



PEOPLE'S REPUBLIC OF CHINA—MACAO SPECIAL ADMINISTRATIVE REGION

SELECTED ISSUES

April 2022

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PEOPLE'S REPUBLIC OF CHINA—MACAO SPECIAL ADMINISTRATIVE REGION

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HOW TO OVERCOME THE BARRIERS TO ECONOMIC DIVERSIFICATION: A LABOR MARKET APPROACH¹

This chapter evaluates whether Macao SAR's current labor market meets the skills demand of the four sectors targeted by the government's diversification strategy. Analysis based on the overall and sectoral occupational composition suggests that sectors targeted by the government's diversification strategy demand high-skilled labor, while Macao SAR's current labor market mainly comprises low and middle-skill-requiring occupations. This indicates a need for skill upgrading to bridge skill gaps. Further estimates show that overcoming the skills mismatch to achieve occupational labor mobility is costly and takes time. These findings underscore the need for Macao SAR to undertake labor market reform to nurture and attract talents.

A. Introduction

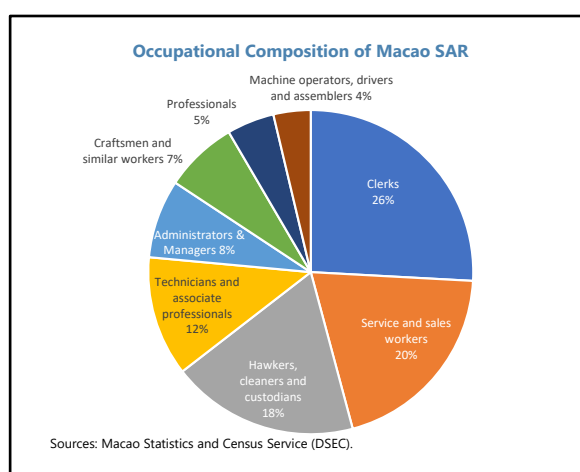
- 1. Macao SAR's Economy heavily relies on the gaming sector.** Since the liberalization in 2002, the gaming sector has experienced rapid growth and become the key driver of economic growth. In 2019, the gaming sector is estimated to account for around 50 percent of GDP and 22 percent of employment. The economy's over-reliance on gaming services has led to high volatility of economic growth, making the economy less resilient to shocks.
- 2. The COVID-19 crisis highlighted the vulnerability of Macao SAR's growth model and made the diversification of the economy more urgent.** Since the pandemic, gaming tourism has been depressed, resulting in a 54 percent decline in economic activity during 2020. In addition, government revenues from the gaming sector, which historically account for about 80 percent of total revenues, plummeted prompting the government to draw down fiscal reserves.
- 3. Macao SAR's diversification plan aims to develop 4 key nongaming sectors.** The recently released Master Plan of the Development of the Guangdong-Macao Intensive Cooperation Zone in Hengqin (GMICZ) envisions the diversification of Macao SAR's economy by developing four nascent industries: (i) scientific and technological research; (ii) traditional Chinese medicine; (iii) tourism, convention, and exhibition services; and (iv) modern financial services.
- 4. This chapter evaluates whether the availability of skills in Macao SAR's current labor market meet the skill requirement of the government's diversification strategies.** Our approach takes four steps. First, it provides an assessment of Macao SAR's current labor market structure by analyzing its occupational composition and assesses skills availability. Second, it compares skills availability in the Macao SAR's current labor market with the skill requirements of the targeted sectors. Third, it estimates the costs of moving workers from the current occupational structure to the target one. Fourth, it draws some policy implications for Macao SAR to address the potential skills mismatch.

¹ Prepared by Ting Lan (STA)

5. Meeting the skill demands for the government's diversification strategy will be challenging due to the insufficient supply of the required skills and high mobility cost. Our analysis suggests high-skill-requiring occupations are in great need in the government's targeted four sectors. However, the pool of skills currently available in Macao SAR's labor market is insufficient for the demand of these targeted sectors. Moreover, our estimates show that overcoming the skill mismatch to achieve occupational labor mobility is costly and takes time.

B. Macao SAR's Labor Market Structure

6. Macao SAR's current labor market is mainly composed of low and middle-skill-requiring occupations.² In 2020, more than 45 percent of the employed were clerks and service and sales workers, and about 25 percent of workers were employed in low-skill-requiring occupations, such as waiters, cleaners, and custodians.³ Only 17 percent of the workers were professionals and technicians.⁴ In the gaming sector, about 84 percent are clerks and service and sales workers, and 6 percent low-skilled workers. Outside the gaming sector, only about 14 percent of the currently employed workers were high-skilled in 2020. In contrast, high-skilled workers compose a much more significant proportion of the labor force in other advanced economies. For example, in the United States, about 27 percent of the workers are high skilled.



7. Analysis of the occupational composition of the sectors targeted by the government's diversification strategy suggests that professionals are in great need.⁵ Professionals are the key labor force in the high-tech sector, about 55 percent, followed by technicians (15 percent). The financial sector, while mainly composed of clerks (50 percent), requires a considerable number of professionals (28 percent). Traditional Chinese medicine is similar to the pharmaceutical and

² We classify low, middle, and high-skilled occupations based on their skill requirement. Low-skill-requiring occupations include waiters, cleaners and custodians, craftsmen and similar workers. Service and sales workers, clerks, machine operators, and technicians are classified as middle-skilled occupations. Professionals, administrators and managers are considered as high-skilled occupations.

³ In this chapter, we analysis Macao SAR's labor market by looking at the overall employed population, which includes both the local and imported workers. Given that most of the imported workers are unskilled, the occupation composition of the local workers is different from that of the overall employed population.

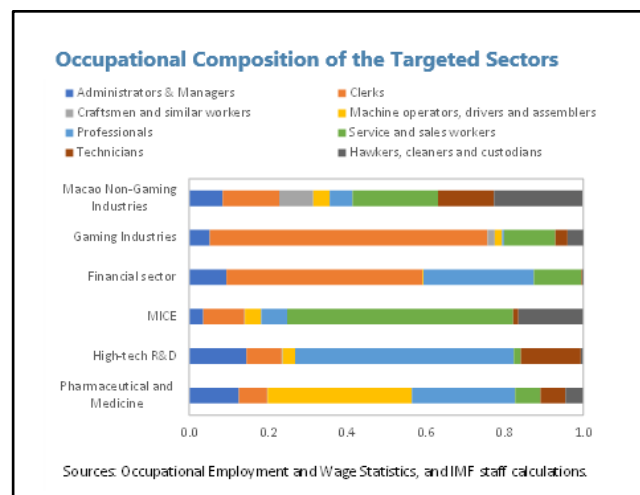
⁴ According to the international standard classification of occupations (ISCO), professionals are defined as occupations that increase the existing stock of knowledge, apply scientific or artistic concepts and theories, teach about the foregoing in a systematic manner, or engage in any combination of these three activities. For example, life scientists, lawyers, and physicians.

⁵ The sectoral occupational composition is calculated using the data from Occupational Employment and Wage Statistics of the United States. We assume that Macao SAR will have similar industry occupation structures as other advanced economies, such as the United States.

medicine sector⁶, which employs 37 percent of machine operators, drivers and assemblers, and 26 percent of professionals. Service and sales workers are much needed in the MICE sector, with about 57 percent of employed.

8. The pool of professionals, machine operators, drivers and assemblers currently available in Macao SAR's labor market is insufficient for the demand of these targeted sectors. Classification of the sectors based on sectoral occupational composition indicates that the

meetings, incentives, conferences, and exhibitions sectors (MICE) demonstrate the closest occupational composition to Macao SAR's current composition.⁷ The financial services and gaming sectors have a notable overlap since they both require a considerable number of clerk occupations. However, financial services require a much higher proportion of professionals. The occupational composition of scientific and technological research and traditional Chinese medicine sectors are the furthest to Macao SAR's overall occupational composition. They both



require significant support from the professionals, while the traditional Chinese medicine sector also demands considerable share of manufacturing workers. However, professionals account for only 5 percent of Macao SAR's overall occupational composition and 6 percent outside the gaming sector. Machine operators, drivers, and assemblers are even more scarce, less than 4 percent of the current occupational structure.

C. Skill Requirements and Occupational Mobility Costs

9. Labor mobility across occupations is a function of skill transferability between the origin and destination occupations. The labor literature suggests that the likelihood and cost of labor mobility across occupations largely depends on the similarity of the skill sets required by the origin and destination occupations (Shaw, 1984; Violante, 2002; Macaluso, 2017; Zuniga and Yuen, 2020). Following Gathmann and Schonberg (2020), we construct a measure of skill distance between occupation pairs, capturing the degree of skill dissimilarity required by the two occupations (Table 1 and Annex II).

10. The current skill set of Macao SAR's labor force does not meet the requirements of the government-targeted sectors. A significant proportion of workers outside gaming sectors are hawkers, cleaners, and custodians. The skill distance between these occupations and the

⁶ Macao SAR aims to develop a comprehensive health industry, including producing Chinese medicine, manufacturing medical equipment, and providing health services. Given the key product of the sector is the Chinese medicine, we benchmark it with the pharmaceutical and medicine sector.

⁷ Sectors are classified into 8 groups based on the similarity of the sectoral occupation composition using machine learning techniques (Annex I)

professionals is about 0.67 (Table 1)⁸, indicating skills obtained by these workers do not line up with the skills required by professionals. The most important five skills for professionals are critical thinking, social perceptiveness, active listening, reading comprehension, and speaking. While the most critical skills needed by hawkers, cleaners, and custodians are active listening, service orientation, coordination, monitoring, and judgment and decision making.⁹ Overall, the average skill distance between low-skill-requiring occupations and professionals is about 0.73, and between middle-skill-requiring occupations and professionals is about 0.44, suggesting considerable skill mismatches between the labor supply in the Macao SAR's labor market and the labor demand in the targeted sectors. This suggests a need for occupational mobility through skill upgrading to shorten the skill distance and overcome the skill mismatches.

Table 1. Macao SAR: Skill Distance Across Occupations

Occupations	Administrators & Managers	Clerks	Craftsmen and similar workers	Machine operators, drivers and assemblers	Professionals	Service and sales workers	Technicians	Hawkers, cleaners and custodians
Administrators & Managers	0.02							
Clerks	0.39	0.24						
Craftsmen and similar workers	0.84	0.61	0.05					
Machine operators, drivers and assemblers	0.84	0.62	0.23	0.20				
Professionals	0.22	0.46	0.78	0.75	0.25			
Service and sales workers	0.31	0.26	0.62	0.70	0.41	0.17		
Technicians	0.53	0.54	0.59	0.50	0.45	0.58	0.39	
Hawkers, cleaners and custodians	0.66	0.39	0.30	0.39	0.67	0.38	0.58	0.23

Sources: O*NET OnLine and IMF staff calculations

Note: Skill distance index measures the degree of skill dissimilarity required by two occupations. Skill distance=0 if two occupations require exactly the same skill set and =1 if two occupations require entirely different skill sets. Skill distance index is constructed following Gathmann and Schonberg (2010).

11. Overcoming the skill mismatches to achieve occupational mobility is costly. On average, it costs about 30 percent of the average annual wage for middle-skilled workers to move to professionals and 40 percent of the average annual wage for low-skilled workers to move to professionals (Table 2). Cross-occupation labor mobility cost largely depends on the skill distance between the sourcing and destination occupations, the worker's initial skill levels, and the destination occupation's entry cost. Naturally, it is more costly for the low-and-middle skilled workers to move to high-skilled-requiring occupations than the other way around.

12. Achieving occupational mobility through skill upgrading also takes time. "Skills gap" represents a massive pool of untapped talent. Occupational training provides the chance for low-and-median skilled workers to upgrade their existing skills and develop new professional competencies. However, nurturing talent often takes time and consistent efforts. It requires about two years of additional training for middle-skilled workers to move to professionals and about three years for the low-skilled workers.

⁸ Following Gathmann and Schonberg (2010), the skill distance index is constructed to measure the skill similarity required by occupations. Skill distance =0 if two occupations require exactly the same skill set and =1 if two occupations require entirely different skill sets. Annex II provides more details on how skill distance is constructed. Annex Table 3 summarizes occupation pairs with the closest and farthest skill distance.

⁹ O*Net Online evaluates the importance of a broad set of skills for each occupation. Annex Table 2 lists the set of skills O*Net Online includes. For each skill, the importance varies between 100 and 0. 100 indicates the skill is most important, and 0 indicates the least.

Table 2. Macao SAR: Mobility Costs Across Occupations

(In percent of annual wage)

Occupations (move from) \ Occupations (move to)	Occupations (move to)							
	Administrators & Managers	Clerks	Craftsmen and similar workers	Machine operators, drivers and assemblers	Professionals	Service and sales workers	Technicians	Waiters, cleaners and custodians
Administrators & Managers	0.31	2.85	4.88	5.23	1.83	1.65	3.85	1.96
Clerks	11.84	2.30	6.63	7.30	15.42	1.88	11.16	2.45
Craftsmen and similar workers	31.09	10.59	0.66	1.75	33.18	7.07	15.97	2.41
Machine operators, drivers and assemblers	29.02	10.19	1.52	1.74	29.79	7.45	13.23	2.75
Professionals	1.40	2.89	3.99	4.11	2.10	1.77	2.93	1.77
Service and sales workers	16.60	4.22	10.99	13.21	23.02	3.58	18.85	3.40
Technicians	7.34	5.34	4.82	4.57	7.28	3.67	6.35	2.29
Waiters, cleaners and custodians	51.29	15.31	9.48	12.55	60.63	8.45	30.77	3.95

Source: IMF staff calculations.

Note: Mobility costs between two occupations are estimated follows the strategy implemented by Cortes and Gallipoli (2016). The approach is based on a model of occupational choice that delivers a gravity equation linking the labor flows to occupation skill distance and transition costs.

Table 3. Macao SAR: Mobility Costs Across Occupations

(In months of additional training)

Occupations (move from) \ Occupations (move to)	Occupations (move to)							
	Administrators & Managers	Clerks	Craftsmen and similar workers	Machine operators, drivers and assemblers	Professionals	Service and sales workers	Technicians	Waiters, cleaners and custodians
Administrators & Managers	1.4	1.3	0.1	1.3	9.3	1.8	9.8	0.1
Clerks	16.8	0.7	0.1	1.2	26.9	1.3	12.6	0.1
Craftsmen and similar workers	23.1	1.6	0.0	0.4	33.5	2.5	12.9	0.1
Machine operators, drivers and assemblers	23.1	1.7	0.0	0.4	32.9	2.6	12.1	0.1
Professionals	6.2	1.4	0.1	1.3	11.6	2.1	9.0	0.1
Service and sales workers	15.3	0.8	0.1	1.2	25.6	1.5	12.8	0.1
Technicians	14.9	1.5	0.1	1.1	20.3	2.4	10.8	0.1
Waiters, cleaners and custodians	20.8	1.3	0.0	0.9	31.6	1.8	12.4	0.1

Source: IMF staff calculations.

Note: Mobility costs between two occupations are estimated follows the strategy implemented by Cortes and Gallipoli (2016). The approach is based on a model of occupational choice that delivers a gravity equation linking the labor flows to occupation skill distance and transition costs.

D. Policies to Overcome the Barriers to Diversification

13. Investment in nurturing talent will help to bridge the gap in occupational composition and facilitate the cross-occupation transition. Scaling-up in public spending on education will be needed to achieve skill upgrading. Investing in outcome-orientated occupational and on-the-job training will facilitate the acquisition of skills. Cooperation with employers will be critical for the success of these efforts. Achieving a greater synergy between higher education and future skill needs and strengthening science-business linkages would also be important.

14. Talent attraction should complement skill upgrading, as nurturing talent often takes time. Recruitment of high-skilled non-resident workers can help Macao SAR to build a deeper pool of qualified workers. The synergy between the high-skilled non-resident workers and Macao SAR local workers can facilitate the knowledge spillover. Thus, streamlining the administrative barriers for hiring high-skilled non-resident workers will help Macao SAR better compete for external talents.

15. Leverage opportunities offered by the increased integration with the GBA. Macao SAR could leverage opportunities offered by the increased integration with the GBA to access the large pool of skilled labor and offshore some economic activities, capitalizing on the Mainland's comparative advantage in manufacturing.

Annex I. Classification Methodology

Sectoral Occupational Composition

The sectoral occupational shares are computed using data from the Occupational Employment and Wage Statistics (OEWS) of the United States, assuming that Macao SAR will have a similar sectoral occupational composition as other advanced economies. Our sectoral analysis is at 4-digit North American Industry Classification System (NAICS) level, covering 250 sectors.

K-means Classification

We use the k-means clustering algorithm (MacQueen et al., 1967) to group sectors into clusters based on the sectoral occupation composition. Sectors are assigned to clusters based on similarity of the occupation shares so as to minimize the within-cluster sum of squared deviations from the cluster mean. The k-means algorithm works as follows: given M sectors, each with a vector of N different occupation shares, $x(k) \in R^N, k = 1, \dots, M$ assign the M sectors into G clusters. The G clusters are indexed by $g = 1, \dots, G$.

1. Initialize cluster centroids $m_1, m_2, \dots, m_G \in R^N$ for each cluster.
2. Assign each sector k to the cluster whose centroid is closest to $x(k)$. The cluster assignment is $c(k) \in \{1, 2, \dots, G\}$,

$$c(k) = \operatorname{argmin}_{g \in \{1, 2, \dots, G\}} |x(k) - m_g|^2$$

3. Replace cluster centroid m_g by the coordinate-wise average of all points (sectors) in the g^{th} cluster,

$$\hat{m}_g = \frac{\sum_{k=1}^M 1(c(k) = g)x(k)}{\sum_{k=1}^M 1(c(k) = g)}$$

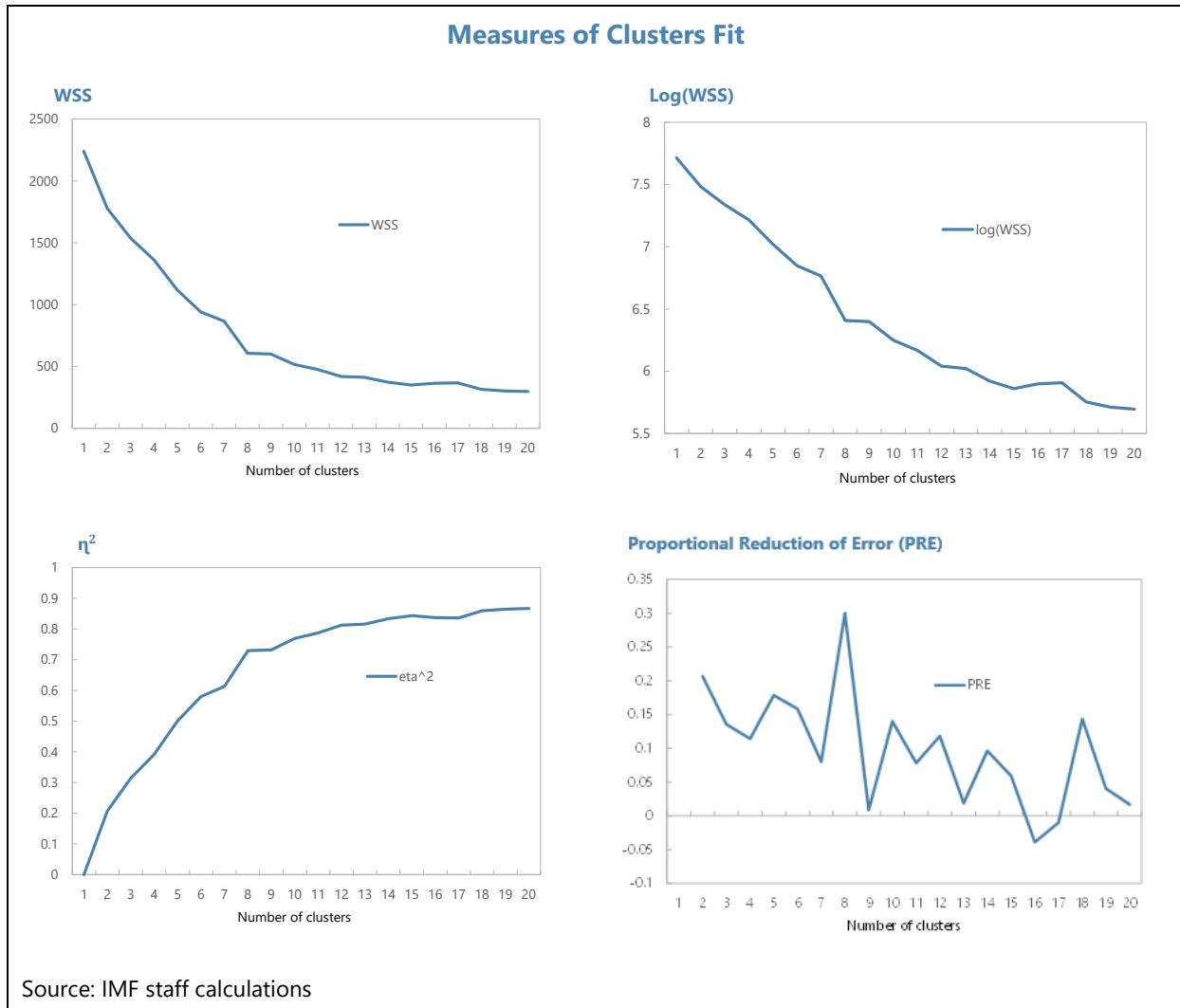
4. Iterate on steps 2 and 3 until convergence.

Following standard practice, we normalize the values of each characteristic to have zero mean and unit variance. We use the “k-means ++” algorithm proposed by Arthur and Vassilvitskii (2006) to choose the initial values for the k-means clustering algorithm, and do extensive checks using alternative starting points.

Choosing the Optimal Number of Clusters:

The K-means algorithm above requires a choice of the number of clusters. There is no unambiguously optimal method for choosing the number of clusters, although there are a number of conceptually similar approaches based on maximizing various measures of cluster fit. To detect the clustering with the optimal number of groups, we use within sum of squares WSS , its logarithm

$\log(WSS)$, η^2 coefficient¹, as well as the proportional reduction of error (PRE) coefficient ²to evaluation our measure of cluster fit and chose the optimal number of clusters.



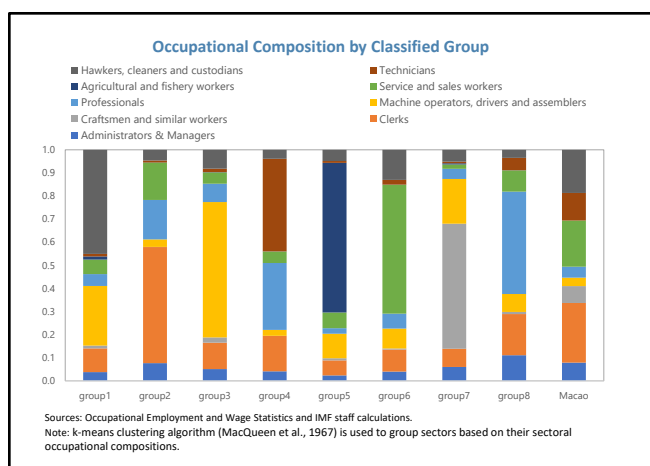
The panel chart summarizes the measures of clusters fit. The analysis suggests $k = 8$ to be a good value of cluster numbers. At $k = 8$, there is a kink in the WSS and $\log(WSS)$, respectively. η^2 coefficient points to a reduction of the WSS by 80% and PRE decreased by about 30% compared with $k = 7$.

¹ $\eta^2(k)$ measures the proportional reduction of the WSS for each cluster solution k compared with the total sum of squares.

² $PRE(k)$ illustrates the proportional reduction of the WSS for cluster solution k compared with the previous solution with $k - 1$ cluster.

Classified Occupational Groups

We classify 250 sectors into 8 groups (clusters) and summarized the average sectoral occupational composition for each group. MICE is classified into group 6,³ which contains a group of service sectors.⁴ The classification suggests Macao SAR's current composition is suitable to develop the MICE sector as it meets the large demand of service and sales workers to develop the MICE sector. The financial services and gaming sectors are classified into the same group (Group 2), as they both need a substantial proportion of clerks.⁵ In the Gaming sector, the most needed clerks are gambling cage workers. While in financial services sectors, the most essential clerks are tellers in credit intermediation and related activities, and bill and account collectors in the non-depository credit intermediation sector. In addition to clerks, financial sectors also need many professionals such as lawyers. Scientific and technological research and traditional Chinese medicine sectors fall to Group 8. They both require significant support from the professionals and the manufacturing workers. Annex Table 1 lists the representative sectors within each group. Representative sectors have the closest occupational composition to the within-group average.



³ We use the k-means clustering algorithm (MacQueen et al., 1967) to group 250 4-digit North American Industry Classification System (NAICS) sectors into 8 groups. The chart summarizes the average occupation shares within each group. It turns out that this procedure results in groups with salient features.

⁴ Annex table 1 lists the representative sectors within each group.

⁵ Clerks are a big occupation category. Under big group, there are 20 detailed subcategories. Annex III Table 5 summarizes the subcategories of clerks following the Standard Occupational Classification (SOC) and Table 6 summarizes the subcategories of the financial clerks. The most needed clerks in the gaming sector are gambling cage workers and in the financial sector are tellers and bill and account collectors.

Annex Table 1. Representative Sectors within Each Group

Group 1	Support Activities for Mining
	Support Activities for Water Transportation Waste Collection
Group 2	Credit Intermediation and Related Activities (5221 And 5223 only)
	Agencies, Brokerages, and Other Insurance Related Activities Office Administrative Services
Group 3	Automotive Repair and Maintenance
	Household Appliance Manufacturing Fabricated Metal Product Manufacturing (3323 and 3324 only)
Group 4	Other Schools and Instruction
	Nursing Care Facilities (Skilled Nursing Facilities) Medical and Diagnostic Laboratories
Group 5	Logging
	Support Activities for Crop Production Support Activities for Animal Production
Group 6	Other Amusement and Recreation Industries
	Building Material and Supplies Dealers Home Furnishings Stores
Group 7	Building Equipment Contractors
	Utility System Construction Other Specialty Trade Contractors
Group 8	Grantmaking and Giving Services
	Business Schools and Computer and Management Training Social Advocacy Organizations

Note: The table reports three representative sectors for each group. Representative sectors have the closest occupational composition to the within-group average.

Annex II. Skill Distance and Mobility Cost

Skill Distance Measure

We construct a distance measure across occupation pairs based on angular separation, following Gathmann and Schonberg (2010). The distance measure reflects the degree of dissimilarity in the mix of skills performed in two occupations. The angular separation between the skill vectors of the two occupations is given by

$$AngSep_{ij} = \frac{\sum_{d=1}^D (S_i^d \times S_j^d)}{\left[\sum_{d=1}^D (S_i^d)^2 \times \sum_{d=1}^D (S_j^d)^2 \right]^{1/2}}$$

Where S_i^d be the importance level of dimension d in occupation i , and S_j^d is the analogous measure for occupation j . D is the total number of dimension being considered. $AngSep_{ij}$ measure is between -1 and 1. It is transform to a distance measure between 0 and 1 as follows, which is increasing in dissimilarity. And the task distance between two occupations i, j is measured as follows:

$$dist_{ij} = \frac{1}{2}(1 - AngSep_{ij})$$

The skill vectors are taken from the O*Net database (Annex Table 2). In total, 35 skill dimensions are included. For each occupation, O*Net evaluates the importance level of each skill dimension. The skill importance varies between 100 and 0, with 100 being the most important and 0 being the least important.

Annex Table 2. List of Skill Set

Active Learning	Operation and Control
Active Listening	Operations Analysis
Complex Problem Solving	Operations Monitoring
Coordination	Persuasion
Critical Thinking	Programming
Equipment Maintenance	Quality Control Analysis
Equipment Selection	Reading Comprehension
Installation	Repairing
Instructing	Science
Judgment and Decision Making	Service Orientation
Learning Strategies	Social Perceptiveness
Management of Financial Resources	Speaking
Management of Material Resources	Systems Analysis
Management of Personnel Resources	Systems Evaluation
Mathematics	Technology Design
Monitoring	Time Management
Negotiation	Troubleshooting
	Writing

Source: O*Net Online.

Note: O*Net Online evaluates the importance of the above 35 skills for each occupation. The skill importance varies between 100 and 0. 100 indicates the skill is most important, and 0 indicates the least.

With the formula described above and the data from O*Net, we compute the bilateral skill distance for occupation pairs at the 2-digit standard occupational classification (SOC) level¹. Annex Table 3 summarizes the occupation pairs with the closest and farthest skill distance².

Annex Table 3. Occupation Pairs with the Closest and Farthest Skill Distance	
Occupation pairs with the closest skill distance	
Information and records processing, except financial	Other administrative support occupations, including clerical
Mathematical, computer and natural scientists	Engineers and architects
Lawyers and judges	Librarians, social scientists, religious workers
Management related occupations	Executives, administrators and managers
Teachers, except college and university	Teachers, college and university
Freight, stock and material handlers	Private household cleaners and servers
Financial records processing occupations	Other administrative support occupations, including clerical
Food service occupations	Office machine operators and mail distributing
Information and records processing, except financial	Secretaries, stenographers, and typists
Sales supervisors and sales reps, finance and business	Lawyers and judges
Occupation pairs with the farthest skill distance	
Librarians, social scientists, religious workers	Machine operators and tenders, not precision
Lawyers and judges	Machine operators and tenders, not precision
Freight, stock and material handlers	Health diagnosing occupations
Machine operators and tenders, not precision	Sales supervisors and sales reps, finance and business
Technicians, except health engineering, and science	Food service occupations
Office machine operators and mail distributing	Engineers and architects
Librarians, social scientists, religious workers	Helpers, construction and production occupations
Machine operators and tenders, not precision	Management related occupations
Freight, stock and material handlers	Teachers, college and university
Fabricators, assemblers and hand working occupations	Librarians, social scientists, religious workers
Source: IMF staff calculations.	

Estimation of Mobility Cost

Our measure of mobility cost between two occupations follows the estimation strategy implemented by Cortes and Gallipoli (2016). The approach is based on a model of occupational choice that delivers a gravity equation linking the labor flows to occupation skill distance and transition costs.

The model implied gravity model is

$$\ln \left(\frac{X_{ij}}{X_{ii}} \right) = \ln T_j + \theta \ln P_j - \ln T_i - \theta \ln P_i - \theta_{ij} \ln d_{ij}$$

¹ The Macao SAR's classification of occupation is at a more aggregated level. It classifies the occupations into 9 big categories. We manually build a concordance between Macao SAR's classification of occupations and the SOC, which allows us to aggregate our results from detailed SOC level to more aggregate broad occupational level defined by Macao SAR.

² Our analysis of skill distance is performed at the 2-digit soc level to line up with the level of aggregation implemented when estimating the occupational labor mobility cost.

Where X_{ij} is the flow of workers from occupation i to j , T_j, T_i, P_j, P_i are occupation-specific characteristics, and d_{ij} is the cost of switch occupation.

The specification of occupation mobility cost is

$$\ln d_{ij} = \beta_1 \ln dist_{ij} + \beta_2 \lambda_{ij}^{NC} + \beta_3 \lambda_{ij}^{RC} + \beta_4 \lambda_{ij}^{RM} + \beta_5 \lambda_{ij}^{NM} + m_j + \epsilon_{ij}$$

Where λ_{ij} are set of dummy variables, equals one if occupation i and j are in different broad task groups and destination occupation is a nonroutine cognitive λ_{ij}^{NC} , routine cognitive λ_{ij}^{RC} , routine manual λ_{ij}^{RM} , and nonroutine manual occupation λ_{ij}^{NM} . m_j is the destination dummy.

Flows of workers across occupations are measured using matched monthly data from the current population survey (CPS). The analysis is at the two-digit SOC level. A finer level of aggregation does not allow us to observe significant flows of workers across some occupation pairs.

The Annex Table 4 puts forward estimates of occupation mobility costs coefficients for a selected number of occupation pairs. The top half of the table lists occupation pairs with the lowest overall mobility costs, whereas the bottom half presents the occupation pairs with the highest mobility costs.

Annex Table 4. Occupation Pairs with the Lowest and Highest Overall Mobility Costs

	Source Occupation	Destination Occupation	Skill Distance Costs	All Costs
Lowest ↑	Management related occupations	Executives, administrators and managers	1.037	2.768
	Information and records processing, except financial	Other administrative support occupations, including clerical	1.021	2.777
	Financial records processing occupations	Other administrative support occupations, including clerical	1.046	2.844
	Secretaries, stenographers, and typists	Other administrative support occupations, including clerical	1.061	2.884
	Librarians, social scientists, religious workers	Executives, administrators and managers	1.081	2.887
	Lawyers and judges	Executives, administrators and managers	1.096	2.926
	Retail and other salespersons	Other administrative support occupations, including clerical	1.097	2.983
	Health assessment and treating occupations	Executives, administrators and managers	1.152	3.075
	Teachers, except college and university	Executives, administrators and managers	1.173	3.131
	Health diagnosing occupations	Executives, administrators and managers	1.176	3.141
↓ Highest	Machine operators and tenders, not precision	Lawyers and judges	2.747	96.289
	Fabricators, assemblers and hand working occupations	Lawyers and judges	2.677	93.826
	Helpers, construction and production occupations	Lawyers and judges	2.669	93.577
	Other precision production occupations	Lawyers and judges	2.622	91.911
	Freight, stock and material handlers	Lawyers and judges	2.552	89.477
	Production inspectors and graders	Lawyers and judges	2.467	86.472
	Transportation and material moving	Lawyers and judges	2.461	86.264
	Construction trades	Lawyers and judges	2.432	85.245
	Private household cleaners and servers	Lawyers and judges	2.350	82.375
	Mechanics and repairers	Lawyers and judges	2.273	79.681

Source: IMF staff calculations.

The mobility cost estimated in the labor flow gravity model is an iceberg cost which reduces the payoff to a worker who switches occupations. For example, the estimated cost of 1.037 associated with the skill costs for move from “Management related occupations” to “Executives, administrators and managers” implies that a movers’ payoff would be 3.7 percent higher if there were no costs associated with the skill content of occupations. Overall, the payoff to a worker moving between these two occupations would be more than 2.7 times higher if all mobility costs were removed. Estimated mobility costs are therefore substantial, even across occupations that see relatively high volumes of labor flows. The move between occupation pairs at the bottom of Annex Table 4 are the most costly. These moves involve a higher skill distance and a transition into occupations with high

skill-independent entry costs (lawyers and judges³). Estimated mobility costs are in fact prohibitively high and we observe essentially very few moves between these occupations.

The mobility costs reflect the efforts that needed to be made to switch occupations. It's a function of the skill distance between the origin and destination occupations and the destination occupation's entry cost. Our analysis will focus on the mobility cost that are due to skill mismatches. $\widehat{\beta}_1 \ln dist_{ij}$ denotes the estimated skill distance-related mobility costs from the structural model.

To evaluate workers' efforts in money units, we estimate the skill distance-related mobility costs in terms of average annual wage as follows

$$Mobility\ Cost_{ij} = W_j \times (\widehat{\beta}_1 \ln dist_{ij} - 1)$$

Where W_j is the destination occupation's annual wage and $(\widehat{\beta}_1 \ln dist_{ij} - 1)$ is the payoff that workers need give up when moving from occupation i to occupation j . Occupational annual wage is taken from DSEC.

To evaluate workers' efforts in education, we estimate the skill distance-related mobility costs in terms of additional training as follows

$$Mobility\ Cost_{ij} = E_j - \frac{E_j}{\widehat{\beta}_1 \ln dist_{ij}}$$

Where E_j is the (extra) year of schooling we observed in the destination occupation j and is calculated by using the education requirement by occupation from DSEC minus the 12 years of compulsory education.

³ Note that Librarians, social scientists, religious workers are the occupation that the least costly to transit to Lawyers and judges.

Annex III. Additional Tables and Figures

Annex Table 5. Detailed Classification of Clerks

43-3099.00	Financial Clerks, All Other
43-4199.00	Information and Record Clerks, All Other
43-5051.00	Postal Service Clerks
43-9061.00	Office Clerks, General Bright Outlook Bright Outlook
23-1012.00	Judicial Law Clerks
41-2021.00	Counter and Rental Clerks
43-3021.00	Billing and Posting Clerks
43-3031.00	Bookkeeping, Accounting, and Auditing Clerks Bright Outlook
43-3051.00	Payroll and Timekeeping Clerks
43-3061.00	Procurement Clerks
43-4011.00	Brokerage Clerks
43-4021.00	Correspondence Clerks
43-4031.00	Court, Municipal, and License Clerks
43-4041.00	Credit Authorizers, Checkers, and Clerks
43-4071.00	File Clerks
43-4081.00	Hotel, Motel, and Resort Desk Clerks Bright Outlook
43-4131.00	Loan Interviewers and Clerks
43-4141.00	New Accounts Clerks
43-4151.00	Order Clerks
43-4171.00	Receptionists and Information Clerks Bright Outlook

Source: O*Net OnLine and Standard Occupational Classification (SOC).

Annex Table 6. Detailed Classification of Financial Clerks

43-3010	Bill and Account Collectors
43-3020	Billing and Posting Clerks
43-3030	Bookkeeping, Accounting, and Auditing Clerks
43-3040	Gambling Cage Workers
43-3050	Payroll and Timekeeping Clerks
43-3060	Procurement Clerks
43-3070	Tellers
43-3090	Miscellaneous Financial Clerks

Source: O*Net OnLine and Standard Occupational Classification (SOC).

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FACTORS CONDUCTIVE FOR DEVELOPMENT OF INTERNATIONAL FINANCIAL CENTERS¹

The Macao SAR government aims to develop a modern financial sector, and some progress has already been made. This chapter evaluates structural factors conducive to the development of financial hubs and studies the experience of the already established financial centers to draw lessons for Macao SAR. The analysis suggests that to further advance Macao SAR's financial sector development, policies should focus on addressing the limited availability of skilled labor, closing the gaps in physical and ICT infrastructure, enhancing the efficiency of public institutions, and improving the business environment.

A. Introduction

1. **Economic diversification is one of the key pillars of the Macao SAR government's economic policy.** The COVID-19 crisis has increased the sense of urgency to diversify the economy's sources of growth, as the dominant gaming sector has been hit hard. The modern financial industry is one of the government's priority areas to develop. The government aims to capitalize on Macao SAR's tight bounds with Portuguese speaking countries (PSC) to occupy the Mainland-PSC niche market.
2. **Macao SAR has made progress in modernizing its financial markets.** In 2018, the Macao SAR's bond market was officially established after three years of preparation. Since then, both the intangible and tangible infrastructure of the bond market has been improved. As of the end of November 2021, the outstanding bond amount adds up to 249.6 billion MOP, equivalent to around US\$31.1 billion, accounting for 15.1 percent of Macao SAR's total foreign assets in banking sector, or 122.1 percent of 2020 GDP.
3. **This chapter looks at structural factors conducive for the development of financial hubs and examines the experience of the already established financial centers to draw lessons for Macao SAR.** The analysis suggests that addressing structural bottlenecks related to the availability of skilled labor, physical and ICT infrastructure, and the efficiency of public institutions, and business environment could further advance the financial sector development. Section B summarizes the recent developments of Macao SAR's bond market, Section C presents the results of the comparative analysis. Section D focuses on the experience of three established international financial centers—Malta, Hong Kong SAR, and Singapore, followed with Section E that discusses some policy considerations.

B. Recent Developments in Macao SAR's Financial Sector

4. **The government made considerable progress in promoting the development of Macao SAR's bond market.** Macao SAR's first bond exchange platform, MOX, was established in 2018. MOX offers services of bond issuance, listing, registration, custody, trading, and settlement. As of

¹ Prepared by Caroline Chenqi Zhou.

the end of November 2021, 86 bonds have been listed² in MOX, with the total listed bond amounting to US\$31 billion 121 percent of 2020 GDP. State owned banks and local governments from the Mainland are the key issuers in the bond market. Despite capital controls in the Mainland, Chinese firms are allowed to borrow foreign currencies from offshore markets to manage currency risk. In this regard, Macao SAR's multi-currency financial market with no restrictions on capital flows is attractive for companies from the Mainland. More than 70 percent of the total listed in MOX is in USD, which probably reflects tighter regulations faced by Chinese firms in the US capital markets amid US-China financial decoupling. The amount of bonds listed by financial corporates are largest, followed by firms engaged in real estate sectors and tourism industry.

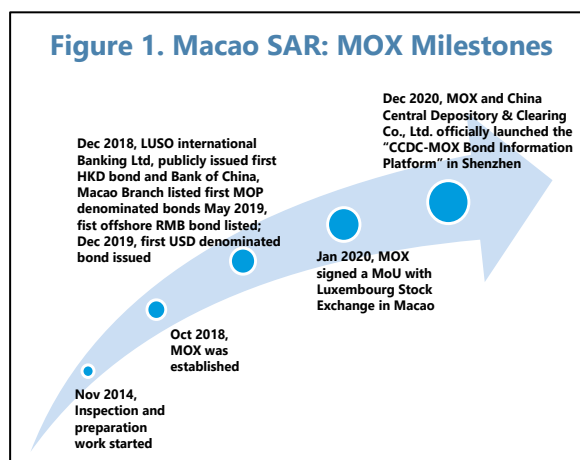


Table 1. Macao SAR: Bond Market (MOX) Listed Bonds

	Listed amount (Billion USD)	Share of total (Percent)	Listed bonds (Number)
Adjusted geographic distribution 1/			
Mainland	14.2	45.6	46
Hong Kong SAR with headquarter in Mainland	5.6	17.9	14
Others with headquarter in Mainland 2/	3.8	12.2	9
Macao SAR with headquarter in Mainland	1.4	4.5	6
Cayman Islands	2.3	7.4	2
Hong Kong SAR	1.8	5.8	3
British Virgin Islands	1.0	3.4	4
Macao SAR	1.0	3.2	2
Currency distribution			
USD	22.2	71.0	52
RMB	4.8	15.4	20
EUR	1.6	5.1	3
HKD	1.3	4.1	4
MOP	1.2	3.8	6
GBP	0.2	0.6	1
Industrial distribution			
Financial sector 3/	18.9	60.6	51
Real estate and construction 4/	5.4	17.2	20
Hotels, Restaurants and Leisure 5/	4.3	13.9	6
Others 6/	2.6	8.3	9

Sources: Chongwa (Macao) Financial Asset Exchange Co., Ltd. (MOX), S&P Capital IQ, and IMF staff calculations.

Notes: 1/ Geographic information is adjusted by their parent companies location.

2/ Others with headquarter in Mainland include Singapore, London, Luxembourg and British Virgin Islands.

3/ Financial sector includes banks, asset management, capital markets, and other financial services.

4/ Real estate includes real estate development and construction and engineering.

5/ Hotels, Restaurants and Leisure includes casinos and gaming.

6/ Others include Utilities industry, Pharmaceuticals, public sector, and unclassified.

C. Comparative Analysis

5. This section aims to compare Macao SAR's performance on structural factors conducive to the development of financial hubs with OECD countries, Hong Kong SAR, and Singapore. The literature suggests an array of factors affecting developments of global financial

² Out of the 86 listed bonds, 13 bonds were issued and listed in MOX whereas the remaining 73 bonds were only listed, but not issued in MOX.

centers (GFCs). These factors can be combined into five categories: (i) availability of skilled labor, (ii) quality of infrastructure, (iii) reputability of a jurisdiction (iv) business environment, and (v) measure of financial development (Tey, 2004; Vo and Nguyen, 2021; Annex I). In line with the literature, Annex II presents correlations between the importance of financial centers rated by the Global Financial Centers Index (GFCI, Z/yen Group, 2021) and structural factors conducive to the development of financial hubs. Hong Kong SAR, Singapore, and the tenth and ninetieth percentiles of the OECD countries are used as benchmarks. Key sources for structural indicators include the Worldwide Governance Indicators, D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017, World Bank's World Development Indicators, International Labor Organization, United Nations' ICT infrastructure, Numbeo, Economic Freedom Heritage Foundation, and Economist Intelligence Unit. Given that some of these indicators are perception based constructed using survey results, it is worth noting that point estimates of these indicators are surrounded by considerable uncertainty, and they reflect relative, not absolute, performance of economies. In line with the IMF Board paper on the "Use of Third-Party Indicators (TPIs) in Fund Reports" Annex III describes the indicators used and their sources.³

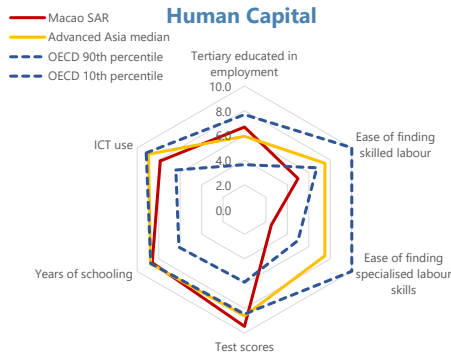
6. Comparative analysis suggests Macao SAR has room to improve the economy's structural characteristics to advance the development of financial hubs (Figure 2).

- **Human Capital:** Macao SAR's labor force has a relatively high share of tertiary educated people compared with OECD countries. However, finding skilled labor, particularly with specialized skills is a challenge for Macao SAR (see Chapter 1).
- **Physical and ICT Infrastructure:** Compared to OECD countries, Macao SAR has considerable room to improve physical and ICT infrastructure. The level of cyber security preparedness is high.
- **Reputation:** Macao SAR performs well in terms of safety and human development. Still, its standings regarding governance, the rule of law, quality of healthcare, pollutions, and housing affordability has room to improve compared with OECD countries.
- **Business Environment:** Many aspects of the business environment can be further enhanced in Macao SAR, particularly business and labor market regulations as well as financial sector regulation.
- **Financial Sector Development:** Despite a healthy banking system, Macao SAR lags behind OECD countries in the local bond market capitalization, market access, and provision of non-life insurance services.

³ Many of these indicators are perception based constructed using survey results and thus more subjective than other economic indicators.

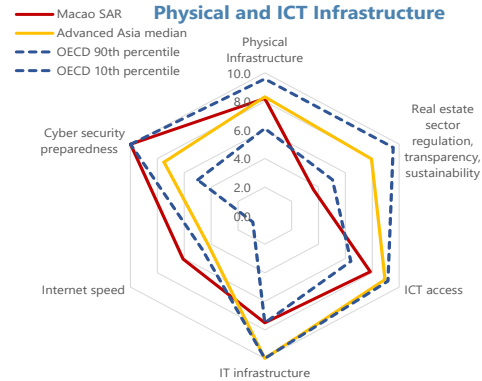
Figure 2. Macao SAR: Factors Conducive for Development of Financial Centers

Macao SAR has a high share of tertiary educated people in the labor force but finding skilled labor is challenging.



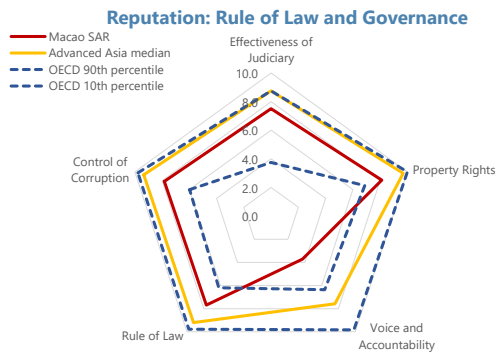
Sources: International Labor Organization (ILO), United Nations (UN)-ICT Development Index, World Bank "Human Capital Index 2020", Economist Intelligence Unit (EIU)-Risk Briefing Database, and IMF staff calculations. Notes: Some of these indicators are perception based constructed using survey results, and their point estimates are surrounded by considerable uncertainty.

Macao SAR enjoys good cyber security preparedness but can improve infrastructure, including ICT.



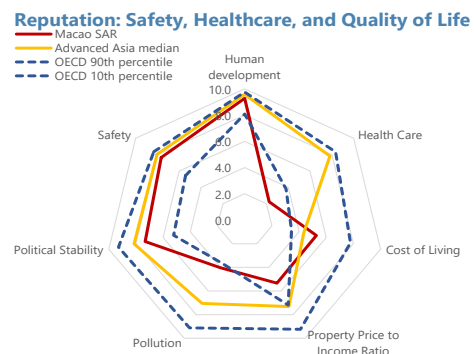
Sources: EIU, Worldwide Broadband Speed League, UN-ITU ICT Development Index, and IMF staff calculations. Notes: Some of these indicators are perception based constructed using survey results, and their point estimates are surrounded by considerable uncertainty.

There is room to enhance governance and rule of law....



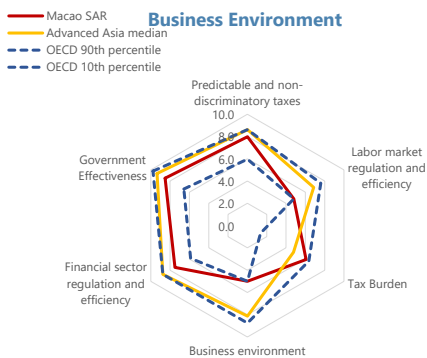
Sources: EIU; World Governance Indicators (WGI), D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017; and IMF staff calculations. Notes: Some of these indicators are perception based constructed using survey results. The confidence band around point estimates for control of corruption is (6.6; 8.5), rule of law is (6.9; 8.4), and voice and accountability is (2.8; 5.2).

...as well as improve healthcare and housing affordability.



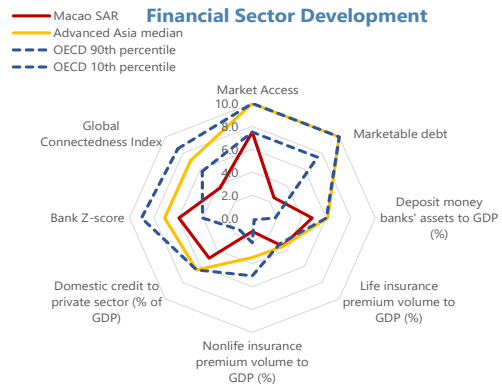
Sources: Mandelej; Numbeo; EIU; and IMF staff calculations. Notes: Some of these indicators are perception based constructed using survey results, and their point estimates are surrounded by considerable uncertainty.

Business and labor regulations are onerous compared with peers.



Sources: EIU; World Governance Indicators (WGI), D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017; and IMF staff calculations. Notes: Some of these indicators are perception based constructed using survey results. The confidence band around the point estimate for government effectiveness is (7.9; 9.5).

Availability of marketable debt and market access is limited in Macao SAR compared with peers.



Sources: EIU, DHL-Global Connectedness Index, World Bank Global Financial Development Database, and IMF staff calculations. Notes: Some of these indicators are perception based constructed using survey results, and their point estimates are surrounded by considerable uncertainty.

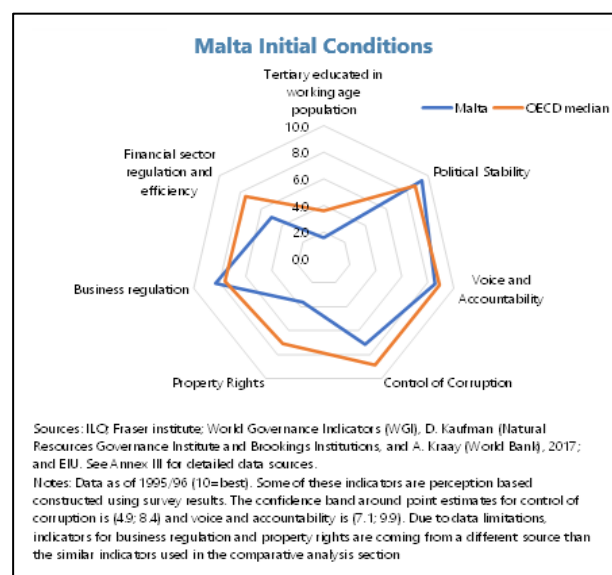
Notes: Scores are normalized from 0 to 10, with 0 being the worst, and 10 being the best. Advanced Asian economies include Australia, Hong Kong SAR, Japan, South Korea, New Zealand, and Singapore. See Selected Issues Paper, chapter II for detailed description of indicators and data sources.

D. Case Studies

7. To distill policy lessons for Macao SAR, the experience of already established financial centers is studied. Specifically, this section examines the experience of Malta, Hong Kong SAR, and Singapore, which are identified as global financial centers by several indices. For each case study, we look at the initial conditions of some structural characteristics, the policies to facilitate the development of its financial sector, and the results of these policies.

Malta

8. Initial conditions. Malta started to develop its financial center in the late 1980s. At the time, Malta was already a high-income country, with solid tourism inflows and high living standards. In terms of financial depth, in 1988 domestic bank deposits accounted for 30 percent of GDP and private credit accounted for 23 percent of GDP⁴. Regarding structural factors conducive to the development of financial centers, Malta's initial conditions compared with the OECD median were not particularly favorable. Political stability and business regulation were areas in which Malta scored better than the OECD average. However, Malta lagged the OECD median regarding the share of tertiary educated labor force, financial regulation, property rights, and control of corruption (text chart).



9. Implemented policies. During 1990s Malta implemented multi-dimensional reforms.

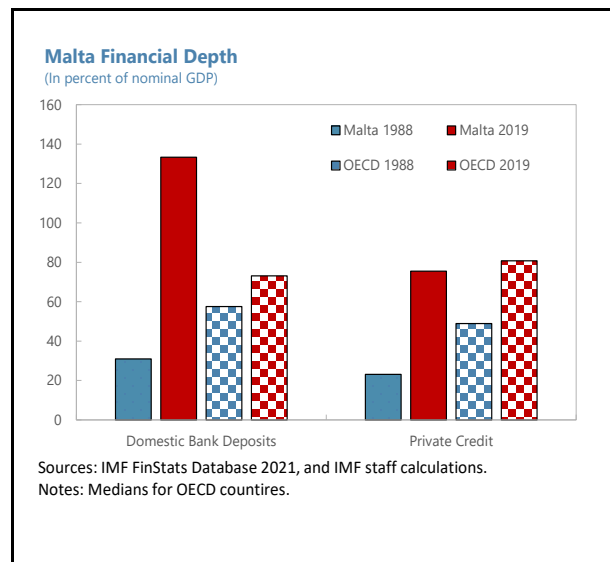
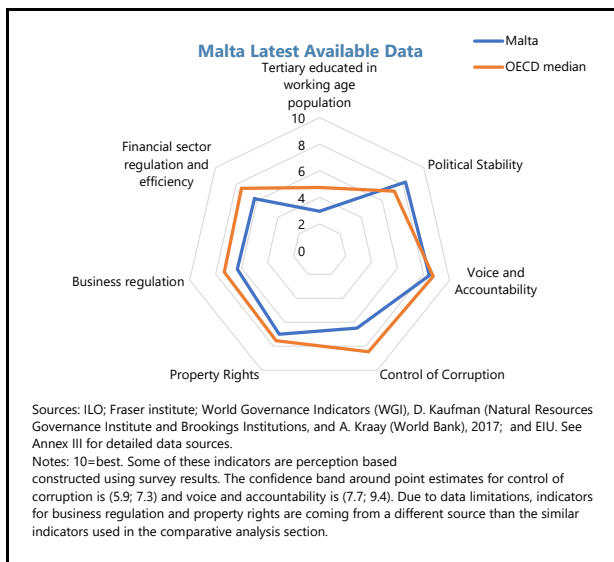
- **Reputable legal framework and robust supervision:** There have been a number of important changes in Malta's banking environment in the early 1990s with a view to foster a more market-oriented financial system. These changes included an overhaul of the banking legislation to align with the European Union (EU) and the Bank of International Settlement (BIS) practices, the expansion of the stock market, and the deregulation of interest rates. As a result, the distinction between offshore and onshore financial activities was abolished to limit illicit and money-laundering activities. The Malta International Business Authority (MIBA) received the responsibility of complete supervision in the fields of banking, insurance, investment services and other financial services (Fabri et al, 1999).
- **Human capital:** Malta's government initiated several reforms of the education system during the 1990s and early 2000s. In 1989, the first National Minimum Curriculum was created, which spelled out the objectives of compulsory education. There was a significant push to promote decentralization in the education system to increase the effectiveness of schools to meet the needs of the Maltese population (Cutajar, 2007). The decentralization process of the education

⁴ Measures for financial depth are calculated by IMF staff using data from IMF FinStats Database 2021.

system entailed increased collaboration between all stakeholders, such as educators, researchers, and policy makers. After joining the EU in 2004, Malta’s labor market was opened to the free movement of all EU citizens for employment purposes, allowing firms in Malta to access the EU’s large pool of skilled labor (National Employment Policy, 2014).

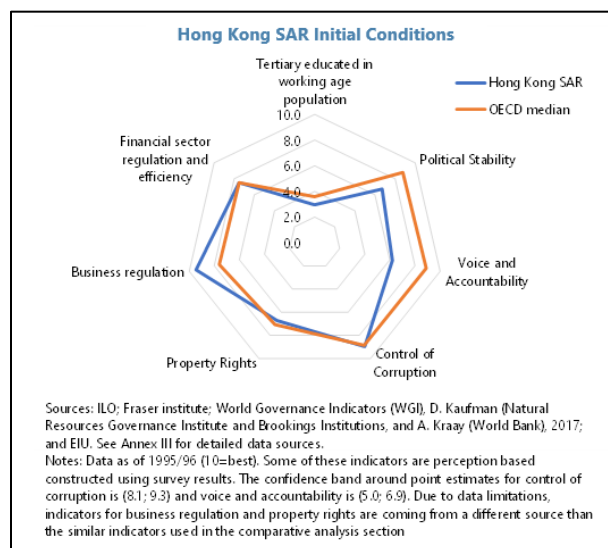
- Business environment:** A broad program of structural reforms was initiated during the 1990s, which removed many trade barriers, deregulated prices, and privatized state assets. In addition, Malta’s Competition Act, in compliance with EU norms, came into force in 1995 (IMF, 1999). Since joining the EU in 2004 and the Euro Area in 2008, Malta has been granted EU passporting rights of financial institutions, which has attracted international businesses, including in finance (IMF Malta FSAP, 2019).

10. Results. The latest data on structural factors conducive to the development of financial hubs suggest that in some areas Malta narrowed its initial gaps with the OECD median (text chart). Malta’s financial sector grew considerably. Relative to the late 1980s, domestic bank deposits relative to GDP increased more than 4 times, while private credit to GDP grew 3-fold, outperforming the increase observed for the OECD median in both areas (text chart).



Hong Kong SAR

11. Initial conditions. In the 1970s and 1980s, Hong Kong SAR was already acting as a commercial, manufacturing, and shipping center in East Asia, with four stock exchanges in operation, strong goods exports, free of capital control, and stable external value of the Hong Kong dollar (Jao, 1979). Supported by its central location in Asia, ideal time-zone position, and flexible labor force, Hong Kong SAR played an important role in trade between Atlantic and Pacific countries, which generated a significant demand for trade-facilitating financial services (Jao, 1979). In the early 1990s, Hong Kong SAR's domestic bank deposits and private credit accounted for 160.3 percent and 149.4 percent of GDP respectively⁵. In the early 1990s, Hong Kong SAR outperformed the OECD median with regard to business regulation, while scoring less favorably on the share of tertiary educated labor force, political stability, and voice and accountability (text chart).



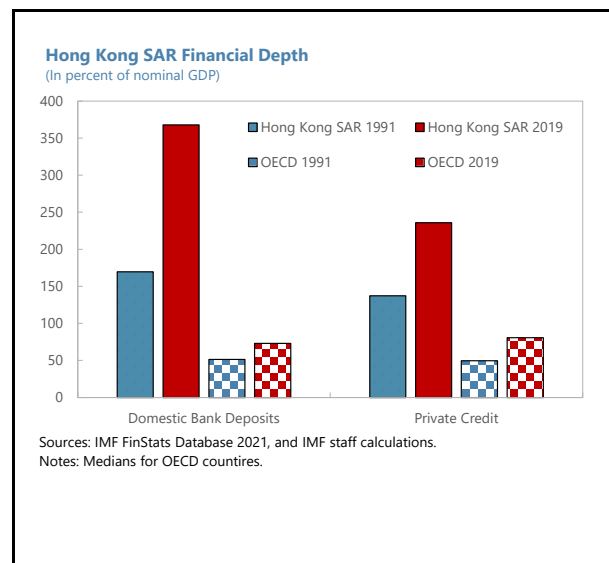
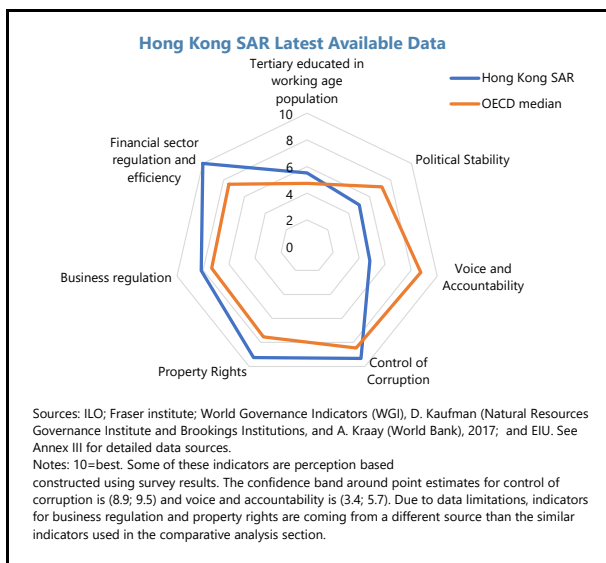
12. Implemented policies. The Hong Kong SAR government aimed to provide a stable framework for the development of Hong Kong SAR to a financial center, while investing in housing, education, and social welfare.

- **Financial regulation:** In 1978, the Hong Kong SAR government began opening the domestic banking market to foreign banks that met certain regulatory and capital criteria, allowing them to conduct all banking business, including retail and wholesale (Jao, 1979). In the late 1980s and early 1990s, the government reformed the banking regulation and supervisory system aligning it with the highest international standards and best practices (Chan, 1998). Hong Kong SAR has maintained the high quality of financial regulation and supervisory framework and established a strong financial sector safety net ([IMF Country Report No. 21/102](#)).
- **Special bilateral financial linkage with Mainland:** In 1978, Mainland China's financial opening-up reforms greatly increased foreign loans and investment from Hong Kong SAR, with ultimately around half of Hong Kong's FDI flows going to Mainland China (Leung and Unterobderdoerster, 2008). Various "connect schemes" have been established to facilitate cross-border transactions and provide mutual market access between Hong Kong SAR and Mainland China, allowing Hong Kong SAR to play an important role as a financial gateway for the Mainland (IMF Hong Kong SAR Article IV consultation, 2022).

⁵ Measures for financial depth are calculated by IMF staff using data from IMF FinStats Database 2021.

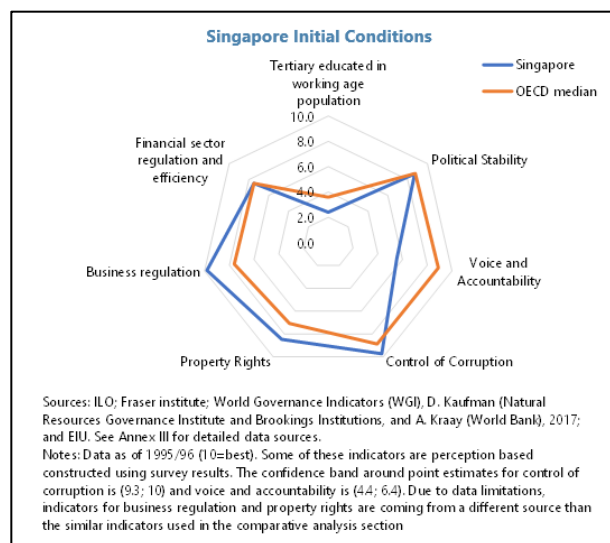
- Infrastructure:** Starting 1950s, the Hong Kong SAR government launched ambitious public housing, land reclamation, and infrastructure investment (Jao, 1979). In 1973, Hong Kong SAR's Housing Authority was established to lead the development of public housing. In the mid-1980s, more than three million people or some 57 percent of the population were accommodated in heavily subsidized public housing estates (Jao, 1979). These public housing investments helped contain the increase in the cost of living that would have threatened Hong Kong SAR's labor-cost advantage. Hong Kong SAR also made considerable investments in financial market infrastructure. It hosts the largest foreign exchange and over-the-counter (OTC) interest derivatives market in Asia.
- Human capital:** Since the 1970s, the Hong Kong SAR government increased public spending on education. In the 1970s, Hong Kong SAR started to provide free universal primary school and expand secondary school provision. And from 1978, the government made education for all children up to the age of 15 compulsory and free (Schenk, 2008). Furthermore, the absence of restrictions on the employment of foreign workers allowed substantial recruitment of foreign specialists, further diversifying the talent pool in Hong Kong SAR (Jao, 1979). More recently, the Hong Kong SAR authorities stepped up efforts to cultivate local talents in fintech and green finance.

13. Results: Building on its initial strength, the implemented policies improved Hong Kong SAR's standing compared with the OECD median in structural categories such as financial sector regulation, the share of tertiary educated in the labor force, property rights, and control of corruption (text chart). Hong Kong SAR's Financial System Stability Assessment highlights the importance of the rule of law, transparent and efficient institutions, high-quality professional services, and strong financial regulatory and supervisory frameworks in maintaining Hong Kong SAR's competitiveness as an international financial center ([IMF Country Report No. 21/102](#)). Hong Kong SAR's domestic bank deposits and private credit almost doubled to 367.8 percent and 235.7 percent of GDP in 2019 compared with the early 1990s, considerably exceeding the pace of financial deepening observed for OECD median (text chart).



Singapore

14. Initial conditions: In the 1970s, Singapore was a labor-intensive commercial center highly relying on foreign capital and with a financial system based on currency board prior to June 1973. During 1970s and 1980s, around 20 percent of its GDP was from financial and business services. In terms of the financial depth in 1980, domestic bank deposits accounted for 50 percent of GDP and private credit accounted for around 70 percent of GDP⁶. In the early 1990s, Singapore ranked better than the OECD median in business regulation, property rights, and control of corruption (text chart). However, Singapore's scores were less favorable in terms of the share of tertiary educated labor force and voice and accountability.



15. Implemented policies

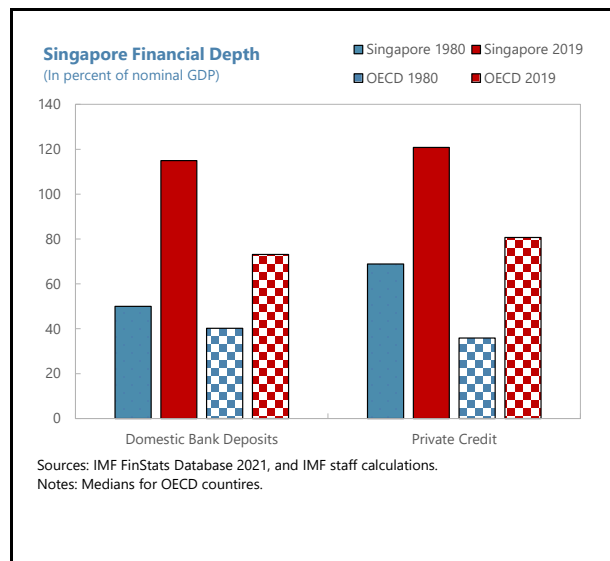
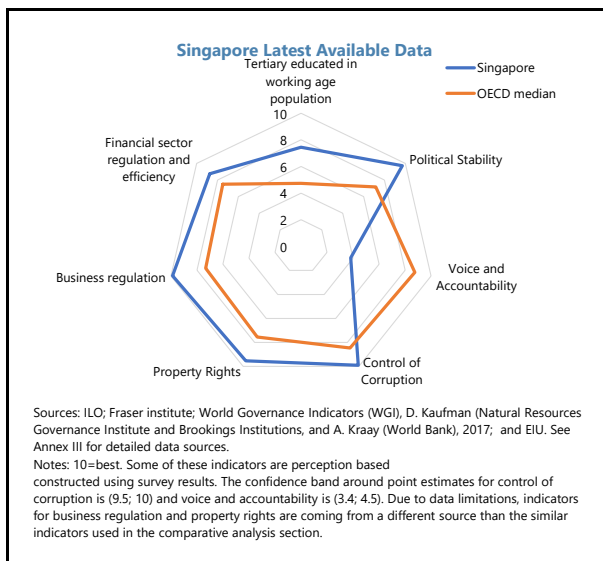
- Targeting niche market:** In 1968, the Singapore government identified a gap in global trading hours, leading to the establishment of an Asian dollar market (ADM), which filled the trading hours between the close of American markets and the opening of European markets on the following day (Woo, 2017). The 1985 Economic Committee, which was convened to examine longer term challenges and prospects for the Singapore economy, further identified risk management, fund management, capital markets, reinsurance, and financial and commodity derivatives as areas of growth for Singapore's financial services industry. Significant policy incentives toward the targeted new industries were deployed, leading to a rapid development of its financial sector (Woo, 2017, Lessard 1994). They have continued to explore new markets including wealth management, financial and commodity derivatives, and fintech ([IMF Country Report No. 19/224](#))
- Robust legal and supervisory framework:** In the late 1990s, Singapore launched a series of reforms to liberalize the financial sector and strengthen the effectiveness of the regulatory and supervisory frameworks (Monetary Authority of Singapore, 2021). The Monetary Authority of Singapore (MAS) continued its efforts strengthening the regulatory environment and establishing a sophisticated framework for financial oversight focused on resilience, innovation, and credibility ([IMF Country Report No. 19/224](#)).
- Effective public institutions and business environment:** Long-range policy planning and cooperation between stakeholders improved regulatory predictability. Singapore policy-planning committees, comprising of policymakers, industry actors, and academic experts,

⁶ Measures for financial depth are calculated by IMF staff using data from IMF FinStats Database 2021.

created a dense network of ‘policy relations’ between state and non-state actors and contributed to greater regulatory compliance (Woo, 2017). This allowed policymakers to incorporate feedback received from industry partners and re-design their regulations to minimize costs arising from overly onerous regulations while at the same time, ensuring overall systemic stability (Woo, 2017).

- Human capital:** Singapore’s Government launched multiple labor policies targeting skill development. The Skills Development Fund (SDF) was formed in 1979, financed by a levy on employers, to upgrade the skills of employees by providing financial assistance for on-the-job training (Bercuson, 1995). Various schemes targeting the development of financial sector skills and expertise followed, including the Financial Sector Talent Development scheme, Financial Training Scheme, Institute of Banking and Finance Standards Training Scheme, and Financial Scholarship Program (Bercuson, 1995). In addition, the Singapore government maintained a favorable treatment of skilled foreign workers (Bercuson, 1995). In recent years, the Infocomm Media Development Authority (IMDA) and the MAS, together with the Skills Future Singapore, six local universities, and five financial associations launched the Tech Skills Accelerator Fintech Collective to strengthen Singapore’s fintech talent pool (Monetary Authority of Singapore 2017).
- Infrastructure:** Capital expenditure rose steadily relative to GDP during the 1970s and 1980s, focusing on infrastructure and public housing development (Bercuson, 1995).

16. Results. The implemented policies helped Singapore surpass the OECD median along many areas of structural indicators (text chart). Domestic bank deposits relative to GDP more than doubled in 2019 compared with 1980, while the private credit to GDP ratio increased by about 55 percentage points during the same period (text chart). The pace of the financial deepening in Singapore was much faster than the OECD median.



E. Policies to Facilitate Development of Financial Hub in Macao SAR

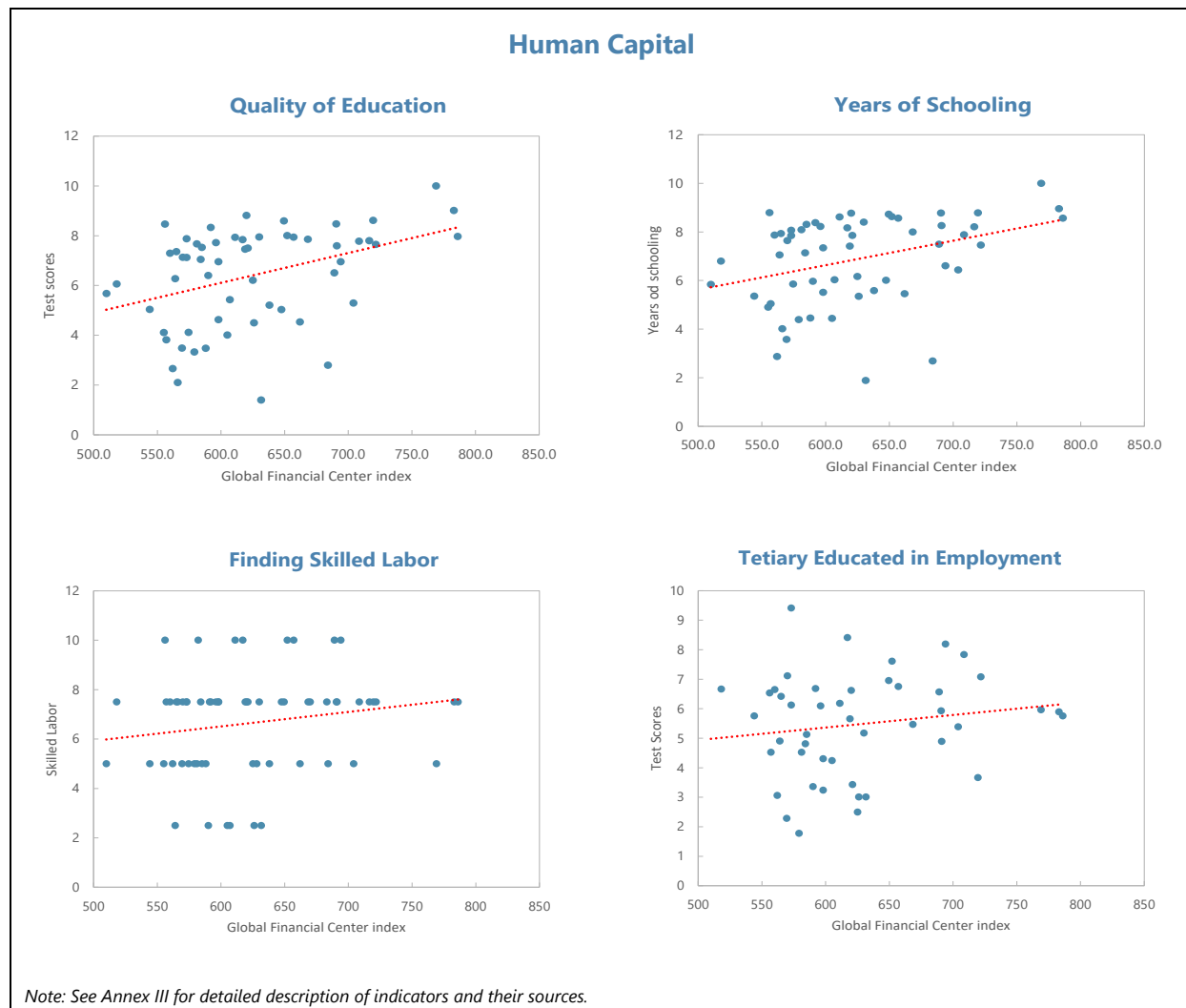
17. This section draws on comparative analysis and case studies to highlight areas where government policy can play a role in facilitating development of Macao SAR's financial sector.

- **Skill building:** Investing in education and training to facilitate the acquisition of skills as well as strengthening science-business linkages would improve the skillset of the domestic labor force (Chapter I). Attracting foreign talents, especially those with financial expertise and skills, could complement domestic labor force.
- **Physical and ICT Infrastructure:** Closing infrastructure gap vis-a-vis OECD countries, including for digital infrastructure, would allow Macao SAR to access skilled labor from remote locations. Boosting the supply of public housing and reforming regulatory frameworks to increase housing supply by the private sector will help with housing affordability.
- **Effective public institutions and business environment:** Increasing regulatory predictability, raising the effectiveness of the judiciary, and strengthening the protection of property rights as well as streamlining labor and business regulations will increase Macao SAR's attractiveness to foreign investors and facilitate resource reallocation toward expanding sectors.
- **Financial supervision:** It is important to balance the government's efforts in promoting financial sector development with the need to preserve financial stability and integrity. The regulatory and supervisory framework should be strengthened to manage potential risks from the expanding financial sector. Expansion of the financial services sector will also require measures to identify and mitigate ML/TF risks, particularly risks associated with offshore activities.

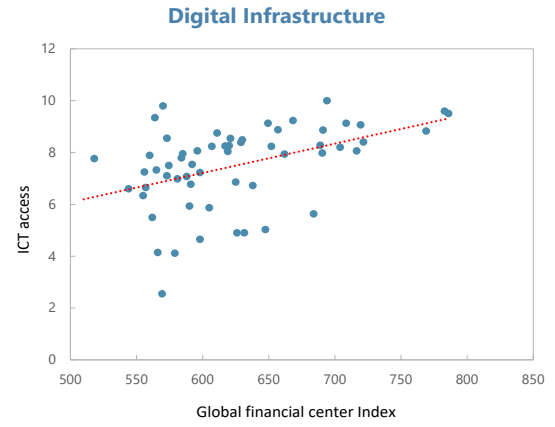
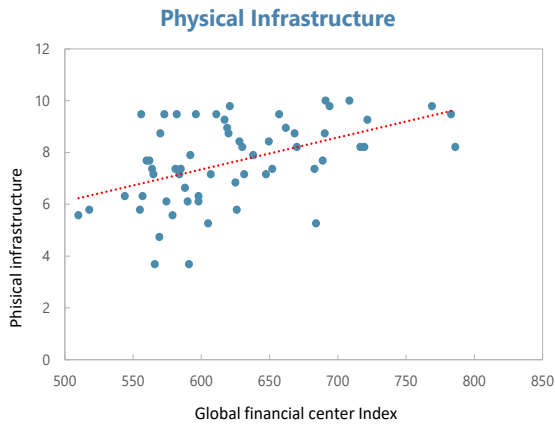
Annex I. Literature Review

Kayral and Karan (2012) show empirically that skilled labor correlates positively with the importance of major financial centers. Moreover, their findings indicate that the quality of the legal system and property rights are the most influential factors for attractiveness of financial centers. Other researchers stress high living standards and trade liberalization are crucial to attract foreign financial inflows (Cheung and Yeung, 2007). Living standards tend to be positively correlated with the level and quality of infrastructure, which, in turn, is a success factor for financial centers (Leyshon, 1995, 1997). Cheung and Yeung (2007) consider the business environment a catalyst for attracting multinational corporations and foreign direct investments.

Annex II. Figures on Correlation Between Factors Conducive for Development of GFC and GFCI

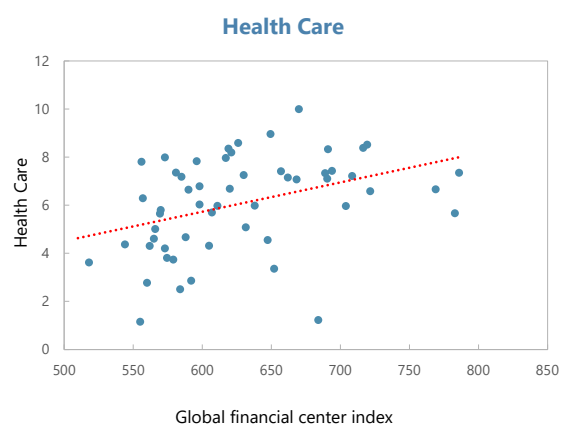
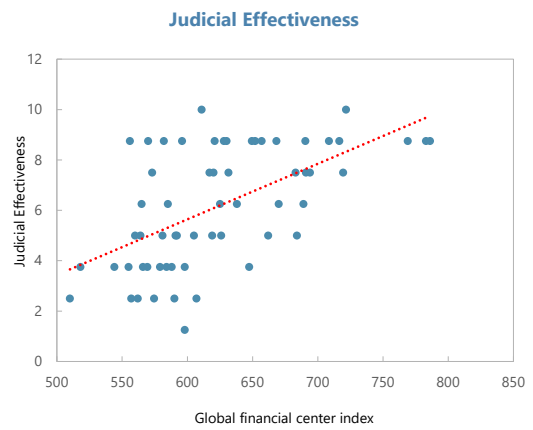
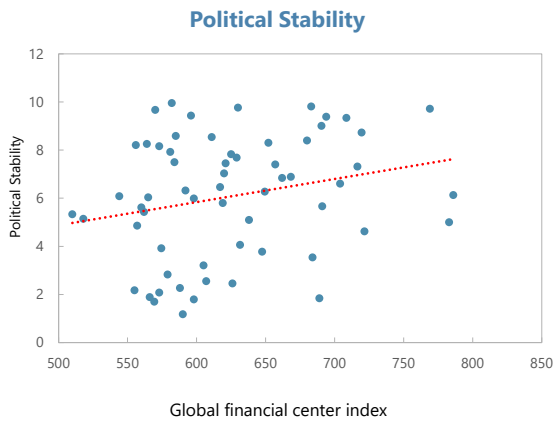


Infrastructure



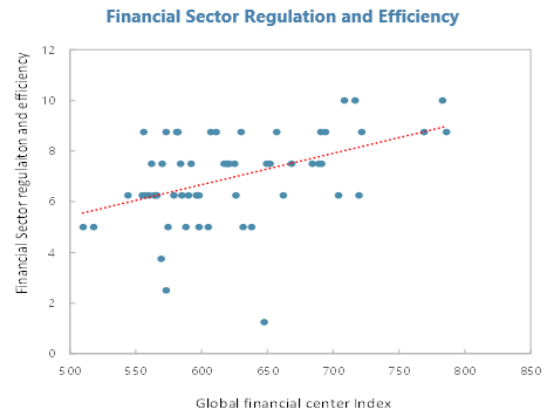
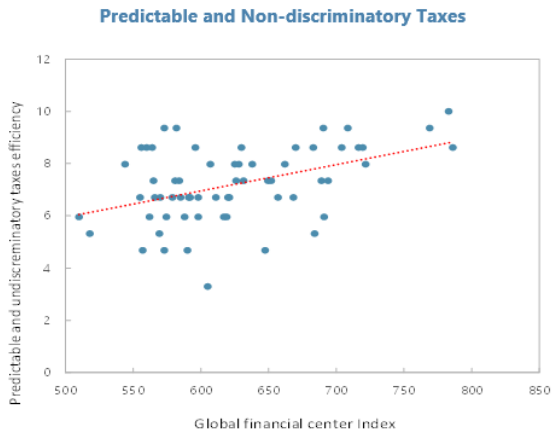
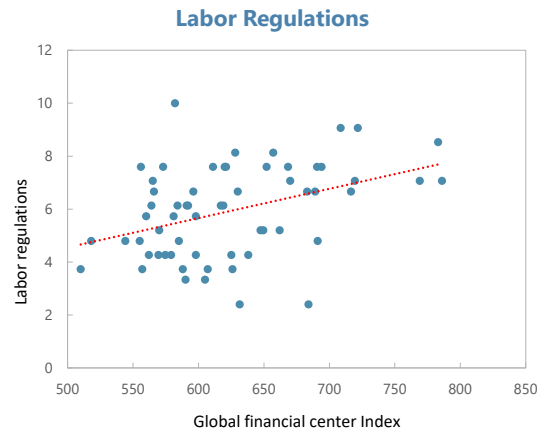
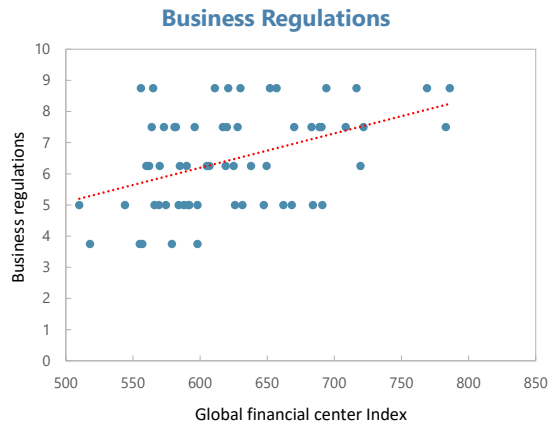
Note: See Annex III for detailed description of indicators and their sources.

Reputation



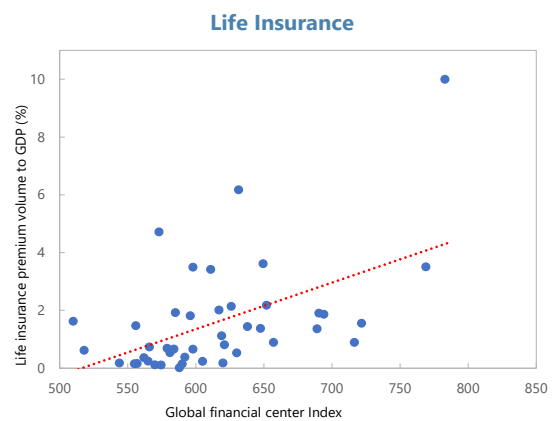
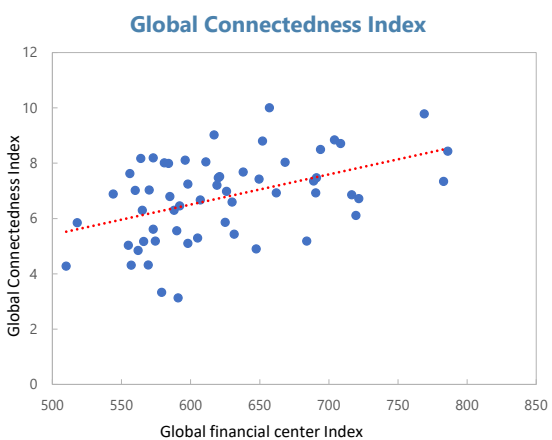
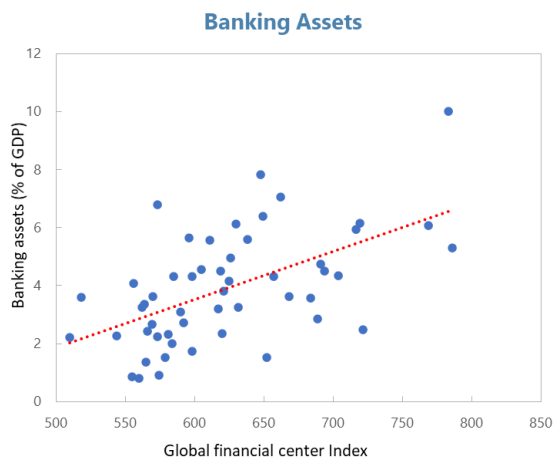
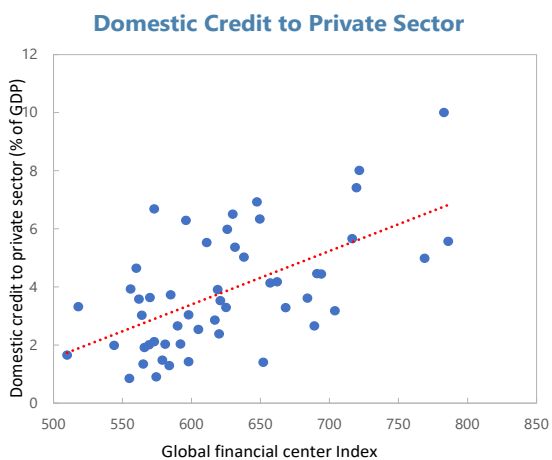
Note: See Annex III for detailed description of indicators and their sources.

Business Environment



Note: See Annex III for detailed description of indicators and their sources.

Financial Development



Note: See Annex III for detailed description of indicators and their sources.

Annex III. Indicators and Sources

Indicator	Source	Notes	Link
Global financial centers index (GFCI) 30	Z/Yen Group and China Development Institute	Competitiveness and rankings for the major financial centers around the world	https://www.zyen.com/publications/public-reports/globalfinancial-centres-index-30/
1. Human Capital			
Tertiary educated in employment	International Labor Organization	Share of people who received advanced educational degrees to total labor force. Advanced educational degrees include bachelor's, master's, and doctor's degrees and equivalent.	
ICT use	United Nations-ICT Development index	Average of percentage of individuals using the internet, fixed-broadband subscriptions per 100 inhabitants, active mobile-broadband subscriptions per 100 inhabitants	https://www.itu.int/net4/ITU-D/di/2017/index.html
Years of schooling	World Bank - "The Human Capital Index 2020"	Learning-Adjusted Years of School are calculated by multiplying the estimates of expected years of school by the ratio of most recent harmonized test scores to 625, where 625 corresponds to advanced attainment on the TIMSS (Trends in International Mathematics and Science Study) test, based on methodology in Filmer et al. (2018). Expected Years of School is calculated as the sum of age-specific enrollment rates between ages 4 and 17. Age-specific enrollment rates are approximated using school enrollment rates at different levels: pre-primary enrollment rates approximate the age-specific enrolment rates for 4- and 5-year-olds; the primary rate approximates for 6–11-year-olds; the lower-secondary rate approximates for 12–14-year-olds; and the upper-secondary approximates for 15–17-year-olds.	https://www.worldbank.org/en/publication/human-capital
Test scores	World Bank - "The Human Capital Index 2020"	Test scores across major international student achievement testing programs measured in TIMSS-equivalent units. Most recent estimates as of 2019 are used.	https://www.worldbank.org/en/publication/human-capital
Ease of finding specialized labor skills	Economist Intelligence Unit-Risk Briefing Database	The index answers the following question. What is the risk that finding specialized labor skills will be a problem?	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Ease of finding skilled labors	Economist Intelligence Unit-Risk Briefing Database	The index answers the following question. What is the risk that finding skilled labor will be a problem?	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
2. Infrastructure			
Physical infrastructure	Economist Intelligence Unit-Risk Briefing Database	The index covers overall physical infrastructure that covers port facilities, air transport, the retail and wholesale distribution networks, the telephone network and the ground transport network, power and etc.	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts

Indicator	Source	Notes	Link
Cyber security preparedness	Economist Intelligence Unit-Risk Briefing Database	The index assesses the risk that the country is not able to withstand cyber-attacks.	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Internet speed	Worldwide Broadband Speed League	Mean download speed (Mbps) from a global league table of internet network speeds derived from over 1.1 billion speed tests taken in the 12 months up to June 30, 2021, and spanning 224 countries.	https://www.cable.co.uk/broadband/speed/worldwide-speed-league/
IT infrastructure	Economist Intelligence Unit-Risk Briefing Database	The index assesses the risks that information technology infrastructure that will prove inadequate to business needs	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
ICT access	United Nations-ITU ICT Development index	Average of fixed-telephone subscriptions per 100 inhabitants, Mobile-cellular telephone subscription per 100 inhabitants, international internet bandwidth (bit/s) per internet user, percentage of households with a computer, percentage of households with internet access.	https://www.itu.int/net4/ITU-D/idi/2017/index.html
Real estate sector regulation, transparency sustainability	JLL	The 2020 Global Real Estate Transparency Index covers 99 countries and territories and 163 cities. The latest Index is based on 210 indicators, having been extended to include additional data on sustainability and resilience, health and wellness, properties and alternatives. These variables are divided into six areas - performance measurement, market fundamentals, governance of listed vehicles, regulatory & legal frameworks, transaction process and environmental sustainability.	https://www.jll.co.uk/en/trends-and-insights/research/global-real-estate-transparency-index#global-rankings
3. Reputation (Rule of Law)			
Property rights	Economist Intelligence Unit-Risk Briefing Database	This indicator is an average of indices that assess (i) risk that contract rights will not be enforced, (ii) the risk of expropriation of foreign assets, (iii) the risks of protection of intellectual property in the two-year forecast period, and (iv) the degree to which private property rights are guaranteed and protected.	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Property rights	Fraser institute, Economic-freedom-of-the-world-2021	Protection of property rights is from World Economic Forum Survey, also used in the Global Competitiveness Report. Survey question: "Property rights, including over financial assets, are poorly defined and not protected by law (= 1) or are clearly defined and well protected by law (= 7)". This replaces a previous question from the Global Competitiveness Report on protection of intellectual property.	fraserinstitute.org/economic-freedom
Control of corruption	Worldwide Governance Indicators, D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017	Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	https://info.worldbank.org/governance/wgi/Home/Documents

Indicator	Source	Notes	Link
Rule of law	Worldwide Governance Indicators, D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017	Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, and the likelihood of crime and violence. It is constructed from surveys of firms and individuals, and from assessments by commercial risk rating agencies, nongovernmental agencies, multilateral aid agencies, and other public sector organizations.	https://info.worldbank.org/governance/wgi/Home/Documents
Voice and accountability	Worldwide Governance Indicators, D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017	Voice and accountability capture perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	https://info.worldbank.org/governance/wgi/Home/Documents
Effectiveness of Judiciary	Economist Intelligence Unit-Risk Briefing Database	This indicator is an average of indices that assess (i) the extent to which the legal process/the courts can be interfered with or distorted to serve particular interests, and (ii) to what extent is the judicial process speedy and efficient.	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
4. Reputation (Living Standard)			
Human development	Mandelely Quality of nationality index	Human Development is measured using the United Nations Development Programme Human Development Index which includes three dimensions of human development: health, education and standard of living.	https://data.mendeley.com/datasets/53zr7cfyrs/1
Safety	Numbeo Crime Index	Numbeo crime index surveys the following questions: How serious you feel the level of crime is Change of crime level in the past three years; Feeling of safety walking during daylight; Feeling of safety walking during night; How worried are you of being mugged or robbed; Worries of having a car stolen (or things from the car); Worries of being physically attacked by strangers; Worries of being insulted or pestered by anybody, while in the street or any other public place; Worries of being subject to a physical attack because of your skin color, ethnic origin, gender or religion; Problem of people using and dealing drugs; How much is the problem property crimes? How much is the problem violent crimes?	https://www.numbeo.com/crime/
Political stability	EIU-Political stability Risk; Worldwide Governance Indicators, D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017- Political Stability	This category addresses the degree to which political institutions are sufficiently stable to support the needs of businesses and investors. It covers the following issues: What is the risk of significant social unrest during the next two years? How clear, established, and accepted are constitutional mechanisms for the orderly transfer of power from one government to another? How likely is it that an opposition party or group will come to power and cause a significant deterioration in business operating conditions? Is excessive power concentrated, or likely to be concentrated, in the executive, so that executive authority lacks accountability and possesses excessive discretion? Is there a risk that international disputes/tensions will negatively affect the economy and/or polity?	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts

Indicator	Source	Notes	Link
Pollution	Numbeo Pollution	Numbeo pollution surveys the following about pollution in the cities: Satisfaction with air quality Quality and accessibility of drinking water Water pollution (general); Satisfaction with garbage disposal; Does people find the city clean and tidy; Noise pollution and light during the night in the city; Green and parks in the city Feeling of being comfortable to spend time in the city because of the pollution.	https://www.numbeo.com/pollution/
Property price to income ratio	Numbeo	Numbeo property price to income ratio is the basic measure for apartment purchase affordability (lower is better). It is generally calculated as the ratio of median apartment prices to median familial disposable income, expressed as years of income (although variations are used also elsewhere).	https://www.numbeo.com/property-investment/indicators_explained.jsp
Cost of living	Numbeo Cost of living Index	Cost of living index measures living expenses related to rent and housing, groceries, restaurants, local purchasing powers, and others. Database was constructed based on user inputs and manually collected data from authoritative sources (websites of supermarkets, taxi company websites, governmental institutions, newspaper articles, other surveys, etc.).	https://www.numbeo.com/cost-of-living/ https://www.numbeo.com/common/motivation_and_methodology.jsp
Health care	Numbeo Health care Index	Numbeo Health care index surveys Skill and competency of medical staff, Speed in completing examination and reports, Equipment for modern diagnosis and treatment, Accuracy and completeness in filling out reports, Friendliness and courtesy of the staff, Responsiveness (waitings) in medical institutions, Convenience of location.	https://www.numbeo.com/health-care/
5. Business Environment			
Predictable and non-discriminatory taxes	Economist Intelligence Unit-Risk Briefing Database	Tax policy risks measure the level of tax, whether the tax policy is predictable and transparent, focusing on the following issues: Is the tax regime clear and predictable? What is the risk that corporations will face discriminatory taxes? Is the corporate tax rate low (or is the prevailing rate of corporate tax actually paid low)? What is the risk from retroactive taxation?	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Government effectiveness	Worldwide Governance Indicators, D. Kaufman (Natural Resources Governance Institute and Brookings Institutions, and A. Kraay (World Bank), 2017	Government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	https://info.worldbank.org/governance/wgi/Home/Documents
Financial sector regulation and efficiency	Economic Freedom Heritage Foundation	Financial freedom is a measure of banking efficiency as well as a measure of independence from government control and interference in the financial sector. The index looks at the following broad areas: (i) the extent of government regulation of financial services, (ii) the degree of state intervention in banks and other financial firms through direct and indirect ownership, (iii) government influence on the allocation of credit, (iv) the extent of financial and capital market development, and (v) openness to foreign competition.	https://www.heritage.org/index/financial-freedom

Indicator	Source	Notes	Link
Labor market regulation and efficiency	Economist Intelligence Unit-Risk Briefing Database	The index looks at the following broad areas: (i) trade unions, (ii) labor strikes, (iii) labor skills, (iv) meritocratic remuneration, and (v) freedom of association.	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Business environment	Economist Intelligence Unit-Risk Briefing Database	This indicator is an average of indices that assess (i) the extent to which the authorities favor domestic interest over foreign companies in legal matters, and (ii) what the impact of government policy on actively promoting competition and curbing unfair business practices.	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Business regulation	Fraser institute, Economic-freedom-of-the-world-2021	Simple average of administrative costs and bureaucracy costs. The sub-component administrative requirements is based on the Global Competitiveness Report question: "Complying with administrative requirements (permits, regulations, reporting) issued by the government in your country is (1 = burdensome, 7 = not burdensome)". The question's wording has varied slightly over the years. The sub-component of bureaucracy costs is based on the "Regulatory Burden Risk Ratings" from IHS Markit, which measures "the risk that normal business operations become more costly due to the regulatory environment. This includes regulatory compliance and bureaucratic inefficiency and/or opacity.	fraserinstitute.org/economic-freedom
Tax Burden	Economic Freedom Heritage Foundation	Tax burden is a composite measure that reflects marginal tax rates on both personal and corporate income and the overall level of taxation (including direct and indirect taxes imposed by all levels of government) as a percentage of gross domestic product (GDP). The component score is derived from three quantitative sub-factors: • The top marginal tax rate on individual income, • The top marginal tax rate on corporate income, and • The total tax burden as a percentage of GDP.	https://www.heritage.org/index/fiscal-freedom
6. Financial			
Market access	Economist Intelligence Unit-Risk Briefing Database	The index answers the following question. Are there restrictions on foreign companies gaining access to local capital markets?	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts
Global connectedness index	DHL-Global Connectedness Index	The DHL Global Connectedness Index measure the depth and breadth of international flows of trade, capital, information, and people over the period from 2001 to 2020. Depth means to compare each cross-border flow to relevant domestic activities. Breadth means to evaluate the extent to which flows are distributed broadly around the globe rather than concentrated between specific origins and destinations.	https://www.dhl.com/global-en/spotlight/globalization/global-connectedness-index.html
Bank Z-score	World Bank Global Financial Development Database	It captures the probability of default of a country's commercial banking system. Z-score compares the buffer of a country's commercial banking system (capitalization and returns) with the volatility of those returns.	https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database
Domestic credit to private sector (% of GDP)	World Bank Global Financial Development Database	Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises.	https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database

Indicator	Source	Notes	Link
Nonlife insurance premium volume to GDP	World Bank Global Financial Development Database	Ratio of nonlife insurance premium volume to GDP. Premium volume is the insurer's direct premiums earned (if Property/Casualty) or received (if Life/Health) during the previous calendar year.	https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database
Life insurance premium volume to GDP	World Bank Global Financial Development Database	Ratio of life insurance premium volume to GDP. Premium volume is the insurer's direct premiums earned (if Property/Casualty) or received (if Life/Health) during the previous calendar year.	https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database
Deposit money banks' assets to GDP	World Bank Global Financial Development Database	Total assets held by deposit money banks as a share of GDP. Assets include claims on domestic real nonfinancial sector which includes central, state and local governments, nonfinancial public enterprises and private sector. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.	https://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database
Marketable debt	Economist Intelligence Unit-Risk Briefing Database	The index answers the following question. Is there a liquid, deep local-currency denominated fixed-rate medium-term (five-years or more) bond market in marketable debt (debt that is traded freely).	http://www.eiu.com/index.asp?layout=RKArticleVW3&article_id=485802032&country_id=1510000351&refm=rkCtry&page_title=Latest%20alerts

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