, Korea has relied relatively heavily on the accumulation of factor inputs—capital and labor. The rate of capital formation has historically been high (Collins and Bosworth, 1996; Lee and Hong, 2012). This has been consistent with the large role of the manufacturing sector as a driver of rapid growth. Rising labor inputs were also an important factor during the high-growth period, as Korea experienced rapid working-age population growth, maintained high levels of hours per worker, and substantially increased skill levels as reflected in large increases in worker educational attainment (Barro and Lee, 2013).

Korea's productivity levels have also converged toward those of advanced economies, though performance has lagged in recent decades. Economy-wide productivity levels increased substantially through the 1990's but have since plateaued at around two-thirds of the levels of the most productive economies (Lee, 2016; Swiston, 2021). Raising productivity has thus been seen as an important priority for rejuvenating economic growth.

Structural factors also point to the importance of raising productivity to attain further increases in standards of living. Korea's already-high dependence on capital accumulation and labor inputs, along with the demographic transition to a more elderly population, imply the scope for input-driven growth will be smaller going forward (Kwon, 2017; Swiston, 2021). Given Korea's high income level it is also likely to follow the path of other economies whose economy has become more service-oriented as living standards rise. The Covid-19 pandemic may have also accelerated structural shifts such as digitalization that will result in a long-term increase in the proportion of services in economic activity.

In this context, this paper constructs a cross-country, industry-level dataset of productivity levels across advanced economies and compares the levels of Korea's labor productivity (LP) and total factor productivity (TFP) with those of other advanced economies. It finds that Korea's LP and TFP are below the respective medians for advanced economies. The broad conclusion from the industry-level data is that in most industries there are substantial gaps relative to the highest-productivity country, or technological frontier. There is wide heterogeneity across industries, though productivity in Korea's

manufacturing sector is generally closer to the technological frontier, while there are larger productivity gaps, on average, in Korea's market-oriented services industries.

The paper then examines the links between product market regulations (PMRs)—and overall or industry-level productivity. The most detailed and comprehensive source, the OECD PMR Indicators, confirms Korea's relatively longstanding tendency toward a more restrictive regulatory environment than peers. Unlike many studies which have relied on annual data and OLS panel approaches (or instrumental variables in a few cases), our panel regressions use System GMM to estimate the impact of PMRs on productivity, while still controlling for each industry's inherent exposure to the impact of regulations. System GMM is well-suited to data like the OECD PMR Indicators with few observations in the time dimension, and also handles well the dynamics inherent in productivity growth.

We find that PMRs are a significant factor in industry-level productivity, with a tighter regulatory environment slowing industry-level growth of both LP and TFP. These effects occur across all the main areas of PMRs—state control, barriers to entrepreneurship, and barriers to trade and investment—as well as most of the detailed OECD PMR indicators.

In addition to the generally negative efficiency effects of PMRs, we also find evidence of effects through innovation, as PMRs constrain productivity growth more when a country-industry observation is closer to the global technological frontier. While we do not find significant differences in the effects of PMRs across broad industry groups such as manufacturing or services, there is evidence that PMRs have larger effects in industries where LP tends to be higher—for example high-tech manufacturing and information-intensive services. Overall, our baseline estimates suggest that reforms to bring Korea's regulatory flexibility in line with the average OECD economy could raise aggregate productivity growth by half to three-quarters of a percentage point per year.

Negative effects of regulation on both industry-level efficiency and the industry composition of activity are apparent when examining the channels through which PMRs affect productivity. We find that restrictive PMRs are associated with slower growth in real value added. This occurs principally through lower TFP and secondarily through reduced labor input, especially in industries near the technological frontier, while we find little impact on capital accumulation. The effects of PMRs are transmitted through higher product prices and unit labor costs of affected industries, pointing to the role of regulation in raising production costs and reducing competitiveness, which can then spill over into other industries through input-output linkages.

These findings are consistent with the existing evidence for advanced economies and confirm that Korea's relatively tight PMRs are likely constraining productivity in services and high-tech manufacturing. These results underscore the importance of PMRs as a driver of productivity and point to how reforms could support reallocation toward dynamic, high-productivity sectors like information and communications, pharmaceuticals, and biotechnology—as well as efficiency in the broader market services sector. Key priorities for reform in Korea include lowering barriers in service and network sectors, reducing restrictions applying to trade and investment, and evaluating the scope of government involvement in the economy.

Comparisons of Productivity Levels by Industry

This section discusses issues relating to measuring levels of productivity by industry on a cross-country basis, describes the features of the dataset used in this paper, and compares Korea's productivity levels with advanced-economy peers.

Productivity measurement and scope of analysis

Cross-country measures of productivity levels by industry can vary widely depending on the assumptions used (Inklaar and Timmer, 2009). This paper begins with data produced by the Groningen Growth and Development Centre, which measures productivity by industry on the same basis across countries by estimating and applying industry-level purchasing power parities. The estimates account for differences in the volumes and types of capital and labor used in production at the detailed industry level. This allows the derivation of estimates for the level of productivity by industry that are comparable across countries for a benchmark year.[1] Growth rates of productivity at the country-industry level are then used to extrapolate from the benchmark year to create a time series.

For industry-level analysis, the focus is on industries in the manufacturing and "market services" sectors.[2] In large part this is because a greater proportion of activities in these industries is operated on a commercial basis, in which production levels and processes respond to various costs and incentives including those posed by the regulatory environment.

Measurement issues constitute a second key reason for focusing on these industries. Inputs and thus productivity are more difficult to measure in "non-market services"—public administration, health, education, and real estate—where output prices are less frequently available (Inklaar and Timmer, 2014). Both real estate and manufacturing of coke and refined petroleum products are excluded from all the industry-level analysis due to differences in measurement across countries for the former, and for substantial variation in the latter, including negative real value added for some countries and time periods. Measurement difficulties also apply, to a lesser extent, to the construction and utilities industries.

Finally, a key factor that hinders productivity analysis in the agriculture, mining, and utilities industries is that exogenous factors like natural resource endowments and weather can outweigh the influence of other determinants like regulation (Topp and Kulys, 2014). Nevertheless, we will test robustness to expanding the sample to all these industries and find that our main results hold.

We analyze both LP and TFP for a few reasons. First, LP data is available for a broader cross-section of countries over a longer period, with the availability of TFP skewed toward relatively wealthier countries

[1] See Inklaar and Timmer (2008, 2009, 2014) for discussion and the methodology, and the Appendix for more details.

[2] Market services include wholesale and retail trade, transportation and storage, accommodation and food services, information and communication, finance and insurance, business services (including professional, scientific, and technical services), and personal services (including arts, entertainment, recreation, and other personal services). See the Appendix for a full categorization of industries.

within the group of advanced economies.[3] Second, TFP is more challenging to measure and thus subject to a greater degree of uncertainty than LP is. However, TFP is conceptually superior as a measure of productivity in that it controls for capital per worker, a key issue for Korea. A comparison of performance in LP relative to TFP also generates insights on the extent to which productivity differences are driven by capital accumulation.

Korea's productivity levels

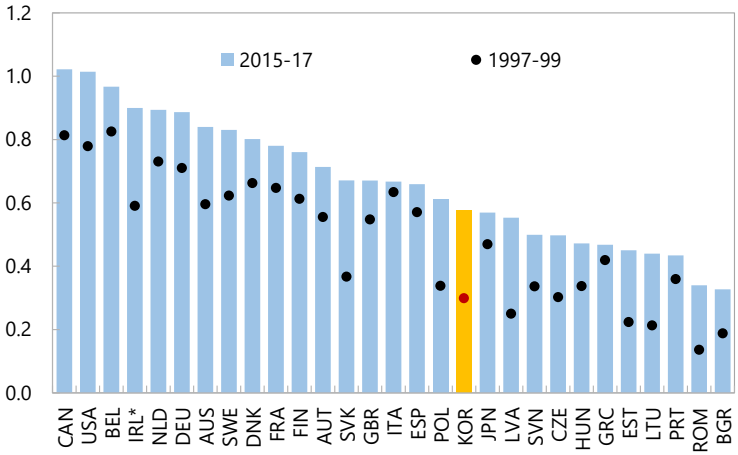
This analysis focuses on advanced economies in the last few decades—generally since 1995. This is the most relevant sample for Korea in the present context and aligns with the availability of data for both productivity and the regulatory environment. Unfortunately, lack of cross-country availability of PPP-adjusted data precludes analysis of developments since the onset of the Covid-19 pandemic.

In recent decades, Korea's overall LP has continued to steadily converge toward the productivity levels of other advanced economies. In the mid-1990's, LP was 40 percent below the advanced economy median, but by 2017, the gap had been closed to less than 15 percent (Figure 1). The pace of convergence was faster through the mid-2000's but slowed subsequently (Figure 2).

Aggregate TFP has also converged toward the levels of other advanced economies, though at a slower pace than for LP. TFP in the overall economy was just over half the advanced economy median in

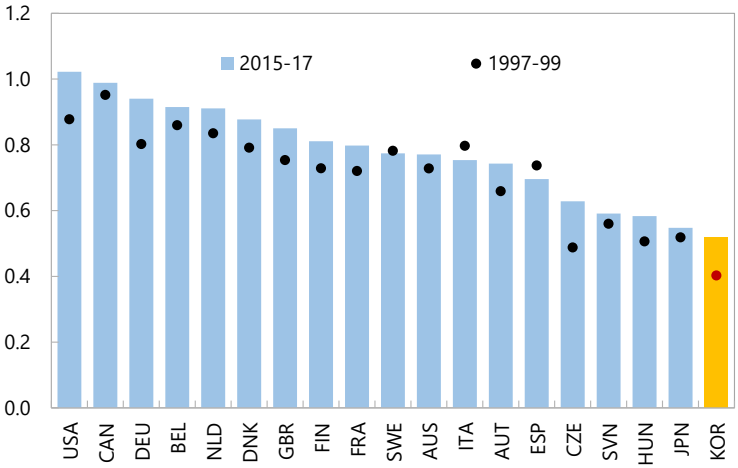
Figure 1. Productivity Levels Across Advanced Economies

Labor productivity (Index, frontier economy in 2009-11 = 1)



Source: IMF staff calculations on data described in Appendix.
Note: * Uses 2012-14 data

Total factor productivity (Index, frontier economy in 2009-11 = 1)

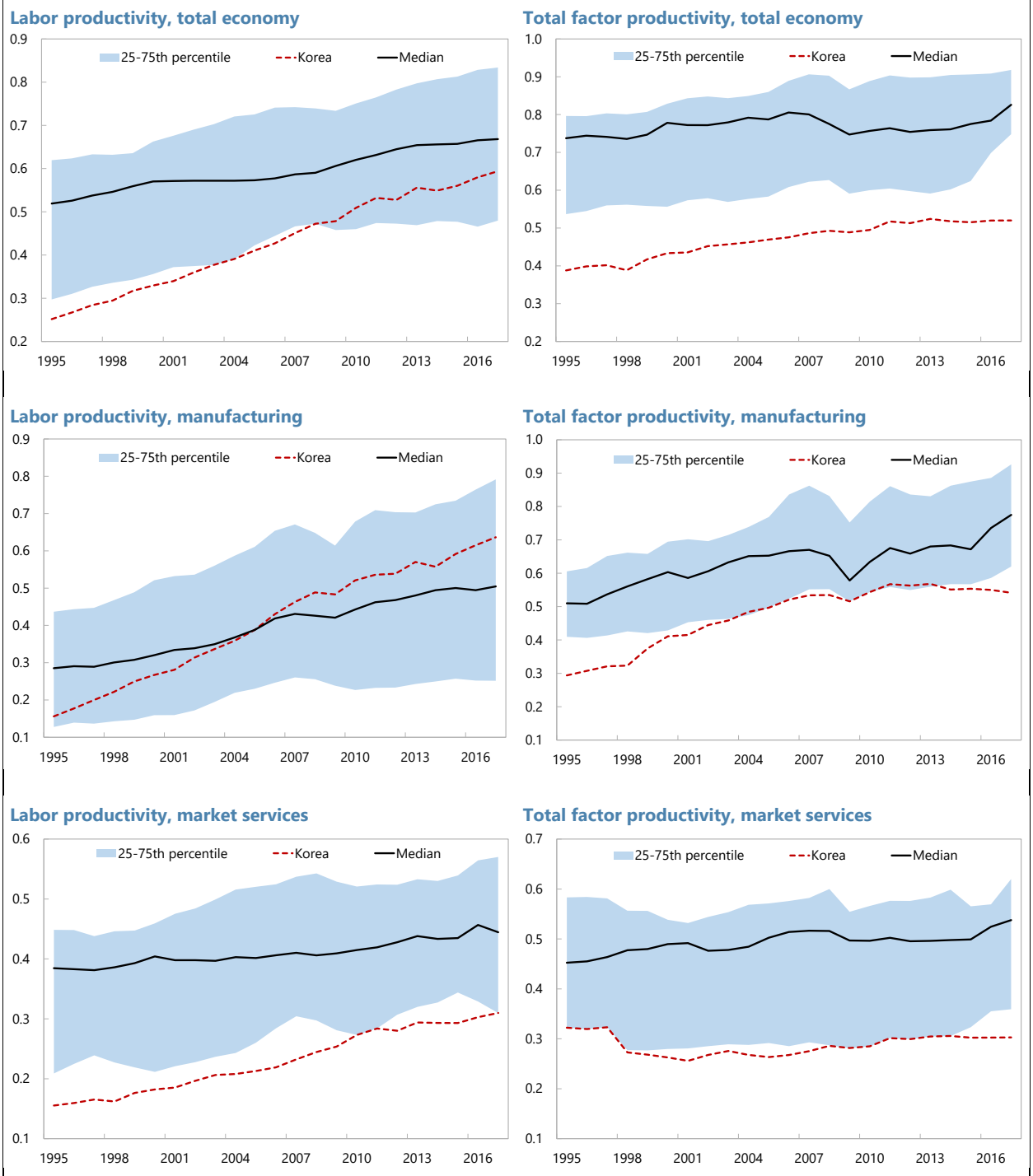


Source: IMF staff calculations on data described in appendix.

[3] See the Appendix for a list of countries. To be included in the analysis, LP or TFP data needed to be available since at least 2000.

Figure 2. Aggregate Productivity Levels Over Time

(Index, frontier economy in 2009-11 = 1)



Source: IMF staff calculations on data described in Appendix.

1995, and this increased to about two-thirds by 2017 (Figure 1).[4] Again, most of this convergence occurred by the mid-2000s (Figure 2). Korea's slower TFP convergence points to the continued important role of inputs in explaining overall economic activity and LP.[5]

Underlying this aggregate productivity performance, there is substantial variation between manufacturing and market services, with manufacturing continuing to be the main driver of Korea's overall productivity gains. Since the 1990's, Korea's LP in manufacturing leaped from the bottom third of the sample to the top third (Figure 2). However, the increase in TFP has been more modest in both absolute and relative terms, illustrating how output gains in manufacturing continued to be driven to a large extent by capital accumulation. Productivity growth has been slower in market services industries, whether looking at LP or TFP, and there has not been noticeable convergence of Korea's productivity levels in market services toward those in other advanced economies (Figure 2).

Figures 3 and 4 display Korea's current standing in LP and TFP relative to both the technological frontier and the cross-country distribution, for detailed industries within the manufacturing and market services sectors.

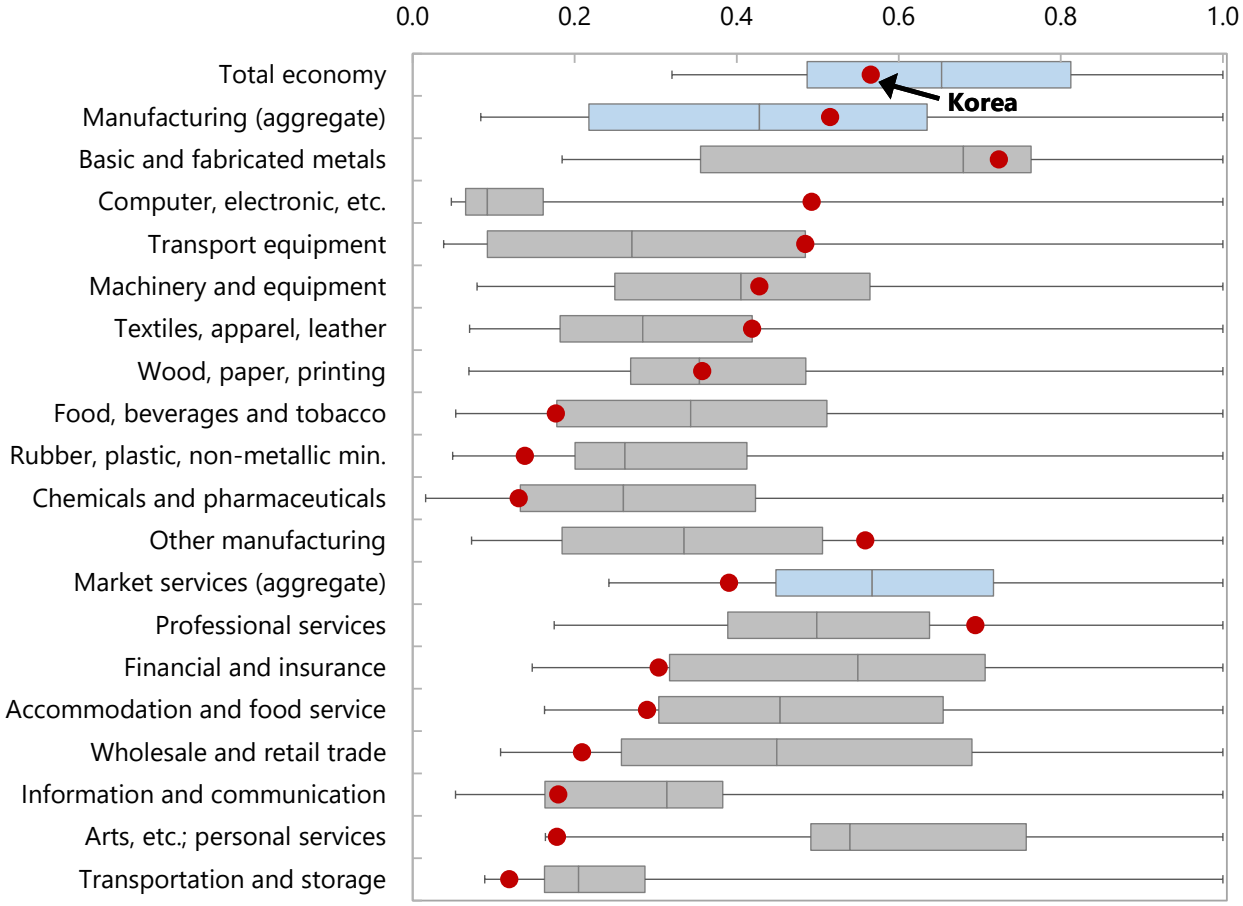
For manufacturing in aggregate, Korea's LP and TFP gaps with respect to the frontier are both about 50 percent, with the gaps for specific industries mostly ranging from about 30 percent to 80 percent. LP is 120 percent of the median, while TFP is 80 percent of the median.[6] In several industries, manufacturing LP and TFP are above the median, while significant gaps remain in food and beverages, chemicals and pharmaceuticals, and rubber and plastics. LP is closest to the frontier for basic and fabricated metals, while TFP is closest to the frontier in basic and fabricated metals and in transportation equipment. Korea also ranks relatively highly in LP and TFP of its computer and other IT equipment manufacturing, due to the strength of its highly competitive semiconductor industry (among others). The gap with the frontier in this industry is explained by the large advantage of the United States relative to all other countries. LP and TFP gaps are generally of a similar magnitude, though Korea's LP is relatively higher than its TFP in computer and electronic manufacturing, given Korea's specialization in capital-intensive production within this industry. By contrast, Korea's manufacturing of transport equipment has a higher standing for its TFP levels than for its LP.

[4] Note the differing samples in the two panels of Figure 1. This is the main reason for Korea's different position in the distribution of economy-wide productivity.

[5] Kim (2008) finds smaller TFP gaps for Korea in 2004, the final year of analysis, albeit using a measurement approach that differs in some key respects. TFP is defined there on a gross output basis and extrapolated using gross output deflators. For Korea, factor inputs are not directly incorporated—capital stock is used instead of capital services and hours worked is used instead of labor services. Nevertheless, the pattern of TFP gaps across industries is similar to that found here.

[6] Korea's standing within the TFP distribution is typically less favorable given the bias in data availability toward higher-income countries even within advanced economies.

Figure 3. Industry-Level Labor Productivity Distribution
(Labor productivity in percent of industry-specific frontier, 2015-17)

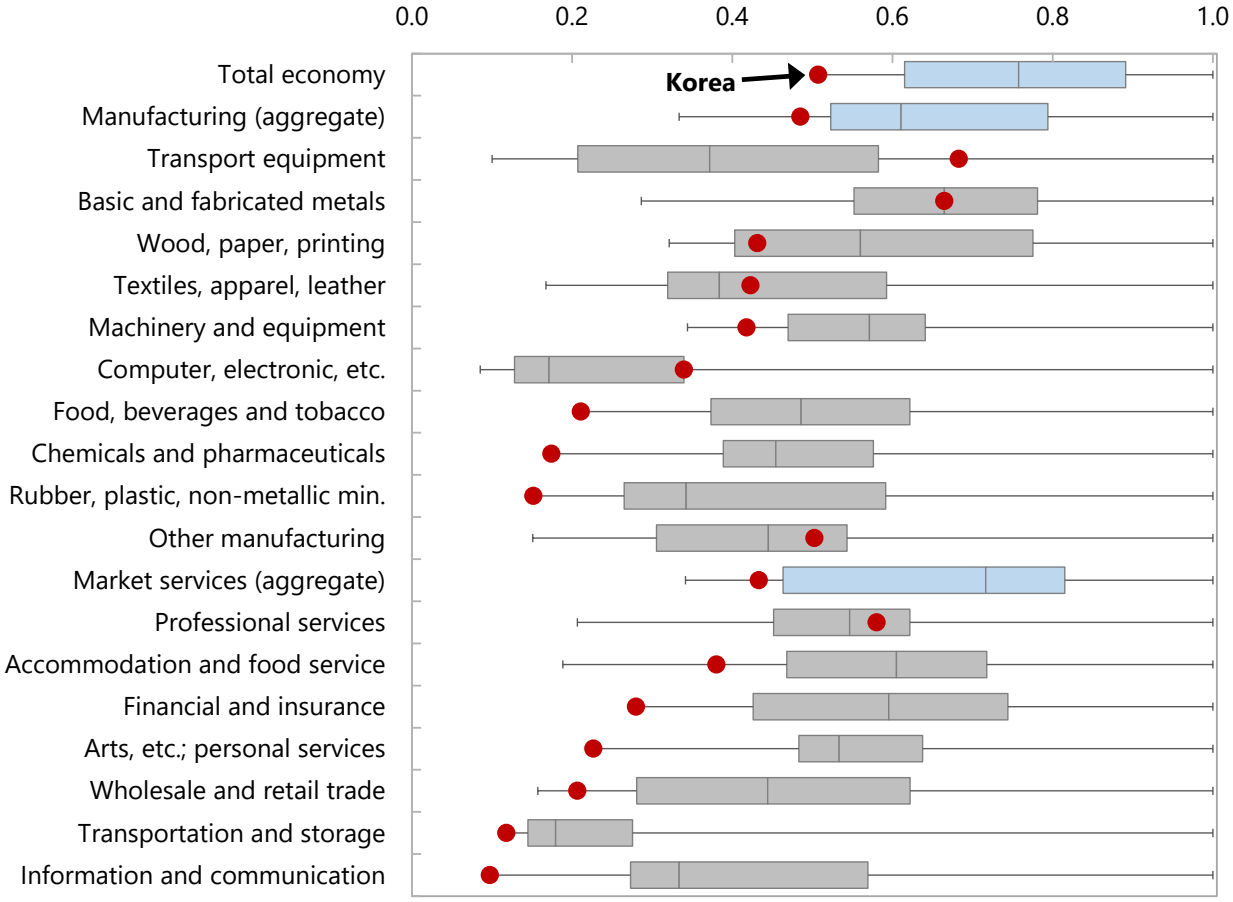


Source: IMF staff calculations on data described in Appendix.
Notes: Red dots show Korea. Gray bars show 25th and 75th percentiles, intersected by the median. The whiskers show the minimum and maximum (this equals one by construction).

Productivity gaps are larger in market services industries, at about 60 percent with respect to the frontier for both LP and TFP. Market services LP is 30 percent below the median, while TFP is 40 percent below. Both LP and TFP are closest to the frontier in the professional and business services industries, where productivity exceeds the median. Meanwhile there are gaps of 75 percent or more with respect to the frontier—or about 35 to 50 percent with respect to the median—in wholesale and retail trade, transportation and storage, information and communication, and personal services.

The detailed industry-level data illustrates the progress Korea has made in converging toward the productivity levels of other advanced economies, especially in manufacturing. However, it also suggests there is significant space to increase Korea's income levels by closing productivity gaps across the economy, particularly in the market services sector.

Figure 4. Industry-Level Total Factor Productivity Distribution
(Total factor productivity in percent of industry-specific frontier, 2015-17)



Source: IMF staff calculations on data described in Appendix.
Notes: Red dots show Korea. Gray bars show 25th and 75th percentiles, intersected by the median. The whiskers show the minimum and maximum (this equals one by construction).

Product market regulations in Korea

As noted in the introduction, PMRs in Korea have long been pointed to as a key factor in the productivity gaps detailed in the previous section, especially in the services sector. This section describes the OECD PMRs that are the most comprehensive source of information in this area, summarizes Korea's standing on PMRs relative to peers, and explains how the PMRs are used in our industry-level empirical analysis.

The OECD PMR Indicators

Assessing Korea's standing on the broad regulatory environment requires a measure that is comparable across countries and over time. The OECD's PMR indicators are sound in this regard, as they result from a questionnaire answered by country authorities (along with other information) and vetted by OECD staff

to ensure strong cross-country comparability and a consistent methodology over time (see Koske and others, 2015). The OECD indicators are available at a high level of detail, while also making available aggregate measures.

The main drawbacks are the short time span of the indicators (beginning in 1998) and the five-year interval at which the indicators are available. These features, and a structural break between the 2013 and 2018 vintages (see Vitale and others, 2020), have limited their use in macro-level studies. Another limitation for industry-specific analysis is that the indicators are available only at the economy-wide level (though a few indicators are focused on or are more applicable to specific industries).

The great degree of detail available for the OECD PMR indicators is a significant advantage relative to other measures of PMR, as this permits a more granular analysis of specific regulatory areas than is possible with other indicators. The OECD PMR indicators cover three broad areas (see Koske and others, 2015), each with two or three subcategories that are comprised by a few specific indicators shown in Table 1.[7] These specific indicators, in turn, reflect responses to several questionnaire items or other pieces of information. These indicators are aggregated, using equal weights, into the subcategories, the three broad areas, and finally an economy-wide indicator of PMR to provide harmonized and comparable high-level readings of the regulatory environment across countries and time.

Table 1. OECD PMR Indicators Structure (2013)

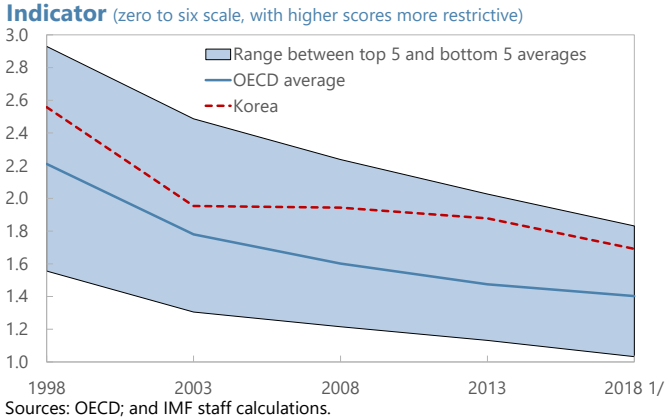
Broad areas	Subcategories	Low-level indicators
State control	Public ownership	Scope of state-owned enterprises (SOEs) Government involvement in network sectors Direct control over enterprises Governance of SOEs
	Involvement in business operations	Price controls Command and control regulation
Barriers to entrepreneurship	Complexity of regulatory procedures	Licenses and permits system Communication and simplification of rules and procedures
	Administrative burdens on start-ups	Administrative burdens for corporations Administrative burdens for sole proprietor firms Barriers in service sectors
	Regulatory protection of incumbents	Legal barriers to entry Antitrust exemptions Barriers in network sectors
Barriers to trade and investment	Explicit barriers to trade and investment	Barriers to FDI Tariff barriers
	Other barriers to trade and investment	Differential treatment of foreign suppliers Barriers to trade facilitation

[7] The structure for 1998-2013 is given because this is used in the empirical analysis.

Korea's standing on PMR indicators

For Korea, the OECD PMR indicators show a growing degree of flexibility, in line with general trends among OECD countries, with Korea's regulatory environment remaining somewhat more restrictive than that of the average OECD economy (Figure 5). Scores can range from zero to six, with Korea's aggregate PMR improving from 2.6 in 1998 to 1.7 in 2018.[8]

Figure 5. OECD Product Market Regulation: Economy-Wide Indicator (zero to six scale, with higher scores more restrictive)



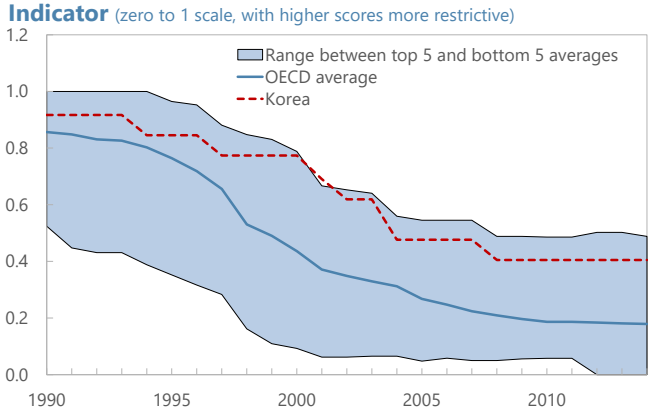
Sources: OECD; and IMF staff calculations.
1/ Scores for 2018 are not fully comparable with previous periods.

While the 2018 indicators are divided into different categories than earlier vintages and there were revisions to the underlying information adding and removing some sectors and regulatory domains, comparison of the 2013 and 2018 indicators suggests these methodological changes did not greatly affect the overall assessment of Korea's regulatory environment relative to peers.[9]

Figure 6 compares subcategories of the PMR indicators, showing Korea relative to the OECD average and the top 5 OECD economies. The main area in which Korea's PMRs are relatively more restrictive is in barriers in services and network sectors (Figure 6). PMRs are also more restrictive than average in public ownership and involvement in business operations. Korea also lags OECD peers in barriers to trade and investment, while it is near the OECD average for the administrative burden on startups. Regulatory complexity/simplification is the one area where the 2013 and 2018 vintages give different views on Korea's standing, with the 2013 vintage showing Korea near the OECD average, while in the 2018 vintage it is ranked among the top 5 in the OECD.

The broad conclusions of the OECD PMR indicators for Korea—an increasingly flexible regulatory regime albeit remaining more restrictive than other advanced economies—are corroborated by other measures of the regulatory environment, notwithstanding some differences in coverage and focus. This includes the product markets component of the IMF's Structural Reform Database (see Alesina and others, 2020), shown in Figure 7, which follows a similar trend to the OECD PMR indicators despite a narrower coverage focused on network sectors. Korea's standing

Figure 7. IMF Product Market Regulation: Economy-Wide Indicator (zero to 1 scale, with higher scores more restrictive)



Sources: IMF Structural Reforms Database; and IMF staff calculations.

[8] Note there could be uncertainty surrounding the point estimates, though this improvement seems to be a general trend.

[9] Also, given the regression sample, the quantitative analysis uses only the 1998-2013 indicators.

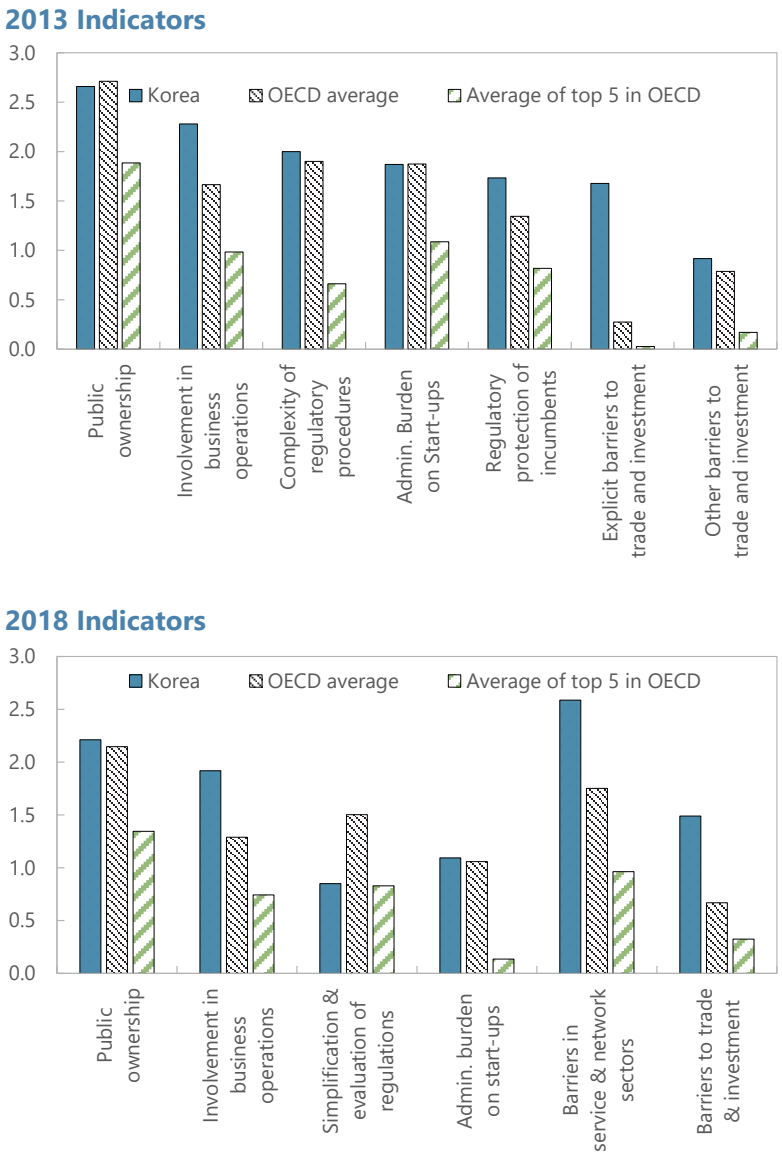
is also broadly comparable in other cross-country datasets, including the relevant components from the Fraser Institute's *Economic Freedom of the World* report, the World Economic Forum's *Global Competitiveness Index*, and the World Bank's *Worldwide Governance Indicators*.[10]

Industry-level PMR indicators

With PMR indicators measured at a country level, not at the level of industries, this poses a challenge to empirical estimation using industry-level data. Theoretically, the impact of PMRs should vary across industries according to the degree to which the regulations constrain each industry's activity—the "industry exposure". Generating industry-specific indicators has focused on adjusting the raw PMRs for this industry exposure as proxied by various metrics.

Measures of the industry-specific burden of PMRs—the "downstream impact" or "knock-on effects"—have been constructed and used in many studies. These have been calculated using indicators capturing the degree to which key industries such as energy, transport, communication, retail distribution, and business services are regulated, applied to the proportion of the output of these industries that is used as inputs in other industries (see Conway and Nicoletti, 2006, and Egert and Wanner, 2016).

Figure 6. OECD Product Market Regulation Indicators by Area
(zero to six scale, with higher scores more restrictive)



Sources: OECD; and IMF staff calculations.

[10] Also, the World Bank's *Doing Business Indicators*, before they were discontinued.

Other studies have used industry exposure to various other structural factors, including firm turnover rates, layoff rates, and degree of dependence on external finance (Andrews and Cingano, 2014; Bassanini and others, 2009). This approach aims to capture industry-inherent characteristics that may mediate the effects of the broad regulatory environment on production, without taking a stance on the specific channel through which the impact operates. For example, regulatory effects could operate through the composition of intermediate inputs (as in the "downstream impact" approach), the use of a different mix of the factors of production, or the ability to reallocate resources in response to shocks.

To better detect the effects of the regulatory environment, we interact the PMR indicators (and other economy-wide structural indicators) with multiple industry-specific characteristics. Specifically, three measures are used:

1. *Layoff exposure:* Layoff rates can be understood as a proxy for the volatility inherent in a given industry, as they reflect the reallocation of labor in response to shocks. This is calculated using layoff rates for United States, as the benchmark economy with generally the most flexible labor market reallocation policies among the group under consideration (Andrews and Cingano, 2014; Bassanini and others, 2009). Thus, layoff exposure by industry is not dependent upon the degree of labor market regulation in any economy outside the United States.
2. *Capital-output ratio:* The ratio is taken as a measure of the capital intensity typical within a given industry. Given the irreversible nature of investment in fixed capital, this could detect the effects of the regulatory environment on investment. This is calculated as the industry average across all available countries and time periods.
3. *Skill requirement:* This is used as a measure of the skilled labor requirements typical for a given industry. The aim is to detect whether the effects of the regulatory environment differ by industry according to the general skill level of that industry's workers, as this may mediate the ability to reallocate resources in response to shocks or changing demand, for example. This is calculated as the industry average across all available countries and time periods, again, with the aim of capturing the industry's inherent characteristics and not reflecting idiosyncrasies driven by labor market regulation.

For the empirical analysis each of these measures is scaled between zero (the industry with the lowest exposure) and one (the industry with the highest exposure). We also combine these three measures into a broad exposure measure by taking the simple average. Combining these industry-specific, time-invariant measures with the PMR indicators that vary by country and time yields a set of PMR indicators varying across countries, industries, and time.

Linking regulations and productivity

Given Korea's level of productivity relative to comparators and its relatively restrictive PMRs, this section discusses the theoretical linkages between regulations and productivity and the empirical findings in similar cross-country, industry-level studies.

Regulation-productivity linkages

The existing literature has examined multiple mechanisms through which regulations could affect productivity. Given the breadth of regulation we focus on regulation broadly related to the economic sphere, which generally involves restrictions on prices, competition, or permissible activities (Broughel and Hahn, 2022).

A key link that has been commonly emphasized is between regulation and the incentives to innovate. Aghion and others (2009) show how regulation can give rise to nonlinear effects on innovation. The prospect of higher competition through firm entry spurs innovation in industries near the technological frontier but not in laggard industries. Broughel (2017) emphasizes how regulation influences and generally slows knowledge diffusion, limiting the pathways available to discover new technologies. For these reasons, the effects of PMR could vary depending on an industry's position relative to the productive frontier, as a measure of the extent to which it relies on innovation rather than imitation.

Another set of channels through which regulation could affect productivity is through the suboptimal allocation or reallocation of resources across industries, firms, and factors of production. By affecting the relative returns and/or costs of capital and labor, regulations can alter the mix of the factors of production, resulting in a less productive use of resources relative to the ideal (Autor and others, 2007; Da-Rocha and others, 2019; Dawson and Seater, 2013). These effects could operate both within the regulated industry and in those either depending on it for inputs or selling their output to it (Bourlès et al, 2013).

Regulation could also weigh on productivity through these same channels by influencing the mix of establishments within an industry. For example, Boedo and Mukoyama (2012) show how entry costs inhibit productivity by allowing low-productivity firms to keep operating and making the establishment size inefficiently large. They, along with Da-Rocha and others (2019) also show how firing costs reduce productivity by impeding the reallocation of labor to high-productivity firms. Such adjustment frictions could influence reallocation along a number of dimensions, thus contributing to economy-wide productivity differentials (e.g., Restuccia and Rogerson, 2017).

Findings of cross-country, industry-level empirical studies

Given our interest in exploring the role of PMRs as a factor explaining cross-country, industry-level productivity differences, what follows is a review of empirical studies focused on this relationship.[11] These studies generally find that more restrictive PMRs weaken productivity growth, with effects varying across industries and differing according to an industry or firm's position relative to the technological frontier. The evidence suggests that the effects of PMRs on productivity operate through innovation, resource reallocation, and production costs.

[11] This includes studies using firm-level data. Broughel and Hahn (2022) provide a broader review of empirical studies on the relationship between regulations and growth, including at the economy-wide level. See Nicoletti and Scarpetta (2005) for an earlier review of empirical studies on regulation and economic performance.

The majority of studies finds a negative relationship between PMRs and cross-country, industry-level productivity levels or growth, though this conclusion is not unanimous. Among those finding a broad negative impact of PMRs on productivity across all industries are several panel data analyses covering OECD economies with various start dates since the 1970s, though Korea is only included in the sample in Duval and Furceri (2018) and Egert and Wanner (2016).[12] By contrast, Dabla-Norris and others (2015) and Saia and others (2015) do not find a significant impact of overall PMRs on productivity in all industries, instead finding significant effects only in industries and circumstances discussed below. Firm-level analysis corroborates the negative impact of PMRs on productivity—both for studies solely covering European countries (Anderton and others, 2019; Arnold and others, 2008), and for those assessing a broader set of OECD economies including Korea (Andrews and Cingano, 2014; Andrews and others, 2015, 2016; Gal, 2013; Gal and Hijzen, 2016).

Differing industry-level effects of PMRs on productivity have frequently been found, with the focus typically on services or industries making intensive use of information and communication technology (ICT). For example, Kim (2008) and van der Marel (2012) find broad effects of PMRs on services productivity, and Dabla-Norris and others (2015) find negative effects of PMRs on services productivity but not in other industries. Meanwhile, larger effects for ICT-using industries have been found by Arnold and others (2008), Conway and others (2006), McMorrow and others (2010), and van der Marel (2012). Similarly, Inklaar and others (2008) find a positive impact of entry liberalization on TFP growth in telecommunications, but not in other market services. As with the broader studies, coverage of Korea is sparse, with only van der Marel (2012) including it in the sample.
Given the potential linkages from regulation to productivity discussed above, some studies address the question of whether the effects of PMRs on productivity differ according to the position relative to the technological frontier. Industry-level studies tend to uncover larger negative effects for industries that are closer to the frontier, suggesting that much of the impact could come through dampening innovation (Bourlès and others, 2013; Dabla-Norris and others, 2015; Saia and others 2015).[13]

By contrast, firm-level analyses yield mixed conclusions about which firms are most affected by PMR. Andrews and others (2016) find that TFP divergence was greater in industries where the pace of PMR reforms was slower, suggesting that restrictions operate by holding back convergence of lagging firms. Anderton and others (2019) also find that tighter PMRs hindered firm-level convergence. However, Arnold and others (2008) find that stricter PMRs hold back the best-performing firms (either at the frontier or those that have been approaching it rapidly) the most, suggesting regulations limit escape competition strategies. Similarly, Bambalaite and others (2020) find using data for European firms that the impact of occupational entry restrictions in services is more negative for higher-productivity firms.

One way to reconcile these findings is that PMRs could affect both efficiency within follower industries and the implementation of new innovations by leader industries. By facilitating the reallocation of

[12] Others reaching the same conclusion but not covering Korea include: Bourlès and others (2013), Cette and others (2017), Conway and others (2006), McMorrow and others (2010), and Nicoletti and Scarpetta (2003). Barone and Cingano (2011) also find negative effects of PMRs using cross-section data.

[13] Nicoletti and Scarpetta (2003) find the negative effects are larger for industries farther from the technological frontier, though only for regulatory indicators that are time-invariant.

resources within an economy to their most productive uses, reforms permit both faster firm-level convergence within an industry and faster reallocation across industries toward higher-productivity ones that are also more likely to be near the global frontier. Also, firm-level evidence pointing to larger effects on leading firms is limited to services, suggesting that the mechanisms operating at the firm level may differ across industries.

This leads to a discussion of the channels through which PMRs have commonly been found to affect productivity. Under the broad heading of resource reallocation, studies show tighter PMRs have inhibited investment and employment in more productive industries and firms. For example, Cette and others (2017) find that a substantial portion of the negative impact of PMR on TFP was driven by associated reductions in ICT capital and R&D capital investment (see also, Conway and Nicoletti, 2006). Griffith and others (2010) also find evidence suggesting that implementation of the European Union's Single Market Programme boosted TFP through increased R&D investment. Gal and Hijzen (2016) find that major product market reforms lifted LP by raising the capital stock and output amidst a smaller increase in employment. Using firm-level data, allocative efficiency—the correlation between firm size and productivity—has been lower where PMRs are more restrictive (Andrews and Cingano, 2014; Arnold and others, 2008). Similarly, Bambalaite and others (2020) find the relationship between productivity and subsequent employment growth is weaker when occupational entry restrictions are stricter.

Policies related to firm creation (or broader entry barriers) and exit have also been found to have significant effects on productivity, pointing to a role for both innovation and resource reallocation. Strong relationships with productivity have been found for costs and administrative burdens for start-ups and efficiency of the bankruptcy system (Anderton and others, 2019; Andrews and others, 2015); and privatization and entry liberalization (Nicoletti and Scarpetta, 2003; Bouis and others, 2016; and Saia and others, 2015).

Finally, PMRs can influence productivity through their effects on broader costs of production through inter-industry linkages. Duval and Furceri (2018) provide results accounting for such linkages, showing that sector-specific PMR reforms raise output in other sectors both by reducing their production costs and raising the reformed sector's demand for their output. Barone and Cingano (2011) also present evidence that higher regulation in services lowers productivity by raising output prices, and Gal and Hijzen (2016) link PMR reforms in upstream industries to higher output and productivity in downstream industries.

These findings are highly relevant for Korea as its restrictive PMR apply economy-wide or to broad sectors, notwithstanding some industry-level regulatory differences. However, in many studies Korea has not been included in the sample under analysis, seemingly driven by two main factors. First, its relatively recent accession to the ranks of advanced economies that are typically covered in these studies, and second, relatively less complete data on productivity than for other advanced economies. Given Korea's regulatory environment and the size of its productivity gaps, this points to the importance of a deeper examination of the effects of its PMR on productivity growth across industries.

Empirical approach

Theoretical and empirical framework

As in other recent cross-country studies on productivity determinants, we apply a neo-Schumpeterian framework in which productivity drivers may differ according to an industry's position with respect to the technological frontier (Bourlès and others, 2013; Dabla-Norris and others, 2015). The fundamental issue is that growth in an industry near the frontier may rely more on innovation, while an industry further from the frontier can rely more on imitation. This implies that the impact of policies and other structural factors could also vary based on the industry's distance to the technological frontier (DTF).

This approach implies the following basic functional form for the analysis:

$$\Delta y_{ci} = \beta_0 + \beta_1 \Delta y_{Li} + \beta_2 (y_{ci} - y_{Li}) + \beta_m \sum_m X_{ci}^m + \beta_n \sum_m X_{ci}^m (y_{ci} - y_{Li}) \quad (1)$$

In Equation (1), Δy is growth of either LP or TFP, with the subscripts *c* and *i* indexing countries and industries, respectively. Country L is the frontier country for a given industry, with the first term aiming to capture knowledge spillovers from developments at the frontier, while the second term captures the DTF. X_{ci}^m is a vector of *m* regulatory and other structural variables, including PMRs.

Economic growth—and therefore productivity growth—is a process which may exhibit important dynamics. A shock or policy change may lead to effects on the level of output that only materialize over a lengthy period, or induce either permanent or temporary growth rate effects (Broughel, 2017). In practice it may be difficult to distinguish between these given the constantly shifting economic landscape, so a lagged dependent variable is included to capture ongoing transitional effects, though we run specifications dropping this as a robustness check.

As is common in the empirical literature, policies and structural factors are lagged one period. This implicitly assumes there is no contemporaneous impact of these factors, and also reduces endogeneity concerns (Saia and others, 2015; Cette and others, 2017). Similarly, while the first term in equation (1) aims to capture spillovers from the frontier, this is assumed to not occur simultaneously, and thus the industry's frontier growth is also lagged by one period. Given the lagged level of productivity is already present on the left-hand side of the equation as part of the dependent variable, the second lag of the DTF term is used as an explanatory variable instead of the first lag.

Time dummies are included to control for time-specific factors, for example the global financial crisis which in this data lowers growth in the 2009-11 period. Industry dummies are also included to account for differences in trend productivity growth across industries due to the inherent nature of the activity (e.g., manufacturing of computers and electronics versus personal services such as haircuts), though we run specifications dropping these as a robustness check. Including country, industry, and time dummies, the specification to be estimated becomes:

$$(2) \quad \Delta y_{cit} = \beta_0 + \beta_1 \Delta y_{Lit-1} + \beta_2 \Delta y_{cit-1} + \beta_3 (y_{cit-2} - y_{Lit-2}) + \beta_m \sum_m X^m_{cit-1} + \beta_n \sum_m X^m_{cit-1} (y_{cit-2} - y_{Lit-2}) + a_1 D_c + a_2 D_i + a_3 D_t + \varepsilon_{cit}$$

Data features and System GMM estimation

The sample for analysis is driven by availability of the OECD PMR indicators and data on country-industry productivity levels. It is well suited for an analysis of Korea's performance and potential, as it has relatively comprehensive coverage of high-income economies in recent decades. Productivity data is available since the mid-1990s for 29 countries for LP and 19 countries for TFP, typically across 26 industries, though as noted the focus is on a smaller number of industries that operates on a commercial basis and where productivity measurement is more reliable. See the Appendix for the industries belonging to each category.

Cross-country empirical growth studies commonly rely on period average data to smooth out cyclical or idiosyncratic fluctuations and simplify estimation of the dynamics, as well as to accommodate the lower-frequency availability of some explanatory variables (Berg and others, 2018; Chang and others, 2009; Cohen and Soto, 2007; Próchniak, 2018). To accommodate the short time span of the data while yielding sufficient observations for analysis, we take non-overlapping three-year averages. Given the five-year frequency of the OECD PMR indicators, they are interpolated, which means the variables still retain some movement across three-year averages. This results in a dataset of seven time periods, though given the inclusion of the OECD PMR indicators in lagged form, the regressions are estimated over a maximum of six periods.

System GMM is an approach designed for such "short T, large N" panel analysis, especially for situations in which the dependent variable is dynamic, depending on its own past realizations. The technique was developed by Arellano and Bover (1995), and Blundell and Bond (1998). For independent variables that are not strictly exogenous, System GMM aims to address their potential endogeneity by instrumenting them with their own lagged values. This is implemented with a system of two equations, one in differences with the lagged explanatory variables in levels as instruments, and the other in levels with the lagged explanatory variables in differences as instruments. System GMM also allows the incorporation of fixed individual effects and deals properly with heteroscedasticity and autocorrelation within individuals.

Subsequent studies have emphasized the importance of avoiding the use of an excessive number of instruments in System GMM specifications, as this can raise concerns over bias and endogeneity (Mehrhoff, 2009; Roodman, 2009). In line with the findings of these studies, the regressions in this paper use collapsed instruments with only the second or third lag as instruments.

The key diagnostic tests for System GMM are for second-order autocorrelation of the residuals in differences (which implies first-order autocorrelation of the residuals in levels) and the Hansen test for exogeneity of the instruments. In either case, rejection of the null would indicate a specification problem. Finally, given the interaction term between PMRs and the DTF, we conduct tests of the joint significance of the two PMR terms in our regressions using F-tests.

Regression results

This section discusses the relationship between PMRs and productivity as estimated in regressions using equation (2) and the framework discussed above.

Baseline specification

The basic results align with neo-Schumpeterian growth theory, showing productivity-enhancing knowledge spillovers from the frontier, convergence to the frontier, and dynamics depending on past growth. Table 2 shows that lagged LP growth, lagged frontier growth and the lagged DTF are significant determinants of LP growth, with these results generally consistent across various specifications. As the DTF variable always takes negative values, this means that industries farther away from the technological frontier tend to converge faster. Table 3 shows similar results for TFP growth, though with a weaker role for spillovers from the frontier and slower speed of convergence.

Significant effects of PMRs on productivity are only found when allowing for differential effects depending on position relative to the frontier. In column 2 of Tables 2 and Table 3, the economy-wide PMR indicator (not weighted by industry characteristics) was added to the regression, but is insignificant for both LP and TFP. This shows that PMRs do not have a consistent linear effect on LP and TFP growth. When interacting with the productivity gap in column 3, however, the effects are significant for LP and for TFP are stronger than in column 2, albeit still not significant. The negative sign on the interaction term implies that industries closer to the technological frontier are affected more by PMRs, in line with most other industry-level PMR-productivity studies. In essence, these findings suggest that PMRs affect productivity through both imitation and innovation.

Columns 4-7 of Tables 2 and 3 highlight the role of industry exposure in distinguishing the impact of PMRs on LP and TFP growth. We find evidence that accounting for any of these exposure measures (capital-output ratio, labor skill levels and layoff exposure) helps to distinguish the effects of PMRs on productivity growth, especially for TFP. The relationships are strongest for the simple average of the three exposure measures, with the effects of PMRs on productivity found to be strongly significant. This simple average exposure measure is thus used in subsequent specifications.

Table 2: Effects of Product Market Regulations on Labor Productivity: Industry Exposure

	Dependent variable: labor productivity growth						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			PMR weighting scheme				
	No PMR	Linear PMR only	Unweighted	Capital-output	Labor skill level	Layoff exposure	Simple average
Labor productivity growth, lagged(-1)	0.14**	0.16***	0.18***	0.18***	0.18***	0.17***	0.17***
	[2.24]	[2.93]	[4.01]	[3.95]	[3.97]	[3.78]	[3.85]
Frontier growth, lagged(-1)	0.70***	0.46**	0.41***	0.28*	0.36**	0.35**	0.39***
	[3.03]	[2.33]	[2.69]	[1.79]	[2.30]	[2.38]	[2.62]
Productivity gap relative to frontier, lagged(-2)	-0.08*	-0.09**	-0.03***	-0.03**	-0.03**	-0.03***	-0.03***
	[-1.95]	[-2.09]	[-3.28]	[-2.12]	[-2.59]	[-3.78]	[-3.36]
PMR indicator, lagged(-1)	…	-0.00	-0.02***	-0.26	-0.10**	-0.09***	-0.05***
		[-0.09]	[-2.70]	[-1.64]	[-2.50]	[-3.35]	[-3.33]
PMR indicator, lagged(-1) *	…	…	-0.03***	-0.44**	-0.16***	-0.12***	-0.06***
productivity gap, lagged(-2)			[-2.96]	[-2.28]	[-3.05]	[-2.74]	[-3.08]
Constant	-0.06***	-0.03*	-0.01	-0.01	-0.01	-0.01*	-0.01*
	[-2.91]	[-1.71]	[-1.50]	[-1.12]	[-1.28]	[-1.92]	[-1.85]
Observations	2,201	2,158	2,158	2,158	2,158	2,158	2,158
Country-industry groups	387	381	381	381	381	381	381
Instruments	33	36	39	39	39	39	39
F-test p-value for PMR terms (joint significance)	…	…	0.01	0.03	0.01	0.00	0.00
Hansen test p-value	0.18	0.24	0.36	0.30	0.20	0.55	0.47
AR(2) test p-value	0.53	0.61	0.76	0.77	0.77	0.78	0.76

Source: IMF staff calculations.

Note: The regressions are run on data from 1997-2017 in non-overlapping three-year periods. Time and industry dummies are included but not shown. T-statistics based on heteroscedasticity-robust standard errors are in brackets. Variables significant at the 1 percent level are denoted by three asterisks, those at the 5 percent level by two asterisks and those at the 10 percent level by one asterisk.

These results are of an economically significant magnitude, as one standard deviation less restrictive PMRs than the sample average is associated with LP growth higher by around 0.7 percent per year, if the industry has the median productivity gap to the frontier. The effects vary depending on each industry's DTF, suggesting that they operate both through a negative impact on efficiency in most cases, as well as by hindering innovation in country-industry observations that are near the technological frontier. For industries with a DTF at the 75th percentile (i.e., low-productivity cases), there is only a small impact of PMRs on productivity, while for those at the 25th percentile, the effects are twice as strong as at the median. For TFP growth, the effects of one standard deviation less restrictive PMRs than the sample average are around 1.2 percent per year at the median. Given the weaker role of the interaction term, the range is narrower, with the effects at the 25th and 75th percentiles estimated at between 1-1.5 percent. For Korea, if reforms were undertaken to bring overall PMRs to the level of the average OECD economy, these estimates translate to an impact on LP growth of 0.5 percent per year (assuming an industry DTF at the median) and 0.8 percent per year for TFP.

Table 3: Effects of Product Market Regulations on Total Factor Productivity: Industry Exposure

	Dependent variable: total factor productivity growth						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			PMR weighting scheme				
	No PMR	Linear PMR only	Unweighted	Capital-output	Labor skill level	Layoff exposure	Simple average
Total factor productivity growth, lagged(-1)	0.15***	0.13**	0.17***	0.17***	0.17***	0.17***	0.16***
	[2.63]	[1.97]	[3.55]	[3.42]	[3.48]	[3.66]	[3.53]
Frontier growth, lagged(-1)	0.12	0.19	0.16	0.12	0.16	0.09	0.14
	[1.16]	[1.49]	[1.57]	[0.98]	[1.45]	[0.88]	[1.35]
Productivity gap relative to frontier, lagged(-2)	-0.04**	-0.04*	-0.01**	-0.02*	-0.02*	-0.01	-0.01
	[-2.03]	[-1.70]	[-1.99]	[-1.86]	[-1.92]	[-1.45]	[-1.56]
PMR indicator, lagged(-1)		-0.00	-0.01	-0.11	-0.06	-0.06***	-0.03***
		[-0.18]	[-1.54]	[-1.08]	[-1.60]	[-3.02]	[-2.70]
PMR indicator, lagged(-1) *			-0.01	-0.21*	-0.08**	-0.04	-0.02
productivity gap, lagged(-2)			[-1.38]	[-1.83]	[-2.14]	[-1.25]	[-1.59]
Constant	-0.04***	-0.02	-0.01	-0.01**	-0.01*	-0.00	-0.00
	[-4.83]	[-1.51]	[-1.20]	[-1.99]	[-1.80]	[-1.00]	[-0.71]
Observations	1,649	1,645	1,645	1,645	1,645	1,645	1,645
Country-industry groups	278	278	278	278	278	278	278
Instruments	32	34	36	36	36	36	36
F-test p-value for PMR terms (joint significance)	...	...	0.19	0.17	0.07	0.01	0.02
Hansen test p-value	0.43	0.42	0.12	0.12	0.27	0.44	0.32
AR(2) test p-value	0.66	0.53	0.55	0.51	0.55	0.60	0.57

Source: IMF staff calculations.
Note: See notes to Table 2.

Detailed results on structural reforms

Looking into more detailed PMR indicators can provide more granular insight into the regulatory areas through which PMRs affect productivity. In this section, we examine which lower-level PMR indicators have the strongest impact on productivity growth.

The regression results of PMR subcategories are presented in Tables 4-6. Table 4 shows the breakdown of level 2 and 3 PMR indicators on LP while Table 5 shows their effect on total factor productivity. Table 6 shows the outcome of level 4 PMR indicators. In some cases the Hansen tests reject the exogeneity of the instrument set—possibly due to the lower degree of variation over time at the country level for some of the detailed indicators.

We find that PMRs across all the main areas, and many of the detailed indicators, have significant effects on both LP and TFP. In many cases, PMRs have both a significant direct relationship with productivity and effects that are stronger in country-industry observations near the technological frontier. Baseline results also largely hold for lagged productivity growth, lagged frontier growth, and lagged productivity gap relative to frontier across most of the specifications.

There is strong evidence that a greater degree of state control has significant negative impacts on productivity growth. The aggregate indicator for state control is strongly significant for both LP and TFP, as are both the level 3 indicators—public ownership and involvement in business operations. For level 4

indicators, scope of state-owned enterprises (SOEs), direct control over enterprises, and price controls are jointly significant on LP growth while scope of SOEs, direct control over enterprises, and command and control regulation are jointly significant on TFP growth. These results indicate that the negative productivity effects of state control extend to all of the detailed PMR indicators.

Similarly, the regression results show that barriers to entrepreneurship also have a significant negative impact on LP and TFP growth. The aggregate indicator and all the level 3 indicators under barriers to entrepreneurship including complexity of regulatory procedures, administrative burden on startups, and regulatory protection of incumbents are all associated with lower LP growth, and the effect is stronger if the industry is closer to the technological frontier. The effect on TFP growth also remains significant for most level 3 indicators. For level 4 indicators, all except barriers in service sectors are jointly significant on LP growth and most have a jointly significant impact on TFP growth, with the impact of service sector barriers especially large.

The effects of barriers to trade and investment are also significant, though less consistently than for the other areas. The aggregate indicator and both the level 3 indicators—explicit barriers to trade and other barriers to trade—are jointly significant for LP growth but not for TFP growth. For level 4 indicators, differential treatment of foreign suppliers is jointly significant for both LP and TFP growth.

The OECD PMR indicators are also available for a few specific industry groups—network industries, retail industries, and professional services.[14] These indicators focus on restrictions on entry and on the scope of permitted activities. The bottom section of Table 6 shows results for specifications using these industry-specific indicators. We find that restrictions in network industries have wide-ranging effects on productivity throughout the economy. This is in line with the results from the more comprehensive economy-wide indicators. Restrictions in professional services are also significant barriers to TFP growth, while we detect only marginally significant economy-wide effects of restrictions in retail sales. Overall, this confirms findings elsewhere in the literature that detect an important impact on productivity of competition in network industries.

[14] See the Appendix for the list of network industries.

Table 4: Effects of Product Market Regulations on Labor Productivity by Broad Areas and Subcategories

	Dependent variable: labor productivity growth										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Overall PMR indicator	State control			Barriers to entrepreneurship				Barriers to trade and investment		
		Aggregate	Public ownership	Involvement in business operation	Aggregate	Complexity of regulatory procedures	Administrative burdens on startups	Regulatory protection of incumbents	Aggregate	Explicit barriers to trade	Other barriers to trade
Labor productivity growth, lagged(-1)	0.17***	0.19***	0.18***	0.17***	0.19***	0.18***	0.16***	0.17***	0.20***	0.17***	0.22***
	[3.85]	[3.89]	[3.87]	[3.19]	[4.02]	[3.89]	[3.51]	[3.54]	[4.02]	[3.49]	[4.36]
Frontier growth, lagged(-1)	0.39***	0.27*	0.25	0.39**	0.38**	0.34**	0.36**	0.48***	0.27*	0.34**	0.29*
	[2.62]	[1.70]	[1.53]	[2.42]	[2.49]	[2.21]	[2.35]	[3.09]	[1.71]	[2.10]	[1.79]
Productivity gap relative to frontier, lagged(-2)	-0.03***	-0.02*	-0.02	-0.02**	-0.03***	-0.02**	-0.04***	-0.04***	-0.03***	-0.03*	-0.03***
	[-3.36]	[-1.72]	[-1.35]	[-2.01]	[-3.18]	[-2.33]	[-2.80]	[-3.57]	[-3.08]	[-1.81]	[-2.80]
PMR indicator, lagged(-1)	-0.05***	-0.04***	-0.04**	-0.05***	-0.04***	-0.03*	-0.06***	-0.03**	-0.02	-0.01	-0.03
	[-3.33]	[-3.14]	[-2.14]	[-2.77]	[-3.38]	[-1.81]	[-3.65]	[-2.42]	[-0.88]	[-0.26]	[-1.33]
PMR indicator, lagged(-1) *	-0.06***	-0.07***	-0.07**	-0.06**	-0.06***	-0.06***	-0.09***	-0.08***	-0.08**	-0.03	-0.06**
productivity gap, lagged(-2)	[-3.08]	[-3.18]	[-2.19]	[-2.55]	[-3.68]	[-2.88]	[-3.47]	[-3.74]	[-2.22]	[-0.72]	[-2.22]
Constant	-0.01*	-0.00	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	[-1.85]	[-0.97]	[-0.27]	[-1.62]	[-1.43]	[-1.05]	[-1.40]	[-1.29]	[-0.98]	[-1.08]	[-1.33]
Observations	2,158	2,158	2,158	2,158	2,158	2,158	2,158	2,158	2,158	2,158	2,158
Country-industry groups	381	381	381	381	381	381	381	381	381	381	381
Instruments	39	39	39	39	39	39	39	39	39	39	39
F-test p-value for PMR terms (joint significance)	0.00	0.01	0.09	0.02	0.00	0.01	0.00	0.00	0.02	0.09	0.07
Hansen test p-value	0.47	0.05	0.14	0.07	0.15	0.27	0.57	0.34	0.54	0.09	0.23
AR(2) test p-value	0.76	0.76	0.85	0.87	0.74	0.80	0.80	0.77	0.96	0.85	0.79

Source: IMF staff calculations.
Note: See notes to Table 2.

Table 5: Effects of Product Market Regulations on Total Factor Productivity by Broad Areas and Subcategories

	Dependent variable: total factor productivity growth										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Overall PMR indicator	State control			Barriers to entrepreneurship				Barriers to trade and investment		
		Aggregate	Public ownership	Involvement in business operation	Aggregate	Complexity of regulatory procedures	Administrative burdens on startups	Regulatory protection of incumbents	Aggregate	Explicit barriers to trade	Other barriers to trade
Total factor productivity growth, lagged(-1)	0.16***	0.15***	0.16***	0.16***	0.17***	0.17***	0.14***	0.16***	0.16***	0.14***	0.15***
	[3.53]	[3.27]	[3.01]	[3.75]	[3.84]	[3.31]	[3.07]	[3.64]	[3.30]	[2.81]	[2.65]
Frontier growth, lagged(-1)	0.14	0.13	0.10	0.17*	0.10	0.09	0.19*	0.16	0.14	0.18	0.17
	[1.35]	[1.32]	[0.88]	[1.77]	[0.96]	[0.81]	[1.88]	[1.50]	[1.28]	[1.50]	[1.61]
Productivity gap relative to frontier, lagged(-2)	-0.01	-0.03***	-0.02*	-0.01	-0.01	-0.01	-0.03***	-0.02**	-0.01	-0.03**	-0.02**
	[-1.56]	[-2.62]	[-1.66]	[-1.17]	[-1.00]	[-0.92]	[-2.80]	[-2.05]	[-1.44]	[-2.13]	[-2.36]
PMR indicator, lagged(-1)	-0.03***	-0.03***	-0.02*	-0.05***	-0.03**	-0.00	-0.04**	-0.02	-0.02	0.00	-0.03
	[-2.70]	[-2.61]	[-1.67]	[-3.63]	[-2.38]	[-0.27]	[-2.41]	[-1.64]	[-1.15]	[0.20]	[-1.63]
PMR indicator, lagged(-1) *	-0.02	-0.05**	-0.06*	-0.05***	-0.03**	-0.02*	-0.06***	-0.04**	-0.03	-0.00	-0.06**
productivity gap, lagged(-2)	[-1.59]	[-2.49]	[-1.92]	[-3.11]	[-2.11]	[-1.65]	[-2.81]	[-2.34]	[-1.32]	[-0.05]	[-1.98]
Constant	-0.00	-0.01***	-0.01	0.00	0.00	-0.01	-0.02***	-0.01	-0.01*	-0.01**	-0.01
	[-0.71]	[-2.95]	[-1.49]	[0.38]	[0.35]	[-1.08]	[-2.92]	[-1.36]	[-1.80]	[-2.41]	[-1.53]
Observations	1,645	1,645	1,645	1,645	1,645	1,645	1,645	1,645	1,645	1,645	1,645
Country-industry groups	278	278	278	278	278	278	278	278	278	278	278
Instruments	36	36	36	36	36	36	36	36	36	36	36
F-test p-value for PMR terms (joint significance)	0.02	0.03	0.14	0.00	0.03	0.18	0.02	0.06	0.42	0.85	0.13
Hansen test p-value	0.32	0.58	0.41	0.94	0.32	0.14	0.47	0.27	0.23	0.21	0.49
AR(2) test p-value	0.57	0.58	0.56	0.58	0.67	0.57	0.66	0.56	0.61	0.51	0.65

Source: IMF staff calculations.
Note: See notes to Table 2.

Table 6: Effects of Product Market Regulations on Productivity: Detailed Indicators

		Labor productivity			Total factor productivity		
		Direct effects	Interaction terms	Joint significance (F-test p-value)	Direct effects	Interaction terms	Joint significance (F-test p-value)
State control	Scope of state-owned enterprises	**-0.09*** **	**-0.16*** **	0.01	**-0.05** **	**-0.09** **	0.07
		[-2.79]	**[-3.05]**		**[-2.38]**	**[-2.44]**	
	Government involvement in network sectors	**-0.04** **	**-0.07** **	0.04	-0.02	**-0.04** **	0.13
		[-2.37]	**[-2.57]**		[-1.42]	**[-2.03]**	
	Direct control over enterprises	*-0.02**	*-0.03**	0.14	*-0.02**	**-0.04** **	0.07
		[-1.67]	*[-1.95]*		*[-1.71]*	**[-2.10]**	
	Price controls	-0.02	**-0.05** **	0.02	*-0.02**	**-0.03** **	0.12
		[-1.60]	**[-2.58]**		*[-1.83]*	**[-2.06]**	
	Command and control regulation	-0.00	0.01	0.58	*-0.03**	**-0.08** **	0.03
		[-0.11]	[0.21]		*[-1.77]*	**[-2.46]**	
Barriers to entrepreneurship	Licenses and permits system	*-0.03**	**-0.06*** **	0.01	-0.00	-0.03	0.14
		[-1.82]	**[-2.67]**		[-0.22]	[-1.29]	
	Communication and simplification of rules and procedures	*-0.03**	**-0.05** **	0.04	-0.00	*-0.02**	0.20
		[-1.68]	**[-2.53]**		[-0.30]	*[-1.79]*	
	Administrative burdens for corporations	**-0.06*** **	**-0.08*** **	0.00	**-0.03** **	**-0.06** **	0.03
		[-3.60]	**[-2.93]**		**[-2.47]**	**[-2.26]**	
	Administrative burdens for sole proprietor firms	**-0.04*** **	**-0.07*** **	0.00	**-0.04*** **	**-0.05*** **	0.00
		[-3.17]	**[-3.55]**		**[-3.59]**	**[-3.15]**	
	Barriers in service sectors	-0.07	-0.03	0.15	**-0.16** **	**-0.21** **	0.09
		[-0.89]	[-0.24]		**[-2.45]**	**[-2.25]**	
	Legal barriers to entry	**-0.05*** **	**-0.09*** **	0.00	*-0.03**	**-0.05** **	0.05
		[-3.39]	**[-3.62]**		*[-1.67]*	**[-2.47]**	
	Antitrust exemptions	**-0.07** **	*-0.11**	0.08	-0.02	-0.05	0.48
		[-2.11]	*[-1.79]*		[-0.82]	[-1.11]	
	Barriers in network sectors	**-0.03** **	**-0.06*** **	0.01	**-0.02** **	*-0.03**	0.04
		[-2.09]	**[-2.99]**		**[-2.09]**	*[-1.93]*	
Barriers to trade and investment	Barriers to FDI	-0.02	-0.05	0.32	-0.00	-0.01	0.90
		[-0.79]	[-1.18]		[-0.23]	[-0.41]	
	Tariff barriers	-0.00	-0.01	0.97	-0.01	-0.03	0.68
		[-0.08]	[-0.19]		[-0.71]	[-0.85]	
	Differential treatment of foreign suppliers	-0.00	*-0.04**	0.01	-0.01	**-0.05** **	0.05
		[-0.13]	*[-1.88]*		[-1.23]	**[-2.31]**	
	Barriers to trade facilitation	**-0.05** **	**-0.07** **	0.11	-0.02	-0.04	0.66
		[-2.10]	**[-2.08]**		[-0.88]	[-0.96]	
Sectorial PMR indicators	Restrictions in network industries	**-0.03** **	**-0.05*** **	0.02	**-0.03*** **	**-0.03** **	0.03
		[-2.04]	**[-2.76]**		**[-2.60]**	**[-2.04]**	
	Restrictions in retail industries	*-0.05**	-0.05	0.10	-0.01	-0.02	0.82
		[-1.83]	[-1.33]		[-0.64]	[-0.59]	
	Restrictions in professional services	-0.04	**-0.07** **	0.10	**-0.04** **	**-0.09** **	0.05
		[-1.60]	**[-2.05]**		**[-2.04]**	**[-2.41]**	

Source: IMF staff calculations.

Note: The table shows the results for PMR terms only, from specifications as in column 7 of Tables 2 and 3. Variables significant at the 1 or 5 percent levels are denoted by bold font, with significance at the 10 percent level denoted by italics.

Differences across industries

To understand in more detail the whether the effects of PMRs on productivity differ across industries, we performed additional analysis using various industry groupings. The industry groups selected are (1) manufacturing, (2) market services, (3) "network" sectors, (4) "ICT-using" industries, (5) "ICT-related" industries, and (6) "high LP" industries.[15] See the appendix for the industries included in each group. The rationale for choosing these industry groupings is to evaluate whether they have different reactions to PMR regulation that are not captured by the industry exposure measures being used to differentiate PMRs across industries.

Results of the regressions are shown in Table 7. Given the results for other variables in the regression are similar to the baseline findings in column 7 of Tables 2 and 3, Table 7 focuses on group-specific effects of PMRs by only showing results for the interaction of the industry groups with the PMR-related terms.

The PMR-industry group dummy interactions are not significant individually. However, there are significant effects of PMR on LP and TFP for high LP industries and on LP for ICT-related industries, as the interactions are jointly significant. This suggests that PMRs tend to have a larger impact on high-productivity industries, though the effects are modest. For Korea, this points to the possibility of structural reforms leading to productivity improvements in information and communication, and finance and insurance—two industries where productivity tends to be high in other countries, but where productivity in Korea lags (see Figures 3 and 4).

Table 7: Effects of Product Market Regulations Across Industries

	Coefficients on industry group dummy interactions with PMRs					
	(1) Manufacturing	(2) Market Services	(3) Network	(4) ICT-using Industries	(5) ICT-related Industries	(6) High LP Industries
	Dependent variable: labor productivity growth					
PMR, lagged(-1)*industry group dummy	-0.01	0.01	-0.04	-0.04	-0.05	-0.05
	(-0.24)	(0.18)	(-0.83)	(-0.92)	(-1.32)	(-1.38)
PMR, lagged(-1)*productivity gap,	0.01	-0.00	-0.02	-0.01	-0.01	-0.01
lagged(-2)*industry group dummy	(0.32)	(-0.13)	(-0.65)	(-0.53)	(-0.52)	(-0.26)
Joint significance of industry group-PMR interactions	0.23	0.60	0.61	0.33	0.02	0.00
	Dependent variable: total factor productivity growth					
PMR, lagged(-1)*industry group dummy	0.01	-0.01	-0.01	-0.02	-0.00	-0.04
	(0.47)	(-0.19)	(-0.38)	(-0.49)	(-0.02)	(-1.64)
PMR, lagged(-1)*productivity gap,	0.00	-0.00	0.01	-0.00	0.02	-0.00
lagged(-2)*industry group dummy	(0.07)	(-0.26)	(0.56)	(-0.26)	(0.92)	(-0.05)
Joint significance of industry group-PMR interactions	0.80	0.97	0.48	0.75	0.32	0.01

Source: IMF staff calculations.
Note: The table shows the results for PMR-industry group interaction terms only, from specifications as in column 7 of Tables 2 and 3.

[15] In line with other studies, ICT-using industries were determined using the degree to which ICT capital is relied upon as an input. ICT-related industries include ICT-using industries and the IT capital-producing industry. High LP industries were determined by examination of the cross country data and selecting the five most industries with the highest levels of LP.

Transmission channels

To shed light on the channels through which the effects of PMRs on productivity are transmitted, we estimated regressions covering the other elements of the production function, as well as measures of prices and costs. In all, the regressions cover: 1) real value added; 2) hours worked; 3) gross fixed capital formation; 4) value added deflators; and 5) unit labor costs (ULC).

Table 8 shows, for the three highest levels of the OECD indicators, the results for both the direct effects of PMRs and the effects through the interaction of PMRs with the industry's distance to the frontier.

Results for real value added are in line with those for LP, showing a significant negative impact of more restrictive PMRs across all areas. A sizable proportion of these effects occur through a reduction in TFP growth, as can be concluded from Tables 3 and 5.

The impact of PMRs on factor accumulation is also negative, albeit not as strong as the effects on productivity, as can be seen in the results for hours worked and gross fixed capital formation. More restrictive PMRs are generally associated with slower growth in both hours worked and gross fixed capital formation, though this does not hold true across all the subcategories, and results are less frequently statistically significant than they are for productivity or value added. In effect, industries facing more binding regulations remain smaller than they otherwise would be.

The results for value added deflators and ULC point to a role for higher costs of doing business in channeling the effects of PMRs on productivity. More restrictive PMRs are associated with somewhat higher value added deflators and substantially higher ULC, with the effects on ULC highly significant in most cases. These effects tend to be stronger for regulations in the areas of state control and barriers to entrepreneurship. The stronger effects of PMRs on ULCs than on final prices suggests that the net impact of restrictive regulations on profits is negative—costs rise by more than any increase in profits brought about by a reduction in competition due to higher entry barriers.

Taken together, these results suggest that tighter PMRs depress productivity by elevating business costs and product prices, while also moderately lowering hours worked and with a minor impact on capital accumulation. Higher costs could in turn feed into costs and competitiveness in other industries that rely on a given industry for inputs. Alternatively, the higher costs in a more tightly-regulated industry reduce its demand for the inputs of other industries, which could reduce productivity in those industries.

Table 8: Channels for Effects of Product Market Regulations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
		State control			Barriers to entrepreneurship				Barriers to trade and investment		
	Overall PMR indicator	Aggregate	Public ownership	Involvement in business operation	Aggregate	Complexity of regulatory procedures	Administrative burdens on startups	Regulatory protection of incumbents	Aggregate	Explicit barriers to trade	Other barriers to trade
Dependent variable: Real value added											
PMR indicator, lagged(-1)	-0.02	-0.03**	-0.03*	-0.04*	-0.01	-0.02	-0.04*	-0.00	-0.02	-0.04	-0.02
	(-1.46)	(-2.00)	(-1.96)	(-1.68)	(-0.80)	(-1.12)	(-1.78)	(-0.02)	(-0.85)	(-1.54)	(-0.93)
PMR indicator, lagged(-1) *	-0.07***	-0.06***	-0.08**	-0.04	-0.05***	-0.05**	-0.08***	-0.06***	-0.11**	-0.11**	-0.07*
productivity gap, lagged(-2)	(-2.95)	(-2.76)	(-2.47)	(-1.48)	(-2.83)	(-2.34)	(-2.82)	(-2.74)	(-2.42)	(-2.28)	(-1.83)
Joint significance, p-value of F-test	0.00	0.02	0.02	0.24	0.00	0.02	0.01	0.00	0.00	0.00	0.09
Dependent variable: Hours worked											
PMR indicator, lagged(-1)	0.00	-0.01	-0.02*	-0.00	0.02*	0.00	0.01	0.03**	-0.03	-0.08***	-0.01
	(0.33)	(-0.62)	(-1.85)	(-0.05)	(1.84)	(0.03)	(0.51)	(2.31)	(-1.17)	(-2.73)	(-0.73)
PMR indicator, lagged(-1) *	-0.04***	-0.03*	-0.06**	-0.00	-0.01	-0.01	-0.02	-0.03*	-0.14***	-0.15***	-0.06*
productivity gap, lagged(-2)	(-2.62)	(-1.70)	(-2.51)	(-0.24)	(-1.03)	(-0.62)	(-1.33)	(-1.82)	(-3.12)	(-3.62)	(-1.88)
Joint significance, p-value of F-test	0.00	0.08	0.02	0.91	0.00	0.49	0.01	0.00	0.00	0.00	0.06
Dependent variable: Gross fixed capital formation											
PMR indicator, lagged(-1)	0.00	-0.01	-0.01	-0.01	-0.02*	-0.02*	0.00	-0.00	0.03	0.03	0.00
	(0.38)	(-0.56)	(-0.91)	(-0.80)	(-1.77)	(-1.67)	(0.18)	(-0.30)	(1.16)	(1.06)	(0.07)
PMR indicator, lagged(-1) *	-0.02	-0.02	-0.03	-0.02	-0.01	-0.00	-0.00	-0.03	0.02	0.02	0.02
productivity gap, lagged(-2)	(-1.24)	(-1.00)	(-1.17)	(-1.06)	(-0.51)	(-0.18)	(-0.26)	(-1.57)	(0.64)	(0.54)	(0.46)
Joint significance, p-value of F-test	0.13	0.56	0.47	0.57	0.21	0.16	0.86	0.23	0.42	0.08	0.75
Dependent variable: Value added deflator											
PMR indicator, lagged(-1)	0.03***	0.03**	0.01	0.03**	0.03**	-0.01	0.04**	0.04***	0.01	0.05***	-0.01
	(2.69)	(2.47)	(1.05)	(2.15)	(2.05)	(-0.48)	(2.47)	(2.72)	(0.58)	(2.62)	(-0.63)
PMR indicator, lagged(-1) *	0.02	0.02	0.00	0.02	0.00	-0.02	0.02	0.01	-0.00	0.08**	-0.03
productivity gap, lagged(-2)	(1.29)	(1.15)	(0.17)	(1.13)	(0.00)	(-1.11)	(1.00)	(0.52)	(-0.10)	(2.53)	(-1.27)
Joint significance, p-value of F-test	0.01	0.00	0.03	0.03	0.00	0.29	0.00	0.01	0.12	0.03	0.11
Dependent variable: Unit labor costs											
PMR indicator, lagged(-1)	0.05***	0.04***	0.04**	0.05***	0.05***	0.06***	0.06***	0.04**	0.04	-0.00	0.04
	(2.86)	(2.95)	(2.08)	(2.86)	(3.39)	(3.11)	(3.01)	(2.46)	(1.25)	(-0.14)	(1.26)
PMR indicator, lagged(-1) *	0.08***	0.08***	0.08**	0.07***	0.07***	0.10***	0.09***	0.08***	0.07	-0.01	0.07
productivity gap, lagged(-2)	(3.17)	(3.43)	(2.37)	(3.28)	(3.87)	(4.03)	(3.36)	(3.84)	(1.25)	(-0.26)	(1.55)
Joint significance, p-value of F-test	0.01	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.43	0.89	0.30

Source: IMF staff calculations.

Note: The table shows the results for PMR terms only, from specifications as in column 7 of Tables 2 and 3.

Model extensions and robustness checks

We ran various extensions of the model and performed several robustness checks to identify other potential drivers of productivity at the industry level and to check the stability of the results.[16]

- *Other structural drivers of productivity:* We used the baseline regressions to search for industry-level relationships of other structural drivers with productivity. From among the numerous potential candidate variables, the following were investigated based on strong *a priori* links from theory and sufficient country and time coverage:
    - Labor market regulation as measured by the IMF's Structural Reform Database, the *CBR-Labour Regulation Index* (see Adams and others, 2016), and OECD indicators on employment protection legislation.
    - Governance as measured by the *Worldwide Governance Indicators*.
    - Research and development expenditure as a share of GDP.
    - Indicators from the Fraser Institute's *Economic Freedom of the World* database.
    - Indicators from the IMF's Structural Reform Database covering liberalization of external trade, external finance, and the domestic financial system.

  These were not significant, and they did not affect the significance of the PMR-productivity relationships or other terms in the regressions.
- *Alternative specifications:* Using the first lag of the DTF instead of the second didn't change the coefficients, but in many specifications failed the Hansen test for exogeneity of instruments. Using the contemporaneous term for growth at the frontier yielded results similar to the baseline specification using the first lag. Excluding the lagged dependent variable resulted in stronger significance for the other terms, including the PMR ones, for both LP and TFP. However, in these specifications the exogeneity of instruments was rejected for TFP and borderline for LP.
- *Industry coverage:* The main results hold when expanding the sample to include, in succession, public services, utilities and construction, agriculture and mining, and all industries.
- *Choice of industry and country dummies:* The results hold when dropping industry dummies, replacing them with country dummies, or including both country and industry dummies.[17]

Conclusions

This paper adds to the empirical literature connecting PMRs and industry-level productivity in advanced economies, spotlighting Korea's standing in these areas. In line with many studies, we find that tighter PMRs are associated with slower growth of LP and TFP at the industry level. Significant negative relationships are present across all the main areas of PMRs—state control, barriers to entrepreneurship, and barriers to trade and investment—as well as most of the detailed indicators. As in other studies, we find that barriers to competition in network sectors have negative effects on economy-wide productivity.

[16] The results described below are available from the authors upon request.

[17] Including country-by-industry dummies would result in an excessive number of instruments.

While the effects of PMRs tend to be larger for country-industry observations that are near the global productivity frontier, we do not find that they vary substantially across broad industry groups such as manufacturing or market services. However, there is some evidence that the highest-productivity industries globally (high-tech manufacturing and information-intensive services) are more affected by PMRs than other industries are. These patterns suggest that restrictive PMRs hinder innovation as well as imitation.

An analysis of the channels through which PMRs operate confirms this, with tighter PMRs slowing real value added growth of affected industries. These negative effects occur principally through TFP and also through hours worked, with a minor impact on capital accumulation. Product prices and unit labor costs are also higher when PMRs are more restrictive, pointing to the importance of regulation in raising production costs and reducing competitiveness, which spills over into other industries through input-output linkages.

Korea's PMRs have become less restrictive since the 1990s, mirroring trends in advanced economy peers. However, they remain on the restrictive side, especially with relatively high barriers remaining in service and network sectors, some binding restrictions still applying to trade and investment, and a relatively broad scope of government involvement in the economy. We find that reforms to bring the broad PMR environment into line with the average OECD economy could raise aggregate productivity growth by half to three quarters of a percentage point per year.

Given the still-large gaps in Korea's productivity relative to other advanced economies, especially in market-oriented service industries, liberalization of these PMRs could help to rejuvenate aggregate growth. Regulatory reform is an especially critical area given that Korea already relies heavily on relatively capital-intensive industries and is experiencing a demographic slowdown that constrains the growth of labor inputs.

References

Adams, Z., Bishop, L., and Deakin, S., 2016. *CBR Labour Regulation Index—Dataset of 117 Countries*, Cambridge: Centre for Business Research.

Aghion, P., R. Blundell, R. Griffith, P. Howitt, and S. Prantl, 2009. "The effects of entry on incumbent innovation and productivity," *Review of Economics and Statistics* 91: 20-32.

Alesina, A., D. Furceri, J. Ostry, C. Papageorgiou, and D. Quinn, 2020. "Structural reforms and elections: Evidence from a world-wide new dataset," NBER Working Paper 26720.

Anderton, R. B. Di Lupidio, and B. Jamulska, 2019. "Product market regulation, business churning and productivity: evidence from the European Union countries," ECB Working Paper No. 2332.

Andrews, D., and F. Cingano, 2014. "Public policy and resource allocation: evidence from firms in OECD countries," *Economic Policy* 255-296.

_____, C. Criscuolo, and P. Gal, 2016. "The best versus the rest: The global productivity slowdown, divergence across firms and the role of public policy," OECD Productivity Working Paper 05.

_____, _____, and _____, 2015. "Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries," OECD Productivity Working Paper 02.

Arellano, M., and O. Bover, 1995. "Another Look at the Instrumental Variable Estimation of Error-Components Models," *Journal of Econometrics* 68: 29-51.

Arnold, J. G. Nicoletti, and S. Scarpetta, 2008. "Regulation, allocative efficiency and productivity in OECD countries: Industry and firm-level evidence," OECD Economics Dept. Working Paper 616.

Autor, D., W. Kerr, and A. Kugler, 2007. "Does employment protection reduce productivity? Evidence from US States," *The Economic Journal* 117: F189-F217.

Barone, G., and F. Cingano, 2011. "Service regulation and growth: Evidence from OECD countries," *The Economic Journal* 121: 931-957.

Barro, R., and J. Lee, 2013. "A New Data Set of Educational Attainment in the World, 1950-2010," *Journal of Development Economics* 104, 184-198.

Bambalaite, I., G. Nicoletti, and C. von Rueden, 2020. "Occupational entry regulations and their effects on productivity in services: Firm-level evidence," OECD Economics Dept. Working Paper 1605.

Bassanini, A., L. Nunziata, and D. Venn, 2009. "Job protection legislation and productivity growth in OECD countries," *Economic Policy* 351-402.

Berg, A., J. Ostry, C. Tsangarides, and Y. Yakhshilikov, 2018. "Redistribution, inequality, and growth: new evidence," *Journal of Economic Growth* 23: 259-305.

Blundell, R., and S. Bond, 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics* 87: 115-143.

Boedo, H., and T. Mukoyama, 2012. "Evaluating the effects of entry regulations and firing costs on international income differences," *Journal of Economic Growth* 17: 143-170.

Bouis, R., R. Duval, and J. Eugster, 2016. "Product Market Deregulation and Growth: Country-Industry-Level Evidence," IMF Working Paper WP/16/114.

Bourlès, R., G. Cette, J. Lopez, J. Mairesse, and G. Nicoletti, 2013. “Do product market regulations in upstream sectors curb productivity growth? Panel data evidence for OECD countries,” *The Review of Economics and Statistics* 95: 1750-1768.

Broughel, J., 2017. *Regulation and Economic Growth: Applying Economic Theory to Public Policy*, Mercatus Center at George Mason University, Arlington, VA.

Broughel, J., and R. Hahn, 2022. “The Impact of Economic Regulation on Growth: Survey and Synthesis,” *Regulation and Governance* 16: 448-469.

Cette, G., J. Lopez, and J. Mairesse, 2017. “Upstream product market regulations, ICT, R&D and productivity,” *Review of Income and Wealth* 63: S68-S89.

Chang, R., L. Kaltani, and N. Loayza, 2009. “Openness Can Be Good for Growth: The Role of Policy Complementarities,” *Journal of Development Economics* 90: 33-49.

Cho, D., and K. Kwon, 2017. “Declining Potential Growth in Korea,” in J. Cohen-Sutton, T. Helbling, A. Posen, and C. Rhee (eds): *Sustaining Economic Growth in Asia*, Peterson Institute for International Economics Press, pp. XXX-XXX.

Cohen, D., and M. Soto, 2007. “Growth and Human Capital: Good Data, Good Results,” *Journal of Economic Growth* 12: 51-76.

Collins, S., and B. Bosworth, 1996. “Economic Growth in East Asia: Accumulation versus Assimilation,” *Brookings Papers on Economic Activity* 2: 135-203.

Conway, P., and G. Nicoletti, 2006. “Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights,” OECD Economics Dept. Working Paper 530.

_____, D. de Rosa, G. Nicoletti, and F. Steiner, 2006. “Product market regulation and productivity convergence,” *OECD Economic Studies* 43: 39-76.

Dabla-Norris, E., and others, 2015. “The New Normal: A Sector-Level Perspective on Productivity Trends in Advanced Economies,” IMF Staff Discussion Note SDN/15/03.

Da-Rocha, J., D. Restuccia, and M. Mendes Tavares, 2019. “Firing costs, misallocation, and aggregate productivity,” *Journal of Economic Dynamics and Control* 98: 60-81.

Dawson, J., and J. Seater, 2013. “Federal regulation and aggregate economic growth,” *Journal of Economic Growth* 18:137-177.

Duval, R., and D. Furceri, 2018. “The Effects of Labor and Product Market Reforms: The Role of Macroeconomic Conditions and Policies,” *IMF Economic Review* 66:31-69.

Egert, B., and I. Wanner, 2016. “Regulations in services sectors and their impact on downstream industries: The OECD 2013 Regimpact Indicator,” OECD Economics Dept. Working Paper 1303.

Gal, P, 2013, "Measuring Total Factor Productivity at the Firm Level using OECD-Orbis," OECD Economics Dept. Working Papers 1049.

_____, and A. Hijzen, “The short-term impact of product market reforms: A cross-country firm-level analysis,” IMF Working Paper WP/16/116.

Griffith, R.,R. Harrison, and H. Simpson, 2010. “Product Market Reform and Innovation in the EU,” *The Scandinavian Journal of Economics* 112: 389-415.

Inklaar, R., and M. Timmer, 2014. “The Relative Price of Services,” *Review of Income and Wealth* 60: 727-746.

_____, and _____, 2009. “Productivity convergence across industries and countries: The importance of theory-based measurement,” *Macroeconomic Dynamics and Control* 13: 218-240.

_____, and _____, 2008. “GGDC productivity level database: International comparisons of output, inputs and productivity at the industry level,” Groningen Growth and Development Centre Working Paper.

_____, _____, and B. van Ark, 2008. “Market services productivity across Europe and the US,” *Economic Policy* 139-194.

Jain-Chandra, S., and L. Zhang, 2014. “How can Korea Boost Potential Output to Ensure Continued Income Convergence?” IMF Working Paper WP/14/54.

Jones, R., 2009. “Boosting Productivity in Korea’s Service Sector,” OECD Economics Dept. Working Paper 673.

_____, and J. Lee, 2016. “Raising Korea’s productivity through innovation and structural reform,” OECD Economics Dept. Working Paper 1324.

Kim, H., 2008. “Market Services Productivity in Korea: An International Comparison,” Bank of Korea Institute for Monetary and Economic Research Working Paper 325.

Koske, I., I. Wanner, R. Bitetti, and O. Barbiero, 2015. “The 2013 update of the OECD’s database on product market regulation: Policy insights for OECD and non-OECD countries,” OECD Economics Dept. Working Paper 1200.

Kwon, J., D. Kim, C. Chee, K. Kim, and K. Noh, 2019. “Estimation of Korea’s Potential Growth,” Bank of Korea Monthly Bulletin 2019-8 (in Korean).

Kwon, K., 2017. “Korea’s Demographic Transition and Long-Term Growth Projection Based on an Overlapping Generations Model,” *KDI Journal of Economic Policy* 39, 25-51.

Lee, J., 2016. “The Republic of Korea’s Economic Growth and Catch-Up: Implications for the People’s Republic of China,” Asian Development Bank Institute Working Paper 571.

_____, and K. Hong, 2012. “Economic growth in Asia: Determinants and prospects,” *Japan and the World Economy* 24: 101-113.

McKinsey & Company, Inc., 1998. *Productivity-led Growth for Korea,* McKinsey Seoul Office and McKinsey Global Institute.

McMorrow, K., W. Röger, and A. Turrini, 2010. “Determinants of TFP growth: A close look at industries driving the EU-US TFP gap,” *Structural Change and Economic Dynamics* 21: 165-180.

Mehrhoff, J., 2009, “A Solution to the Problem of Too Many Instruments in Dynamic Panel Data GMM,” Discussion Paper No. 31/2009 (Frankfurt: Deutsche Bundesbank).

Nicoletti, G., and S. Scarpetta, 2005. “Regulation and Economic Performance: Product Market Reforms and Productivity in the OECD,” OECD Economics Dept. Working Papers 460.

_____, and _____, 2003. “Regulation, Productivity and Growth: OECD Evidence,” OECD Economics Dept. Working Papers 347.

OECD, 2016. *OECD Economic Surveys: Korea 2016*, OECD Publishing, Paris.

_____, 2014. *OECD Economic Surveys: Korea 2014*, OECD Publishing, Paris.

Próchniak, M., 2018. “The impact of product market competition on GDP per capita growth in the EU countries: does the model of capitalism matter?” *Post-Communist Economies* 30(2): 131-155.

Radelet, S., J. Sachs, and J. Lee, 2001. "The Determinants and Prospects of Economic Growth in Asia," *International Economic Journal* 15(3): 1-29.

Restuccia, D., and R. Rogerson, 2017. "The Causes and Costs of Misallocation," *Journal of Economic Perspectives* 31(3): 151-174.

Roodman, D., 2009, "A Note on the Theme of Too Many Instruments," *Oxford Bulletin of Economics and Statistics* 71: 135-158.

Saia, A., D. Andrews, and S. Albrizio, 2015. "Productivity Spillovers from the Global Frontier and Public Policy: Industry-Level Evidence," OECD Economics Dept. Working Papers 1238.

Swiston, A., 2021. "Korea's Growth Prospects: Overcoming Demographics and COVID-19," IMF Working Paper WP/21/92.

Topp, V., and T. Kulys, 2014. "On Productivity: The Influence of Natural Resource Inputs," *International Productivity Monitor* 27: 64-78.

van der Marel, E., 2012. "Trade in Services and TFP: The Role of Regulation," *The World Economy* 1530-1558.

Vitale, C., C. Moiso, and I. Wanner, 2020. "A detailed explanation of the methodology used to build the OECD PMR Indicators," OECD Methodology Note, available at: https://www.oecd.org/economy/reform/indicators-of-product-market-regulation/.

Young, S., 2019, "The Korean Economic Miracle: Secrets and Lessons," in T. Kim and S. Young (eds): *Lessons for Sustainable Development for South Korea*, Korea Development Institute pp. 25-64.

Zoli, E., H. Wang, D. Laxton, S. Mursula, and J. Yao, 2018, "A New Strategy for Korea's Fiscal Policy in a Low Growth Environment," IMF Working Paper WP/18/91.

Appendix. Methodology and Data Coverage

Industry-level growth decomposition and productivity comparisons

Productivity data sources: For Korea, data was taken mainly from the Korea Productivity Center, supplemented by data from the Asia KLEMS database; Bank of Korea; Haver Analytics; and Statistics Korea. Data for most countries is from various vintages of the EU KLEMS database available at https://euklems.eu/ and http://www.euklems.net/. Additional data was used to fill in data for some industries, series, or time periods in the following cases:

- Australia: Australian Bureau of Statistics; OECD Structural Analysis Database.
- Canada: Statistics Canada; OECD Structural Analysis Database.
- Hungary: OECD Structural Analysis Database.
- United States: Bureau of Economic Analysis; Bureau of Labor Statistics; Haver Analytics.

Relative productivity: Inklaar and Timmer (2008) estimate levels of labor productivity (LP) and total factor productivity (TFP) across countries and industries for 1997. We use the levels estimated using double deflation and applied to value added (LP_VADD and MFP_VADD in the dataset), These levels are spliced forward and backward using country-industry-specific LP and TFP series.

In four cases—Bulgaria, Korea, Romania, and Slovakia, the level of LP was estimated using Inklaar and Timmer (2014), which estimated LP levels for broad sectors, adjusted for international prices. Industry-level relative LP y_{ir} was estimated by scaling each industry's LP (y_i) by that of its broad sector (y_s):

$$y_{ir} = y_{sr} * y_i / y_s$$

Where y_{sr} is the LP of the country's sector *s* relative to the United States, as estimated by Inklaar and Timmer (2014). This yields industry-specific relative LP for 2005. For other years, this level is spliced forward and backward using country-industry-specific LP series.

For Korea (also for Canada), levels of LP are available in Inklaar and Timmer (2008) but levels of TFP are not. The 1997 TFP levels were estimated as the fitted values resulting from an estimation of TFP on LP across countries and industries where both variables were available, given the average country-level correlation of 0.92 in the available data. This estimation includes country and industry fixed effects:

$$TFP_{ci} = \alpha + \gamma_c + \delta_i + \beta * LP_{ci}$$

As in other cases, TFP levels are spliced forward and backward using country-industry-specific series.

Country groups

Total factor productivity (19): Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Korea, Netherlands, Slovenia, Spain, Sweden, United Kingdom, United States.
Labor productivity (29): The TFP group plus Bulgaria, Estonia, Greece, Ireland, Latvia, Lithuania, Poland, Portugal, Romania, Slovak Republic.
OECD PMR indicators (35): The TFP group plus Chile, Estonia, Greece, Iceland, Ireland, Israel, Latvia, Luxembourg, Mexico, New Zealand, Norway, Poland, Portugal, Slovak Republic, Switzerland, Turkey.

Industry categorization

KLEMS 2019 Code	Description	Regression groups				
		Manu-facturing	Market services	Network	ICT-using	High LP
A	Agriculture, forestry and fishing					
B	Mining and quarrying					
C	Total manufacturing	X 1/				
C10_C12	Food, beverages and tobacco	X				
C13_C15	Textiles, apparel, leather, etc.	X				
C16_C18	Wood, paper, printing, etc.	X				
C19	Coke and refined petroleum					
C20_C21	Chemicals and pharmaceuticals	X				X
C22_C23	Rubber, plastic, non-metallic min.	X				
C24_C25	Basic and fabricated metals	X				
C26_C27	Computer, electronic, optical products; electrical equipment	X			X 2/	X
C28	Machinery and equipment n.e.c.	X			X	
C29_C30	Transport equipment	X				
C31_C33	Other manufacturing	X				
D_E	Utilities			X		X
F	Construction					
G	Wholesale and retail trade		X		X	
H	Transportation and storage		X	X		
I	Accommodation and food service		X			
J	Information and communication		X	X	X	X
K	Financial and insurance activities		X		X	X
L	Real estate activities					
M_N	Professional services		X		X	
O	Public administration and defense					
P	Education					
Q	Health and social work					
R_S	Arts, etc.; personal services		X			
TOT	Total economy					

1/ Total manufacturing is only included where detailed industry-level manufacturing data is not available.
2/ The ICT-related group consists of this industry along with all the ICT-using industries.

PUBLICATIONS