GROUP OF TWENTY

MINIMIZING SCARRING FROM THE PANDEMIC—TECHNICAL ANNEX

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INTERNATIONAL MONETARY FUND*

*Does not necessarily reflect the views of the IMF Executive Board

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CONTENT

OVERVIEW OF ANNEXES

1. This document includes three annexes, supporting the technical analysis presented in the 2022 G-20 Background Note on Minimizing Scarring from the Pandemic.[1] Annex I provides details behind the analysis of informality shares in Figures 6 and 7 of the main text. Annex II describes the model-based analysis of the long-term impact of schooling losses in Figure 12 of the main text. Annex III presents the analysis of the impact of labor market policies on reallocation in Figure 17, right panel of the main text.

ANNEX I. ANALYSIS OF INFORMALITY SHARES

This annex describes and details the data and the results behind Figures 6 and 7 of the main text.

A. Data

2. The analysis relies on data from five G-20 emerging market economies. These countries are *Brazil, Indonesia, Mexico, Russia and South Africa*. The sources of the data are the Brazil National Household Sample Survey (PNAD), the Indonesia Statistics Office (BPS), the Mexican National Survey of Occupation and Employment (ENOE), the Russian Labor Force Survey from Statistics Russia, and the Quarterly Labor Force Survey from Statistics South Africa.

3. The definition of informality varies across countries:

- *Brazil*. Informal workers are those employees who do not hold a formal labor contract, those who are self-employed, and those who are domestic workers employed by households.
- *Indonesia*. Informal workers are those whose main job status is not defined as "employers of formal workers" and "workers/employees" as provided by the Indonesia Statistics Office.
- *Mexico*. Informal workers are those who work in the informal sector as defined by the Mexican Institute for Statistics and Geography (INEGI), unpaid workers, salaried domestic workers working for households, and workers that are not enrolled or make no contributions to the social security system.[2]
- *Russia*. Informal workers are persons employed by at least one informal sector unit of production during the reference period, irrespective of their employment status and irrespective of whether this job was primary or additional for them. Informal sector units of production are defined by

[1] These annexes, and the G20 Background Note these support, was prepared under the supervision of Shekhar Aiyar by a team led by Lone Christiansen and comprising Mehdi Benatiya Andaloussi, Eric Bang, Chanpheng Fizzarotti, Ashique Habib (co-lead), Davide Malacrino, and Chao Wang. Ilse Peirtsegaele provided administrative support. These do not necessarily reflect the views of G-20 members. G-20 notes by the IMF are available on IMF.org.

[2] For a more extensive definition of informal sector see the following document from the INEGI website: https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/metodologias/ENOE/ENOE2014/informal_laboral/702825060459.pdf

absence of their government registration as a legal entity. Informal sector employment includes the following: sole entrepreneurs; persons employed by sole entrepreneurs and individuals; family members assisting in a family business; persons working individually, without registration as a sole entrepreneur; persons working as part of their household production of agricultural, forestry, hunting and fishing goods intended to be sold or exchanged; persons working as part of their household production of household goods intended to be sold or exchanged.

- *South Africa*. Informal workers are (i) employees working in establishments that employ fewer than five employees and do not deduct income tax from their salaries/wages; and (ii) employers, own-account workers, and persons helping without pay in their household business and who are not registered for either income tax or value-added tax.

B. Results

4. Figures 6 and 7 present the data. Figure 6 reports the share of informal employment over total employment, relying on the definitions of informality listed before. Figure 7 relies on the following decomposition of the change in the shares of informal employment in total employment, where I_t is the number of informal employed workers at time *t*, E_t is the total number of employed workers at time *t*, I_{st} is the number of informal employed workers at time *t* in sector *s*, and E_{st} is the total number of employed workers at time *t* in sector *s*.

$$\frac{I_t}{E_t}-\frac{I_{t-1}}{E_{t-1}}=\sum_{s\in S_c}\frac{E_{st-1}}{E_{t-1}}\left(\frac{I_{st}}{E_{st}}-\frac{I_{st-1}}{E_{st-1}}\right)+\sum_{s\in S_c}\frac{I_{st-1}}{E_{st-1}}\left(\frac{E_{st}}{E_t}-\frac{E_{st-1}}{E_{t-1}}\right)+\sum_{s\in S_c}\left(\frac{I_{st}}{E_{st}}-\frac{I_{st-1}}{E_{st-1}}\right)\left(\frac{E_{st}}{E_t}-\frac{E_{st-1}}{E_{t-1}}\right)$$

5. The decomposition can be interpreted as the sum of three components.

- *Within-sector component*. The first element of the right-hand side of the equation is the "within sector component", calculated as the sum over sectors of the share of employment in each sector E_{st-1}/E_{t-1} at time *t-1* and multiplied by the change in informal employment *within* each sector between times *t-1* and *t*: $(I_{st}/E_{st}-I_{st-1}/E_{st-1})$.

- *Between-sector component*. The second element of the right-hand side of the equation is the "between sector component," calculated (symmetrically) as the sum over sectors of the share of informal employment in each sector I_{st-1}/E_{st-1} at time *t-1* multiplied by the change in the shares of sectoral employment *between* sectors between times *t-1* and *t*: $(E_{st}/E_t-E_{st-1}/E_{t-1})$.

- *Remaining component*. The last term is a cross product between changes in employment shares across sectors and changes in informality shares within sectors. This term is small in practice and omitted from the chart.

6. The sums on the right-hand side of the equation are taken over a collection of sectors aggregates which vary at the country level (S_c). The country-specific element arises because sectors are defined as aggregated NACE sectors (Table A1.a) and the aggregation changes at the country level based on data availability. For *Brazil* and *Mexico*, the aggregates are defined by groups A, BDE, C, F, G I, H, KLMN, PQ, RST, OU. For *Indonesia* the groups are A, B, C, D, E, F, G, H, I, J, K, L, MN, O, P,

Q, RSTU. For *Russia*, the groups are BDE, C, F, GI, HJ, KLMN, PQ, RSTUO. For *South Africa*, the groups are B, C, DE, F, GI, H, KLMN, RST.

Table AI.1. NACE Sectors

A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam, and air conditioning supply
E	Water supply; sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	real estate activities
M	Professional, scientific, and technical activities
N	Administrative and support service activities
O	Public administration and defense; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment, and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organizations and bodies

ANNEX II. LONG-TERM EFFECTS OF LEARNING LOSSES

This annex describes the model and the simulation exercise behind Figure 12 of the main text.

A. The Model

7. A heterogenous agent general equilibrium model is used to illustrate the potential long-term implications of leaving learning losses among current students unaddressed. A full description of the model and its baseline calibration to the *United States*, which is used here, can be found in Lizarazo Ruiz, Peralta Alva, and Puy (2017). The model contains three types of workers, differentiated by skill level (low-, medium-, and high-skilled workers). Competitive firms operate in three sectors: low-skilled services (e.g., retail); high-skilled services (e.g., finance); and manufacturing. Firms use capital and labor for production, with the reliance on capital and labor varying exogenously across sectors: *low-skilled services* are reliant on low- and medium-skilled labor; *high-skilled services* are reliant on medium- and high-skilled labor; and *manufacturing* is more capital intensive than the two service sectors. The equilibrium concept is that of a stationary, steady-state equilibrium. Thus, the model is intended for analyzing the long-term implications of shocks once short-term dynamics have dissipated.

8. The model has been previously applied to assess long-term macroeconomic and distributional outcomes, arising from the interaction between workers' skill levels and policy and structural changes. For example, the model was used to simulate the impact of US tax reform in the context of the 2017 Article IV staff report for the *United States* (IMF, 2017). The model, with its current calibration, has also been used to analyze the potential impact of accelerating automation in the IMF's G-20 Notes on *Technology and the Future of Work* (IMF, 2018a) and *Future of Work: Measurement and Policy Challenges* (IMF, 2018b).

9. The most salient set of parameters for the current analysis are the distribution of skills, which are set exogenously. In the baseline calibration, the three types of workers are mapped to those with high-school education or less (low-skilled); some tertiary education, up to a bachelor's degree (medium-skilled); and more than bachelor's degree (high-skilled). The skill levels are calibrated based on years of schooling for the three groups. The medium skill level is normalized to 1. Table AII.1 summarizes the calibrated parameter values.

Table AII.1. Parameter Values

	Skill level	Population share
Low-skilled	0.7	0.33
Medium-skilled	1 (normalized)	0.5
High-skilled	1.1	0.17

B. Model Simulations

10. The model is used to simulate, in a representative G-20 advanced economy, the potential impact on output and inequality if education losses are left unaddressed. This simulation abstracts from the impact of other channels of COVID-19-induced scarring. The exercise considers the following scenario, based on analysis in the main text:

- *Learning losses will eventually impact a sizable share of the labor force*. About a third of future workers will be scarred by disruptions to schooling, once all the affected students have entered the labor force (Figure 11, right panel of the main text).

- *School disruptions result in lower skill levels*. In the median G-20 advanced economy, the estimated length of schooling disruption is about 0.75 years (Figure 9, left panel of the main text). Based on a pre-crisis average of 16 years of schooling, the disruption is assumed to reduce the skill level of the affected cohort by about 4.5 percent.

11. The reduction in skill levels is mapped to the model by changing the parameters governing skill levels and population shares of the three types of workers. All other parameters are kept constant at their calibrated values. The skill-related parameters are adjusted as follows:

- *Adjustments to the share of high- and low-skilled workers in the labor force*. First, in line with recent estimates[3], and to capture some of the distributional effects of learning losses, the share of high-skilled workers amongst the cohort affected by learning losses is reduced by 3 percentage points and the share of low-skilled workers is increased by 3 percentage points. As this affected cohort accounts for a third of the total labor force, the share of high-skilled (low-skilled) workers in the overall labor force decreases (increases) by about 1 percentage point. As a result of these adjustments, the average skill level for the affected cohort falls by about 1.2 percent.

- *Reduction in parameters for skill levels*. The three parameters governing the skill levels are reduced by 3.3 percent, for a total reduction in average skill levels for the affected cohort of 4.5 percent.

[3] Fernald and others (2021) and references therein.

ANNEX III. LABOR MARKET POLICIES AND LABOR REALLOCATION

This annex describes the data and analysis behind Figure 17, right panel of the main text.

A. Data

12. The analysis is based on data from 18 European economies. The economies in the analysis are *Austria*, *Belgium*, *Czechia*, *Denmark*, *Estonia*, *Finland*, *France*, *Germany*, *Greece*, *Hungary*, *Italy*, *Netherlands*, *Norway*, *Poland*, *Portugal*, *Slovak Republic*, *Spain*, and the *United Kingdom*. The data cover the years 1998–2017.

- *Firm-level data*. Orbis data are used, including number of employees, cost of employees, firm age, sector, turnover revenue, and material costs.

- *Labor market policies*. The OECD Labor Market Programs database is used to construct, for each country, measures of annual expenditures as share of GDP on policies intended to support job retention, and those intended to support worker reallocation. *Job retention policies* include (i) benefits administration (ii) workplace training, (iii) apprenticeship, (iv) employment incentives for maintenance, (keeping jobs), (v) partial unemployment benefits, and (vi) part-time unemployment benefits. *Reallocation policies* include (i) placement administration, (ii) institutional training, (iii) integrated training (23), (iv) employment incentives for recruitment (hiring), (v) direct job creation, (vi) start-up incentives, (vii) early retirement.[4]

B. Empirical Specification

13. The analysis is based on standard models of dynamic allocative efficiency.[5] These models predict that firms with labor productivity should attract more labor and grow faster than firms with lower labor productivity, absent factors hindering reallocation. As such, a standard model, which regresses a measure of employment growth on a measure of lagged firm-level labor productivity, is augmented by terms interacting lagged labor productivity with the policy variables.[6]

[4] See IMF (2021).

[5] See Foster and others (2016), Decker and others (2017).

[6] A similar framework is applied by Andrews and others (2021) to study the impact of pandemic-period labor market support policies in Australia; by Demmou and Franco (2021) to study the impact of credit guarantee schemes on reallocation; and by Aiyar and others (2019) to study the impact of insolvency regime quality on capital reallocation. See also Adalet McGowan and others (2017).

14. The estimated equation is as follows:

- *The equation.*

$$GrEmp_{i,t} = \beta_0 + \beta_1 * labprod_{i,t-1} + \beta_2 * reten_{c,t-1} * labprod_{i,t-1} + \beta_3 * realloc_{c,t-1} * labprod_{i,t-1} + X_{i,t-1} + \delta_{s,c} + \delta_{c,t} + \epsilon_{i,t}$$

- *Subscripts*. The subscript i denotes a firm, s denotes a sector, c denotes a country, and t denotes a year.

- *Productivity*. Firm-level annual employment growth is measured by the log difference in the number of employees ($GrEmp_{i,t}$) and firm-level lagged labor productivity is measured by the log of the ratio of the lagged value added to number of employees ($labprod_{i,t-1}$).

- *Policy variables*. The policy variables are constructed as described above ($reten_{c,t-1}$ and $realloc_{c,t-1}$).

- *Dummies*. Firm size and firm age group dummies are included ($X_{i,t-1}$), as well as country-by-sector ($\delta_{s,c}$) and country-by-year ($\delta_{c,t}$) fixed effects.

- *Coefficients*. The coefficient β_1 captures the average correlation between lagged firm labor productivity and employment growth that would prevail if the two policy spending measures were both zero. The coefficients for the interaction terms, β_2 and β_3, reflect respectively the impacts of the job retention and reallocation policies on the correlation between labor productivity and employment growth. For example, a negative value of β_2 indicates that higher expenditure on job retention measures diminishes the correlation between firm labor productivity and employment growth—in other words, that such policy is associated with a slower pace of productivity enhancing reallocation.

C. Results

15. Table AIII.1 presents the results. The regression specification above is used to construct Figure 17, right panel, of the main text. Retention policies are found to be associated with lowering the correlation between firm labor productivity and employment growth. The estimated impact of reallocation policies is statistically insignificant.

Table AIII.1. Association Between Labor Market Policies and Reallocation

VARIABLES	(1) GrEmp	(2) GrEmp	(3) GrEmp
Constant	-0.686***	-0.678***	-0.686***
	(0.0281)	(0.0287)	(0.0276)
lag(labprod)	0.0772***	0.0609***	0.0724***
	(0.00488)	(0.00347)	(0.00356)
lag(labprod)*lag(reten)	-0.0319***		-0.0269**
	(0.0104)		(0.0106)
lag(labprod)*lag(realloc)	-0.00699	0.00886	
	(0.00743)	(0.00776)	
N	8,581,695	10,044,795	8,655,018
R-squared	0.054	0.054	0.054
Country-sector FE	YES	YES	YES
Country-year FE	YES	YES	YES

Clustered standard errors (country-sector) in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D. Robustness

16. Table AIII.2 reports robustness exercises.

- *The concurrent impact of policies on reallocation is investigated*. This yields similar results as the baseline specification (columns 1–3).

- *The potential for the impact of policies varying by sector is considered*. For example, sectors that tend to have higher need for worker reallocation may be particularly impacted by job retention policies. Therefore, the interaction terms are augmented by a measure of sectoral reallocation calculated from outside the sample (similar to Rajan and Zingales, 1995). The sectoral reallocation measure is calculated using data from the *United States* and is the annual within-sector standard deviation of firm employment growth, averaged over (1998–2017). The estimated equation is:

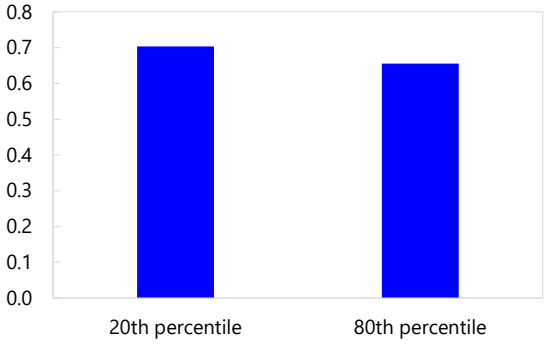
$$GrEmp_{i,t} = \beta_0 + \beta_1 * labprod_{i,t-1} + \beta_2 * reten_{c,t-1} * labprod_{i,t-1} * empReallo c_s^{US} + \beta_3 * realloc_{c,t-1} * labprod_{i,t-1} * empReallo c_s^{US} + X_{i,t-1} + \delta_{s,c} + \delta_{c,t} + \epsilon_{i,t}$$

17. Columns 4 to 6 in Table AIII.3 reports the results. Figure AIII.1 compares the economic significance of the specification above against the baseline specification by evaluating the relationship between employment growth and labor productivity—with the measure of sectoral reallocation held at the median level—in economies at the 20th percentile and 80th percentile of job retention policy spending. The estimated effects are qualitatively similar to those reported in the main text (Figure 17, right panel).

Figure AIII.1. Impact of Policies on Reallocation

Change in employment growth from a 10 percent increase in labor productivity

(percent; policy spending at 20th and 80th percentiles respectively, median sectoral reallocation)



Sources: Orbis; OECD; IMF staff calculations.

Table AIII.2. Association Between Labor Market Policies and Reallocation—Robustness

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	DEmp	DEmp	DEmp	DEmp	DEmp	DEmp
Constant	-0.684***	-0.676***	-0.684***	-0.687***	-0.676***	-0.686***
	(0.0279)	(0.0291)	(0.0277)	(0.0275)	(0.0284)	(0.0275)
lag(labprod)	0.0777***	0.0630***	0.0715***	0.0724***	0.0640***	0.0711***
	(0.00498)	(0.00357)	(0.00371)	(0.00377)	(0.00266)	(0.00320)
lag(labprod)*lag(reten)	-0.0300***		-0.0236**			
	(0.0113)		(0.0113)			
lag(labprod)*lag(realloc)	-0.00932	0.00434				
	(0.00739)	(0.00790)				
lag(labprod)*lag(reten)*(emp realloc US)				-0.0966***		-0.0932***
				(0.0277)		(0.0270)
lag(labprod)*lag(realloc)*(emp realloc US)				-0.00807	0.00884	
				(0.0135)	(0.0103)	
N	8,488,366	10,066,956	8,553,921	8,579,656	10,042,533	8,652,979
R-squared	0.054	0.054	0.054	0.054	0.054	0.054
Country-sector FE	YES	YES	YES	YES	YES	YES
Country-year FE	YES	YES	YES	YES	YES	YES

Clustered standard errors (country-sector) in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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