



JAPAN

SELECTED ISSUES

March 2023

This Selected Issues paper on Japan was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on March 7, 2023.

Copies of this report are available to the public from

International Monetary Fund • Publication Services

PO Box 92780 • Washington, D.C. 20090

Telephone: (202) 623-7430 • Fax: (202) 623-7201

E-mail: publications@imf.org Web: <http://www.imf.org>

Price: \$18.00 per printed copy

International Monetary Fund
Washington, D.C.



JAPAN

SELECTED ISSUES

March 7, 2023

Approved By
**Asia and Pacific
Department**

Prepared by a team led by Ranil Salgado with individual chapters authored by Kaustubh Chahande, Purva Khera, Asao Kohei, Pablo Lopez Murphy, and Rui Xu (all APD), Jochen M. Schmittmann (OAP), Zhiyong An (FAD), Salih Fendoglu (MCM), and Seho Kim (University of Maryland).

CONTENTS

DRIVERS OF CORPORATE CASH HOLDINGS IN JAPAN	4
A. Introduction	4
B. Data and Methodology	5
C. Empirical Results	8
D. Policy Implications	9
FIGURES	
1. Corporate Savings and Cash Holdings in Japan	6
2. Stylized Facts	7
TABLES	
1. Determinants of Corporate Cash Holdings in Publicly Listed Firms	10
2. Determinants of Corporate Cash Holdings in Private Firms	11
References	12
A NEW GROWTH ENGINE FOR JAPAN: WOMEN IN STEM FIELDS	13
A. Introduction	13
B. An Endogenous Growth Model with STEM Talent	15
C. Results	16
D. Policy Implications	18
BOXES	
1. Model Setup	20

2. Consumption-Equivalent Welfare	21
-----------------------------------	----

FIGURES

1. Women in Labor Market	14
2. Barriers to Female STEM Workers	19

TABLES

1. Parameter Calibration	16
2. Welfare Impact of Removing Barriers to Female STEM Workers	17

References	22
------------	----

STRUCTURAL BARRIERS TO WAGE INCOME GROWTH IN JAPAN 23

A. Introduction	23
B. Resolving the “Wage Puzzle”	24
C. The rise of Part-Time workers and Their Reduced Hours	27
D. The Absence of a Wage-Price Spiral	29
E. Policy Implications	30

FIGURES

1. Wage Dynamics	26
2. Dual Labor Market	29

TABLE

1. Determinants of Wage Growth	30
--------------------------------	----

References	33
------------	----

JGB YIELD CURVE AND MACRO-FINANCIAL STABILITY: HOW WOULD A STEEPER JGB YIELD CURVE AFFECT BANK PROFITABILITY? 34

A. Introduction	34
B. Data and Characterization of JGB Yield Curve	35
C. Empirical Results	37
D. Taking Stock and Policy Implications	40

FIGURE

1. Characterization of the JGB Yield Curve	36
--	----

APPENDIX

I. Tables	42
-----------	----

References	41
OPTIONS TO STRENGTHEN THE SOCIAL SAFETY NET IN JAPAN	43
A. Introduction	43
B. The EITC in Theory	46
C. The EITC in OECD Countries	47
D. Key Policy Issues	48
BOX	
1. The Public Assistance Program in Japan	45
FIGURES	
1. Unemployment Rate and Poverty Rate of the Working-Age Population, 2018	43
2. Average Annual Income: Regular Versus Non-Regular Workers	44
References	52
THE FINANCIAL IMPACT OF CARBON TAXATION ON CORPORATES	55
A. Introduction	55
B. Emission Trends in Japan	56
C. Methodology and Data	57
D. Results	58
E. Conclusion and Policy Implications	61
FIGURES	
1. Emission and Energy Trends	56
2. Sectoral Emissions	57
3. ICRs Under Carbon Tax Scenarios Covering Scope 1 and 2 Emissions	59
4. ICRs Under Carbon Tax Scenarios Covering Scope 1 Emissions Only	59
5. Share of Firms with Debt at Risk Covering Scope 1 and 2 Emissions	60
References	62

DRIVERS OF CORPORATE CASH HOLDINGS IN JAPAN¹

In Japan, corporate savings have risen since 2000 in line with profits. A large share of the additional savings was kept as cash holdings (i.e., cash and short-term investments) rather than used for investment. Building on a rich literature, this paper identifies two additional drivers of corporate cash holdings using financial data of public and private Japanese firms. First, a higher share of intangible capital is associated with more cash holdings. This indicates the presence of financial frictions as intangible capital is not easily collateralizable. Such financial friction could be alleviated by shifting towards cash flow-based lending that is prevalent in the United States (US). Second, corporate tax cuts are associated with more cash holdings while having no significant effect on investment. Given the significant fiscal cost, the efficiency of corporate tax cuts should be re-evaluated.

A. Introduction

1. In Japan, private savings have shifted from households to the corporate sector.

Household net savings, defined as gross savings minus investment, had declined before the pandemic. At the same time, Japanese corporations went from net borrowers to net savers after the asset bubble burst in the 1990s. The rise of corporate savings mainly reflects higher corporate profits while investment has stagnated.

2. Instead of scaling up investment, firms have been using their savings to deleverage and, since 2004, accumulate cash and other liquid assets. The corporate leverage ratio declined from the peak of 45 percent of total assets to about 30 percent. After the leverage ratio started to stabilize around 2004, firms began to accumulate cash and other liquid assets.

3. The literature has highlighted a few drivers of cash holdings in Japan. In general, cash holdings reflect precautionary motives given funding uncertainty faced by firms, especially during downturns (see Bates et al., 2009; Sher, 2014; and Dao and Maggi, 2018). In addition, Japanese firms have increased foreign direct investment (FDI) to diversify their production. Since it is hard to collateralize foreign assets, firms need to accumulate liquid assets to finance their FDI, as indicated by Kang and Piao (2015). Cross-country analysis in Aoyagi and Ganelli (2017) also suggests that weaker corporate governance in Japan, as measured by available indices in 2000-2013, might have contributed to higher cash holdings because managers typically prefer to hold more cash than the level optimal for shareholders.

4. This paper proposes two new drivers of corporate cash holdings and tests them using firm-level data in Japan.

- *The first driver is the rising share of intangible capital.* This is motivated by the rich literature on corporate cash holdings in the US (Opler et al, 1999; Bates et al., 2009; Falato et al. 2020). In particular, Falato et al. (2020) showed that intangible capital can explain 75 percent of increasing

¹ Prepared by Seho Kim (University of Maryland), Pablo Lopez-Murphy, and Rui Xu (both APD).

corporate cash holdings in the US. This is because intangible capital cannot be easily verified or liquidated, and as such, cannot be pledged as collateral to raise debt financing. Under frictional capital markets, where external funds command substantial premiums, the rising importance of intangible capital boosts firms' precautionary demand for cash to ensure sufficient liquidity for future investment opportunities. In Japan, the share of intangible assets (as a percent of total capital) increased by more than 5 percentage points since 2004, as shown in Figure 1.

- *The second contributing factor is declining corporate tax rates.* In Japan, the statutory corporate tax rate (i.e. central and local taxes combined) declined from 40 percent in 2004 to around 30 percent in 2016. Theoretically, lower corporate tax rates would increase the return on liquid assets and thus encourage more cash holdings (Riddick and Whited 2009). Kawamoto and Muraki (2020) found that reductions in statutory corporate income tax rates can explain one-third of the rise in corporate net financial assets in 2003-17 across 12 economies.

5. Empirical results confirm that more intangible capital and lower corporate tax rates contribute to corporate cash holdings, with the tax cuts more relevant for public firms. In terms of magnitude, the rising intangible capital in Japan can explain about a quarter of the increase of cash holdings among public firms, and about 30 percent of the increase of cash holdings among private firms. The decreasing corporate tax rates can explain about 4 percent of the increase in cash holdings among public firms. The effect of tax cuts is much weaker among private firms due to various subsidies and exemptions for SMEs.

B. Data and Methodology

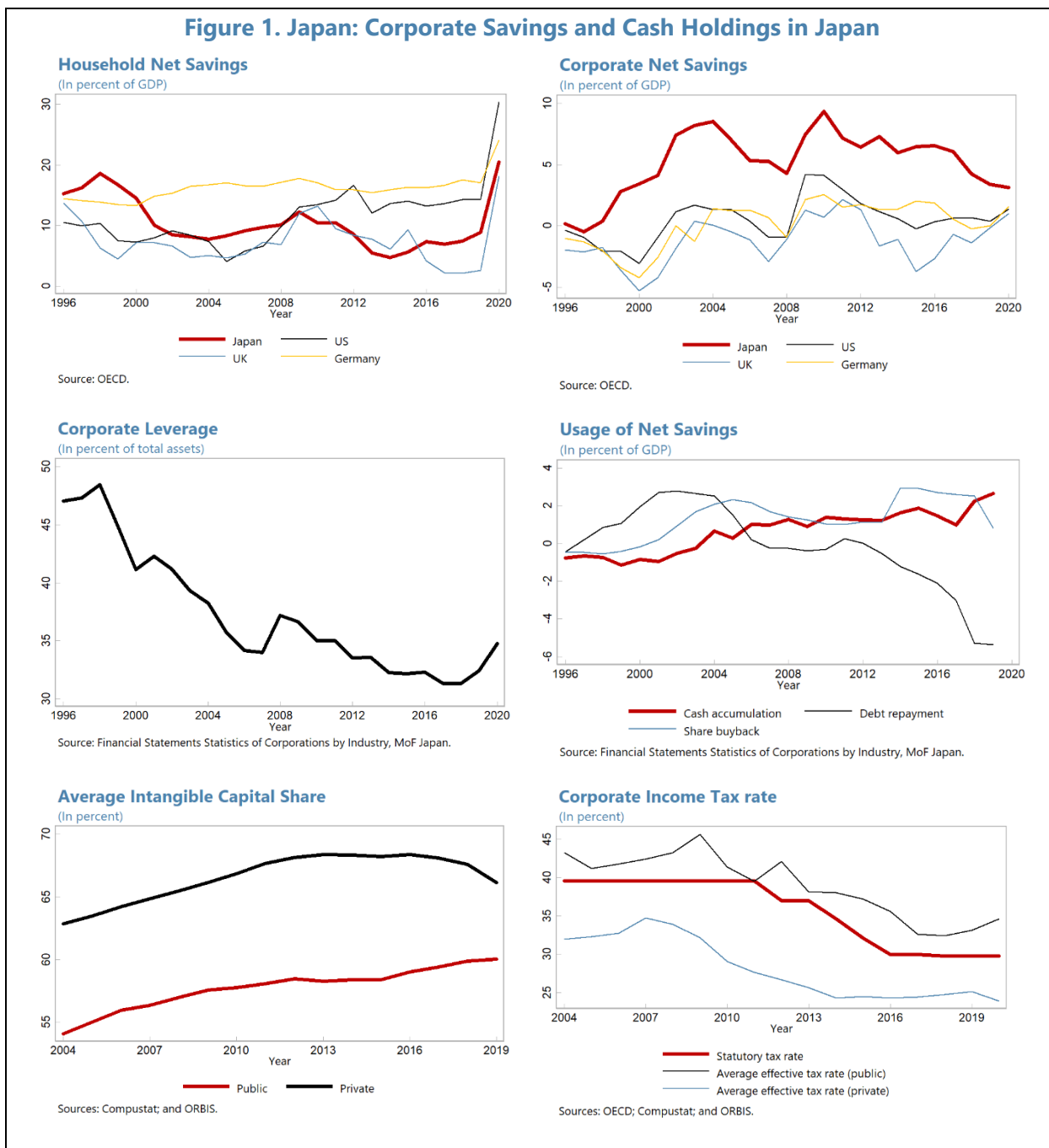
6. Two data sources are used to cover both publicly listed firms and private firms. For public firms, we use Compustat-Global which covers the universe of publicly listed firms in Japan. For private firms, we use Orbis database.² Although Orbis also includes some public firms, the coverage is incomplete, and the sample fluctuates over time. Given the difference in the two data sources, a separate analysis is done for public firms vs. private firms.

7. Our sample covers around 70 percent of the firms surveyed for the Financial Statements Statistics of Corporations by Industry (FSSCI). The coverage is increasing over time mainly due to the evolving sample of private firms in Orbis. Orbis started to have significant coverage of Japanese firms in 2003 and the coverage has increased over time.

8. Following the literature, cash holdings are defined as the sum of cash deposits and other liquid assets (as a share of total assets) Liquid assets include government and other marketable securities listed as short-term. They are treated as cash as they can be converted into cash immediately. Cash and liquid assets are captured in a variable named Cash and Short-term Investments (CHE) in Compustat-Global for publicly listed firms. In Orbis, cash holdings are captured

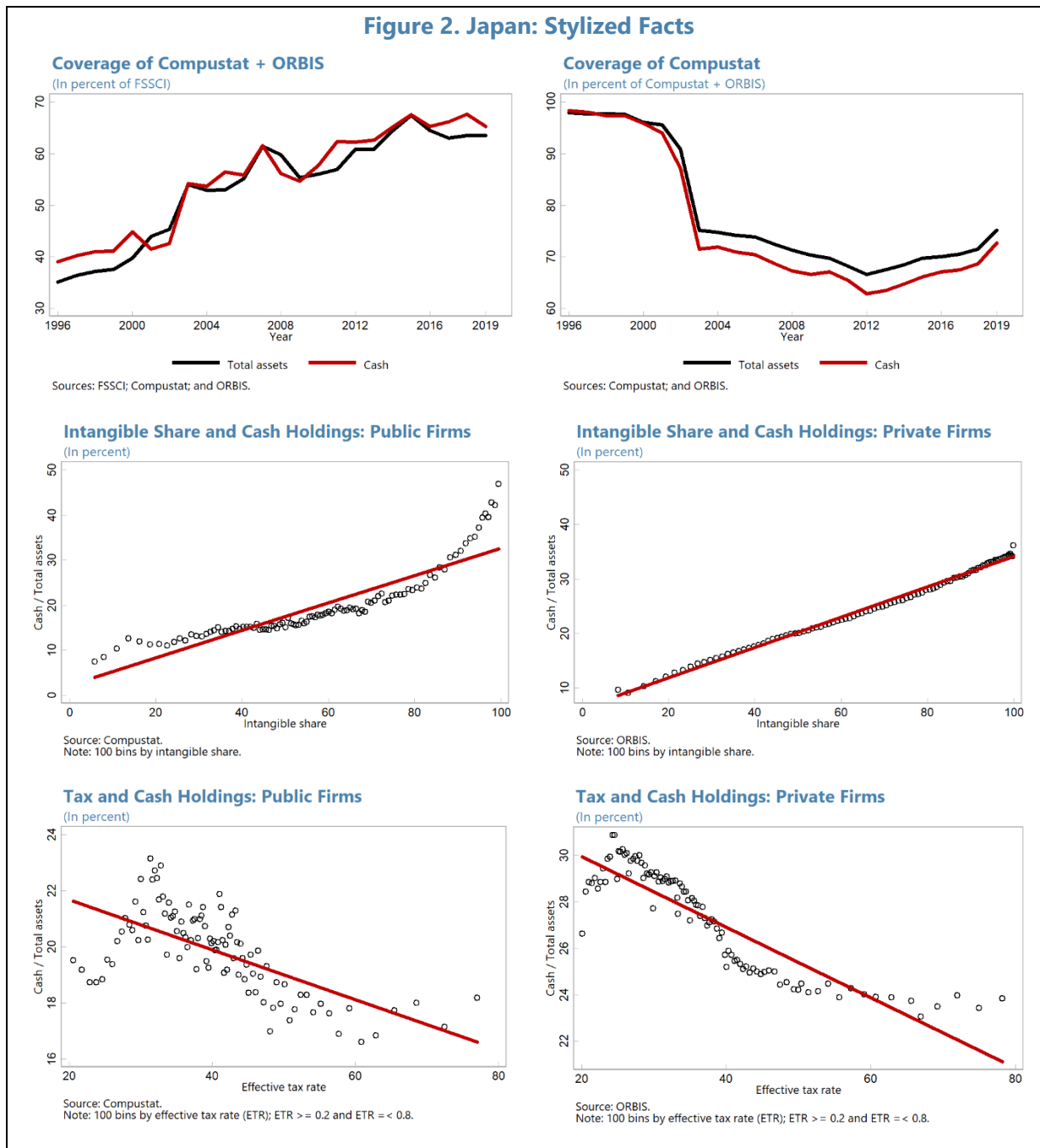
² The cleaned Orbis database comes from Diez et al. 2021.

in a variable called Cash and Cash Equivalent. For the regression analysis, we follow the literature and winsorize dependent and independent variables at level 1 percent and 99 percent.



9. Among Japanese firms, cash holdings are positively associated with intangible share. This is true for both private and public firms, as shown in Figure 2. Intangible capital is estimated by accumulating the intangible investment using the perpetual inventory method. Following the literature, intangible investment is defined as the sum of R&D investment and 30 percent of selling and administrative expenses. In some cases, intangible assets enter the balance sheet, such as when

a company acquires an external patent or does M&A. As a robustness check, we add the “book” intangible assets to our baseline intangible capital.



10. On the other hand, cash holdings are negatively associated with corporate tax rates. This implies that firms tend to save the tax deduction instead of investing them. For corporate tax rate, we calculate the effective tax rate (ETR) using tax payments and pre-tax income. Compared to the statutory tax rates, the effective tax rates can capture the idiosyncratic effects of various tax credits, transfer pricing, and tax loss carryover. From a cash flow point of view, the effective tax rates

matter more than the statutory tax rates. Fiscal policies can affect effective tax rates through tax credits, such as the one introduced in 2013 to incentivize wage increases.

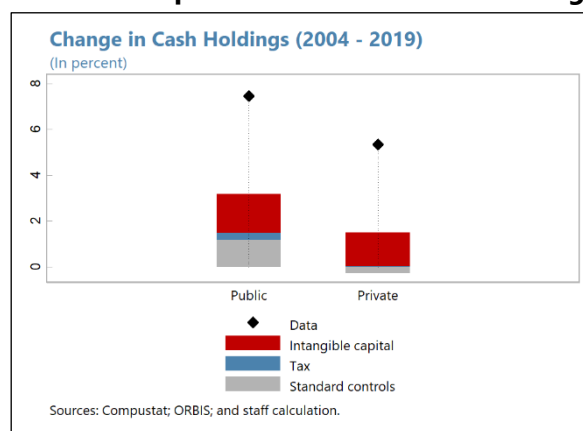
11. Fixed-effect panel regression models are estimated using either the public firm sample or the private firm sample. Standard controls are included, namely cash flow volatility, market-to-book ratio, total assets, cash flow (as a share of total assets), capital expenditures (as a share of total assets), a dummy for paying dividend, net working capital (as a share of total assets), and leverage.³ The two variables of interest, namely intangible share and tax rates, are lagged by one year to mitigate potential reverse causality issue. Firm fixed effects are included in all specifications. Year fixed effects are not included for tax rate analysis as most variations in tax rates come from the time dimension. Instead, a recession dummy is included.

C. Empirical Results

12. Firms increase cash holdings when intangible capital shares go up. This holds for both public (Table 1) and private firms (Table 2), suggesting the presence of financing constraints. In terms of magnitude, a 1 percentage point increase in intangible share is associated with about 0.24 percentage point increase in cash over asset ratio among public firms, and 0.27 percentage point increase in cash ratios among private firms. The effect is larger among private firms because they likely have less collateral and face more financing constraints.

13. Firms also increase cash holdings when effective tax rates go down. It means that firms tend to save the tax reduction. An auxiliary regression on firm investment suggests that tax cuts do not boost investment. The effect of tax rates on cash holdings is stronger among public firms (Table 1) than among private ones (Table 2). This likely reflects the fact that public firms pay more taxes. The tax rates among private firms are also very noisy, suggesting attenuation bias. Once we exclude observations with tax rates below 20 percent or above 80 percent, the coefficient increases by seven-fold.

14. The two factors combined can explain more than a quarter of the new cash holdings since 2004. Among public firms, the average cash holdings increased by about 7.5 percentage points, of which 1.7 percentage points can be explained by the rising intangible share and 0.3 percentage points by lower tax rates. Among private firms, the average cash holdings increased by about 5.4 percentage points, of which 1.5 percentage points can be explained by intangible share.



³ Market-to-book ratio and a dummy for paying dividend are excluded in a regression with private firms as private firms do not have market values and Orbis does not have information on dividend.

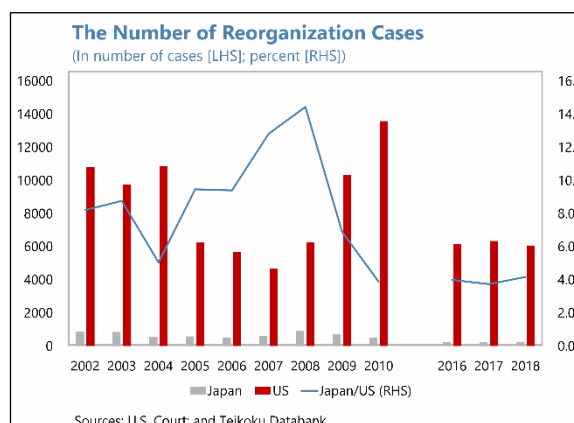
15. The results are robust to using alternative measures of intangible shares and tax rates.

When we add the book value of intangible assets to our baseline intangible capital, the coefficient is slightly lower but remains significant. The effect of statutory tax rates is statistically significant and larger for both public and private firms, suggesting some attenuation bias in the effective tax rates.

D. Policy Implications

16. Easing financing barriers can reduce precautionary cash holdings, especially in sectors that rely more on intangible capital. As suggested by OECD (2021), the following set of policy measures could help.

- Standard innovation policies that would benefit investment in intangibles.* The development of venture capital markets, which are important source of finance for start-ups and intangible intensive firms, and government support of high growth SMEs could ease the financing frictions faces by young innovative firms. For larger firms, the expansion of well-designed R&D tax incentives could incentivize more innovative investment.
- Financial market policies that favor intangible-intensive projects.* While Japanese banks still require physical capital and prefer real estate as collateral, cash flow-based lending (CBL) that relies on firms' operating profits is common for banks in the US (Lian and Ma 2021). Under CBL, creditors can still recover their investment through the reorganization process even if the borrower defaults. The CBL regime could relieve the collateral constraint as it favors innovative firms with intangible-intensive projects. However, adopting CBL is still challenging in Japan due to the rarity of corporate reorganization. Improving labor flexibility and improving the venture capital and private equity market could pave the way to CBL.
- Use of intellectual property-backed loans.* Assets protected by intellectual property rights (IPR) – such as patents, trademarks, copyrights, and design rights – can serve as collateral when searching for bank financing. The Japan Patent Office (JPO) already provides IP Business Valuation reports to banks by request. However, prudential regulation may create barrier to the development of loans secured against intangibles, as IP-backed loans are perceived as riskier and do not contribute to the banks' regulatory capital. To remove such barriers, revising Basel III regulations to account for the new financing needs of corporations, while ensuring financial stability, is needed. But the process will likely be complex and lengthy, requiring international cooperation. An alternative to allow banks to transfer part of the risk from their balance sheets to those of insurance companies is currently being investigated by the British Business Bank (British Business Bank, 2018).



17. Corporate tax cuts have not been effective in boosting investment. Lower tax rates helped corporations improve profits, but most of the reduced tax bills were saved in cash or other liquid assets. Firms did not increase investment or raise wages. Given the significant fiscal cost and the already high public debt, more caution is needed for broad-based corporate tax cuts in the future.

Table 1. Japan: Determinants of Corporate Cash Holdings in Publicly Listed Firms

VARIABLES	Cash / Total assets				
	(1)	(2)	(3)	(4)	(5)
(Lagged) intangible share	0.232***	0.199***		0.238***	0.248***
	(0.018)	(0.013)		(0.019)	(0.020)
(Lagged) effective tax rate			-0.025***	-0.021***	-0.039***
			(0.003)	(0.003)	(0.004)
Cash flow volatility	0.821***	0.041	0.964***	0.736***	0.673***
	(0.267)	(0.201)	(0.275)	(0.249)	(0.242)
Market to book ratio	0.002	-0.001	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
log(Total assets)	0.017***	0.000	0.010**	0.021***	0.023***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Cash flow / Total assets	0.206***	0.163***	0.219***	0.223***	0.233***
	(0.015)	(0.013)	(0.013)	(0.013)	(0.012)
Capex / Total assets	-0.337***	-0.303***	-0.356***	-0.351***	-0.377***
	(0.031)	(0.027)	(0.030)	(0.028)	(0.027)
Positive dividend (dummy)	-0.000	0.002	-0.006	-0.003	-0.011*
	(0.003)	(0.002)	(0.005)	(0.005)	(0.006)
Net working capital / Total assets	-0.220***	-0.247***	-0.248***	-0.259***	-0.265***
	(0.020)	(0.019)	(0.024)	(0.022)	(0.020)
Debt / Total assets	-0.212***	-0.207***	-0.247***	-0.219***	-0.213***
	(0.021)	(0.020)	(0.020)	(0.021)	(0.021)
Recession dummy			-0.014***	-0.012***	-0.011***
			(0.001)	(0.001)	(0.001)
Constant	-0.114*	0.123**	0.117**	-0.136*	-0.146**
	(0.066)	(0.062)	(0.053)	(0.070)	(0.072)
Adj. R-squared	0.835	0.843	0.848	0.855	0.861
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	No	No
Remove tax rate outliers (<20% or >80%)	No	No	No	No	Yes
N	42982	42982	34920	34920	31226

Note: standard errors are clustered at industry level; *** p<0.01, ** p<0.05, * p<0.1

Sources: Compustat Global and author's calculation.

Table 2. Japan: Determinants of Corporate Cash Holdings in Private Firms

VARIABLES	Cash / Total assets				
	(1)	(2)	(3)	(4)	(5)
(Lagged) intangible share	0.256***	0.248***		0.269***	0.266***
	(0.008)	(0.008)		(0.009)	(0.011)
(Lagged) effective tax rate			-0.002***	-0.002**	-0.015***
			(0.001)	(0.001)	(0.001)
Cash flow volatility	0.119*	-0.022	0.184**	0.170**	0.241**
	(0.064)	(0.020)	(0.090)	(0.082)	(0.120)
log(Total assets)	0.020***	0.017***	-0.009*	0.012*	0.003
	(0.005)	(0.004)	(0.005)	(0.006)	(0.008)
Cash flow / Total assets	0.128***	0.126***	0.147***	0.159***	0.189***
	(0.007)	(0.006)	(0.011)	(0.011)	(0.021)
Capex / Total assets	-0.273***	-0.267***	-0.190***	-0.301***	-0.327***
	(0.009)	(0.010)	(0.008)	(0.011)	(0.013)
Net working capital / Total assets	-0.255***	-0.257***	-0.310***	-0.322***	-0.384***
	(0.015)	(0.015)	(0.017)	(0.017)	(0.020)
Debt / Total assets	-0.061***	-0.064***	-0.071***	-0.051***	-0.025***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
Recession dummy			-0.002**	-0.001	-0.000
			(0.001)	(0.001)	(0.001)
Constant	-0.299***	-0.229***	0.432***	-0.150	0.029
	(0.093)	(0.085)	(0.110)	(0.123)	(0.161)
Adj. R-squared	0.828	0.831	0.839	0.847	0.866
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	No	No
Remove tax rate outliers (<20% or >80%)	No	No	No	No	Yes
N	497954	497954	342688	342687	207678

Note: standard errors are clustered at industry level; *** p<0.01, ** p<0.05, * p<0.1

Sources: Orbis Database and author's calculation.

References

- Aoyagi, Chie and G. Ganelli. 2017. "Unstash the Cash! Corporate Governance Reform in Japan." *Journal of Banking and Financial Economics*, 1(7) 51-69.
- Bates, T. W., K. M. Kahle, and R. M. Stulz. 2009. "Why Do U.S. Firms Hold so Much More Cash than They Used To?" *Journal of Finance* 64 (5): 1985–2021.
- British Business Bank, 2018. "Using IP to Access Growth Funding." Intellectual Property Office Report.
- Dao, M. C., and C. Maggi. 2018. "The Rise in Corporate Saving and Cash Holding in Advanced Economies : Aggregate and Firm Level Trends." *IMF Working Papers* 18/262.
- Diez, F. J., J. Fan and C. Villegas-Sanchez, 2021. "Global declining competition?" *Journal of International Economics* 132: 103492.
- Falato, A., D. Kadyrzhanova, J. Sim and R. Steri. 2020. "Rising Intangible Capital, Shrinking Debt Capacity, and the US Corporate Savings Glut." *Journal of Finance, Forthcoming*.
- Kang, J. S. and S. Piao. 2015. "Production Offshoring and Investment by Japanese Firms." *IMF Working Papers* 15/183.
- Kawamoto, A. and K. Muraki. 2020. "Tax Competition: Is it a Source of the Corporate Savings Glut?." *World Bank Policy Research Working Paper* 9302.
- Lian, C., & Ma, Y. (2021). Anatomy of corporate borrowing constraints. *The Quarterly Journal of Economics*, 136(1), 229-291.
- OECD, 2021. "Bridging the gap in the financing of intangibles to support productivity: Background paper." An OECD contribution to the G20 Italian Presidency 2021.
- Opler, T., Pinkowitz, L., Stulz, R., & Williamson, R. (1999). The determinants and implications of corporate cash holdings. *Journal of Financial Economics*, 52(1), 3-46.
- Riddick, L. A., and T. M. Whited. 2009. "The Corporate Propensity to Save." *Journal of Finance* 64 (4): 1729–66.
- Sher, G. 2014. "Cashing in for Growth: Corporate Cash Holdings as an Opportunity for Investment in Japan." *IMF Working Papers* 14/221.

A NEW GROWTH ENGINE FOR JAPAN: WOMEN IN STEM FIELDS¹

Despite recent improvements in female labor force participation, women remain under-represented in STEM fields in Japan. Given the close link between STEM workers and innovation, encouraging women to pursue STEM careers could boost growth potential. Using a calibrated endogenous growth model with STEM talent, this paper quantifies the potential gains from eliminating barriers to STEM fields among women. The findings suggest that bridging the gender gap in STEM fields can boost TFP growth by 20 percent and consumption-equivalent welfare by 4 percent in Japan.

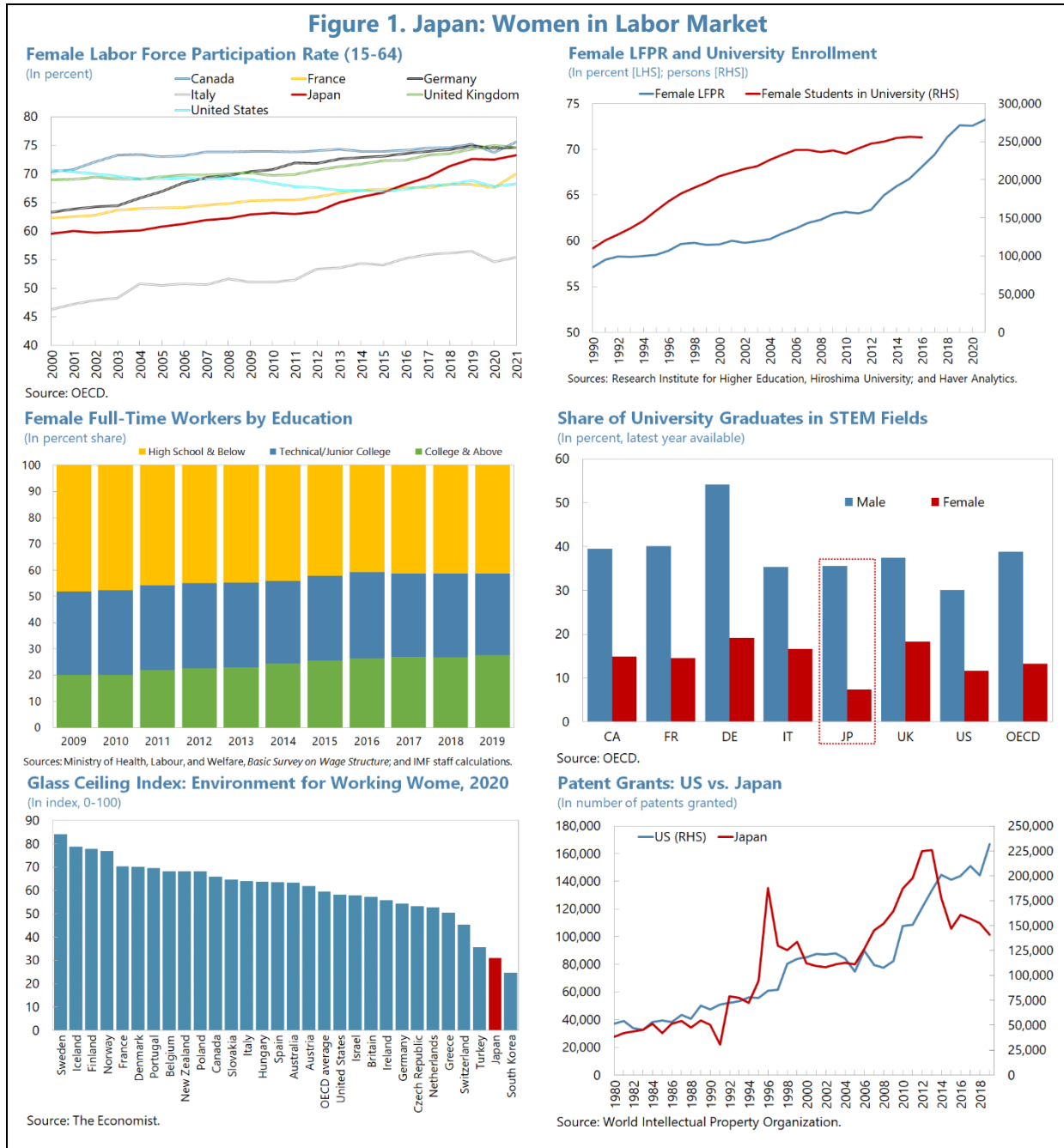
A. Introduction

1. **Since Abenomics, more women have joined the labor force amid economic recovery and improved childcare support.** The female labor force participation rate rose by 10 percentage points in the last 10 years, approaching the highest level among G7 countries. The education level among female workers has also improved significantly, suggesting that new female workers are better educated. This is in line with the sharp rise in female university students since 1990.
2. **However, women are still severely under-represented in STEM fields.** Among G7 countries, the share of women enrolled in science, technology, engineering, and mathematics (STEM) fields in university is the lowest in Japan at around 7 percent. The share is likely lower among STEM professions as women tend to drop out throughout their professional career.
3. **In addition to explicit gender pay gaps, cultural biases and adverse working environments are discouraging women from pursuing STEM careers.** Starting from junior school, science-related subjects are less popular among girls than among boys. The low proportions of women in STEM fields can be attributed to three factors according to Homma et al. (2013): 1) few role models for younger women; 2) unconscious bias among male researchers towards female colleagues; and 3) avoiding competition and underestimation of ability by women themselves. These factors are compounded by the social norm of long working hours and mandatory socializing after work in a male-dominated society. According to the Glass Ceiling index compiled by The Economist magazine, Japan is the second worst in terms of environment for working women. These gender biases discourage women from entering STEM fields and hurt economic growth due to talent misallocation (see Hsieh et al. for a related study on the United States).
4. **Encouraging more women to join STEM fields could help spark innovation and lift potential growth rates in an ageing society.** The growth economics literature has established the key role of STEM workers as fundamental inputs for innovation and the main driver of productivity growth (see Griliches 1992 and Jones 1995). Innovation seems to be slowing in Japan, with patent grants declining since 2012. As the labor force continues to age and labor force participation of

¹ Prepared by Rui Xu (APD).

female and senior workers peaks, the only way to boost potential growth is to improve total factor productivity through technological progress. Tapping into the underutilized talent of female workers is one of the most promising growth engines for Japan.

5. This paper quantifies the potential gains from eliminating barriers to STEM fields among women. Using an endogenous growth model with STEM talent, this paper finds that bridging the gender gap in STEM fields can encourage more women to join the STEM fields and boost the TFP growth by 20 percent.

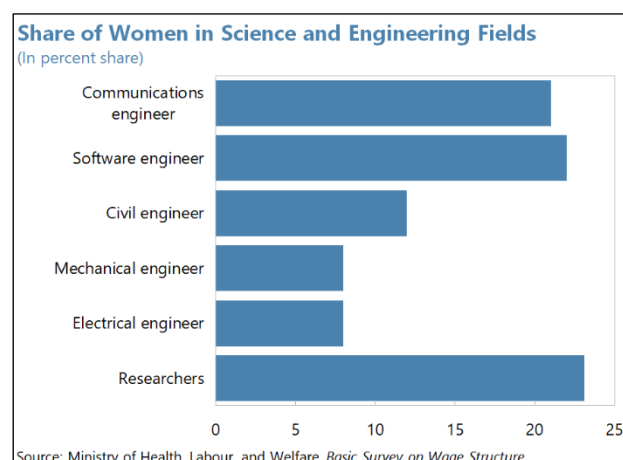


B. An Endogenous Growth Model with STEM Talent

6. As in a standard endogenous growth model, growth is driven by research conducted by firms that are under monopolistic competition. While final goods producers make no profit under perfect competition, the intermediate goods producers make monopolistic profits as their products are imperfect substitutes. The profits provide incentives to hire researchers to do R&D and invent better intermediate products. In this paper, we will treat STEM workers as researchers, and use these two terms interchangeably. In equilibrium, more R&D will lead to higher growth, but the amount of R&D depends on the country's efficiency in innovation. The detailed model setup is included in Box 1.

7. Each person, regardless of gender, is endowed with a different level of talent for research activity but the same talent for final goods production. The research talent is assumed to follow Pareto distribution as in the literature. All workers in the final goods sector will be paid the same wage whereas researchers will be paid based on their specific research talent. This implies that only people who are very talented in research will choose to be researchers.

8. Based on the model, discrimination against female researchers will raise the bar for women researchers and reduce the number of women in STEM fields. The discrimination could come from either schooling biases or labor market discrimination. Schooling bias is modelled as a uniform discount factor on women's research *talent*, whereas labor market discrimination is modelled as a uniform discount factor on female researchers' *wages* with no effect on productivity. Both types of discrimination will discourage women from entering STEM fields and thus reduce equilibrium growth rates. The schooling bias matters more for economic growth because it lowers female researchers' productivity.



9. The discrimination against female researchers would lower long-term growth rates due to talent misallocation. To overcome the schooling bias and the gender pay gap, women need to be more talented than their male peers to pursue STEM careers. The higher talent cutoff leads to talent misallocation as fewer women will choose STEM fields. Such misallocation would reduce long-run growth, as it lowers total research talent devoted to R&D.

10. Therefore, eliminating discrimination against women in STEM fields will boost long-run growth and increase the income of female researchers. Faster growth will benefit the workers as well. The effect on male researchers is ambiguous. On one hand, higher growth

rates would put their consumption on a steeper trajectory. On the other hand, more women in STEM fields will drive down the unit wage for researchers and raise the bar for male researchers. The net effect on male researchers' welfare is a quantitative question. We will calculate consumption-equivalent welfare change (Lucas 1987) to evaluate the net effect on each agent (see Box 2).

11. The model is calibrated to Japan by matching key moments in macro data. One challenge is to separate schooling bias from labor market discrimination. With only wage and occupation data, the two biases are isomorphic and thus cannot be separately identified. To identify schooling bias, research efficiency data among women vs. men is needed, but such data are not typically unavailable. Naïve publication data would understate the productivity of female researchers due to gender discrimination, as shown in Bendels et al. (2018). For the baseline calibration, we assume all misallocation comes from labor market discrimination. This provides a more conservative estimate of the gains from removing the gender bias. As a robustness check, we consider an alternative scenario where half of the discrimination comes from schooling bias.

Table 1. Japan: Parameter Calibration

Parameters Set Externally		
Parameter	Explanation	Source, Value
α	1-labor share	PWT10, 0.4
ρ	Discount rate	0.02
γ	Risk Aversion (CRRA)	Hall (2009), 2.0

Parameter Set Independently		
Parameter	Explanation	Source, Value
θ	Pareto shape parameter	Basic Survey on Wage Structure, 3.5

Parameters Estimated Jointly		
Parameter	Targeted moments, Value	Source
$\eta=0.024$	TFP growth rate	PWT10
$\lambda=2.4$	% of STEM workers among male: 10%	Basic Survey on Wage Structure
$\delta=0.4$	% of STEM workers among female: 2%	Basic Survey on Wage Structure

Source: IMF staff estimates.

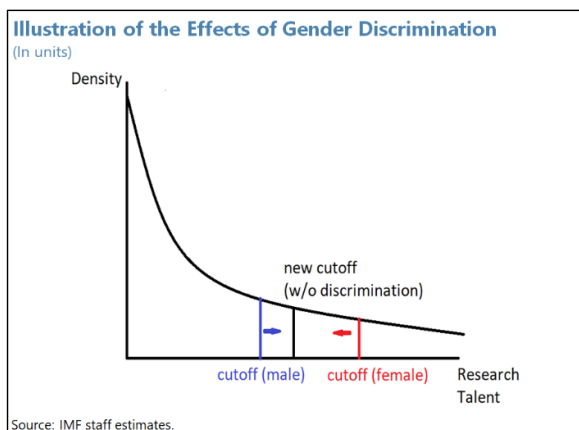
C. Results

12. Bridging the gender gap in STEM fields could raise TFP growth by 20 percent. The increase mainly reflects an increase in the number of researchers by correcting misallocation of talent. Removing discrimination against female researchers would increase their wages and incentivize more women to pursue a career in STEM fields. However, the additional supply of female researchers would push down the wage for each unit of research talent and drive out the marginal

male researchers. The total number of researchers would still increase by about 20 percent as the additional female researchers outnumber the replaced male ones.

13. The welfare impact differs across agents, with the most gains among female scientists while male scientists would be worse off.

Due to faster TFP growth, output and wages will grow along a steeper trajectory, benefiting all agents. However, the entry of new female scientists will push down the wage for all researchers in the near term. For male researchers, the crowding-out effect dominates the growth effect, leading to welfare loss of 5.3 percent. For female researchers, the income boost from removing gender discrimination is much stronger than the crowding out effect, leading to a welfare gain of up to 12.5 percent. For workers, their welfare will improve in line with faster TFP growth by about 4.2 percent. Some agents would change professions, i.e., the marginal male researchers would be crowded out due to entrance of new female researchers. Their welfare gains depend on the individual’s research talent.



% change	Old female researchers	New female researchers	Remaining male researchers	Male researchers who dropped out	Workers
CE Welfare	12.5	[4.2~12.5]	-5.3	[-5.3,4.2]	4.2

Source: IMF staff estimates.

14. Average consumption-equivalent welfare would rise by about 4 percent. The benefit is quantitatively significant considering the demographic headwinds in Japan. For reference, the welfare gains from a 10-percentage point increase in female labor force participation rate (LFPR) are only about 3.5 percent given the current labor market structure. As the participation rate plateaus, more emphasis should be on removing gender pay gaps and discrimination, which would incentivize women to undertake more productive and growth-enhancing jobs.

15. The gains would be larger if we also consider potential schooling barriers for women in STEM fields. Schooling barriers capture the cultural and societal bias against girls in STEM fields. By discouraging girls from pursuing STEM education, women’s effective research talent is discounted and their relative pay in STEM fields would drop. Removing such barriers will not only attract new female researchers, but also increase the effective research talent of the existing female researchers. Assuming that half of the distortion comes from schooling, removing the schooling barriers and the pay gap can boost TFP growth by 26 percent and average welfare by 4.5 percent.

D. Policy Implications

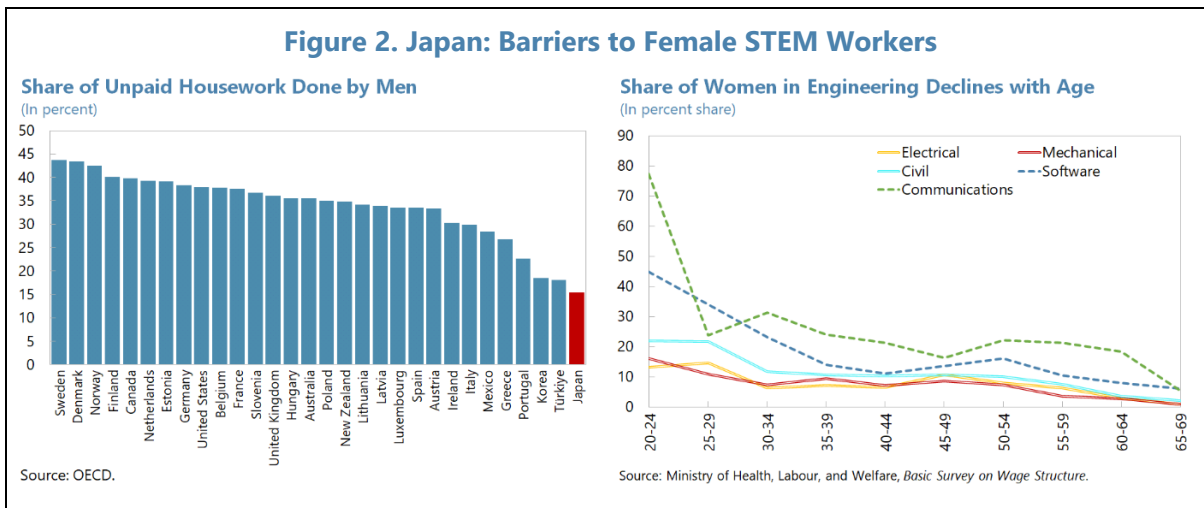
16. Policies that promote female STEM workers should remove both financial and non-financial barriers. First, Japanese women face explicit pay gaps in nominal income. Among OECD countries, Japan's gender pay gap is the third highest. Second, female workers face implicit pay gaps due to disproportionate family care burdens and work-place discrimination. Compared to other OECD countries, Japanese men do the least amount of housework, making it difficult for working moms to keep their full-time jobs. 30 percent of women quit their jobs when they give birth, and many do not come back as full-time workers under the rigid labor market structure. In addition, many managers are hostile towards working moms—one out of every five pregnant full-time working women have experienced maternity harassment according to the Japan Institute for Labour Policy and Training. Although the maternity leave policy is generous in Japan, the harassment may discourage women from returning to their full-time positions after childbirth given no legal consequences for maternity harassment. And third, cultural bias and social stereotypes are preventing young girls from exploring the STEM fields in schools.

17. The government can help reduce the explicit gender pay gap through policies and leading by example. The recent "framework policies" that require companies to increase the transparency of their gender wage gap is a welcome step. In addition, public agencies should promote female leaders to set an example for the private sector. Public universities can consider using female-specific quotas to improve diversity and representation of women in STEM fields.

18. Work style reforms and a more flexible labor market can help address the implicit gender pay gap. Despite the generous parental leave policy on paper, very few men take childcare leave lest they disappoint their managers and coworkers. The government is trying to double the number of men taking paternity leave by 2025, but mandatory leave policies may be needed to achieve that. Reducing working hours and adopting flexible work arrangements (such as teleworking) are needed to allow men to contribute more to housework so that women can retain their full-time jobs. To help women reenter the labor market as full-time workers, the labor market in STEM fields needs to be more flexible, with hiring and promotion based on merit instead of seniority. As an example, more flexible hiring policies in medical and legal fields (likely due to the certificate requirement) have allowed women to reenter the labor force as full-time workers after childbirth.

19. Parents, schools, and the society at large should eliminate gender stereotyping and explore the use of quotas to correct for gender biases. The gender stereotype that boys are better at math and science fields has been prevalent everywhere but is now gradually improving in the United States, China, and some other countries. A few factors have proved helpful. First, more training and workshops should take place to counter gender bias for teachers and parents. Second, the government and public universities should support female scientists through targeted research grants and special quotas. In the presence of gender bias in STEM fields, quotas are needed to correct for such biases and improve diversity. The recent decision by Tokyo Tech to introduce special quotas for female students is a welcome step. And third, role

models and mentoring are essential for women in STEM given all the biases. Schools could invite successful female scientists to share their experiences. Women in senior positions can also mentor young colleagues on how to deal with conflicts between work and family.



Box 1. Japan: Model Setup

The model is built on the endogenous growth model with quality ladders, adding agents with heterogeneous STEM talent. The agents maximize present discounted utility: $U(\epsilon, t) = \int_t^{\infty} e^{-\rho(\tau-t)} \cdot \frac{c(\epsilon, \tau)^{1-\gamma} - 1}{1-\gamma} d\tau$. Each person is born with talent ϵ for STEM (i.e., research talent) drawn from a Pareto distribution. Agents choose to be a worker or a researcher given the prevailing wages and their research talent ϵ .

As in a standard endogenous growth model with quality ladders, there are two types of production activity. Final goods are produced using labor L_Y and all available intermediate goods (i.e., machines) $x(i, t)$: $Y(t) = \int_0^1 A(i, t)x(i, t)^\alpha di \cdot L_Y(t)^{1-\alpha}$. The machines have quality $A(i, t)$ and are imperfect substitutes. The machine producers can make monopolistic profits, which are used to innovate and improve the quality $A(i, t)$. Growth in the economy is driven by the rising quality of the machines.

The R&D process is a key aspect of the model. Researchers try to innovate, and they can succeed with a flow rate of η to come up with a new machine of quality $\lambda A(i, t)$. The aggregate arrival rate of ideas is then given by the success rate multiplier by the total human capital involved in research: $z(t) = \eta \cdot H_R(t)$. The researchers are paid based on the expected profits from inventing the new machines.

A decentralized equilibrium of the model consists of time paths of individual choices $\{c(\epsilon, t), a(\epsilon, t)\}_{t=0}^{\infty}$, average technology $\{A(t)\}_{t=0}^{\infty}$, efficiency wage of each occupation $\{w_Y(t), w_R(\epsilon, t)\}_{t=0}^{\infty}$, labor demand in final goods sector $\{L_Y(t)\}_{t=0}^{\infty}$, aggregate quantities $\{Y(t), X(t), C(t)\}_{t=0}^{\infty}$, interest rate $\{r(t)\}_{t=0}^{\infty}$ and talent cutoff of researchers $\{\epsilon^*(t)\}_{t=0}^{\infty}$ such that

- Agents maximize utility;
- Demand of labor and intermediate goods is given by the final goods sector;
- Each monopolist of intermediate goods maximizes profits;
- There is free entry of intermediate firms, requiring $w_R(t)$ to equal to the value of innovation;
- An individual chooses to be a STEM worker if her talent ϵ is greater than the cutoff ϵ^* , where ϵ^* is pinned down by $w_Y(t) = \epsilon^*(t)w_R(t)$; and
- Growth is pinned down by the amount of total STEM talent among researchers.

Gender discrimination in STEM fields incorporates both explicit pay gaps and implicit barriers. For simplicity, the discrimination is captured by a discount factor (i.e., δ) on female researcher's wages in the model. The talent cutoff for female researchers $\epsilon_F^*(t)$ is pinned down by $w_Y(t) = \epsilon_F^*(t)(1 - \delta) \cdot w_R^F(t)$.

Box 2. Japan: Consumption-Equivalent Welfare

As in Lucas (1987), an individual's welfare change is defined as the amount of extra consumption $\omega(\epsilon)$ that a rational consumer would require in order to be indifferent between the new equilibrium (after removing the barriers to women in STEM) and the old equilibrium. $\omega(\epsilon)$ would differ across individuals depending on their research talent ϵ and gender.

$$\int_0^{\infty} e^{-\rho t} \cdot \frac{[(1 + \omega(\epsilon)) \cdot c_t^{old}(\epsilon)]^{1-\gamma}}{1-\gamma} dt = \int_0^{\infty} e^{-\rho t} \cdot \frac{[c_t^{new}(\epsilon)]^{1-\gamma}}{1-\gamma} dt$$

The average welfare change ω is calculated using the total welfare of all individuals, as shown below.

$$\int_0^{\infty} e^{-\rho t} \cdot \int_1^{\infty} \frac{[(1 + \omega) \cdot c_t^{old}(\epsilon)]^{1-\gamma}}{1-\gamma} f(\epsilon) d\epsilon \cdot dt = \int_0^{\infty} e^{-\rho t} \cdot \int_1^{\infty} \frac{[c_t^{new}(\epsilon)]^{1-\gamma}}{1-\gamma} f(\epsilon) d\epsilon \cdot dt$$

References

- Bendels, M. H. K., Ruth Müller, Doerthe Brueggmann and David A. Groneberg. 2018. "Gender disparities in high-quality research revealed by Nature Index journals." *Plos One*
- Griliches, Zvi. 1992. "The search for R&D spillovers." *Scandinavian Journal of Economics*, 94: S29–S47
- Homma, M. K., R. Motohashi, and H. Ohtsubo. 2013. "Japan's lagging gender equality." *Science* 340(6131), 428-430
- Hsieh, C. T. , E. Hurst, C. I. Jones, P. J. Klenow. 2019. "The allocation of talent and US economic growth." *Econometrica*. 87(5):1439-74.
- Jones, C. I. 1995. "Time series tests of endogenous growth models." *Quarterly Journal of Economics* 110, no. 2:495–525.
- . 2002. "Sources of U.S. economic growth in a world of ideas." *American Economic Review* 92(1):220–39.
- Lucas, R. E. 1987. "Models of Business Cycles." Wiley-Blackwell.

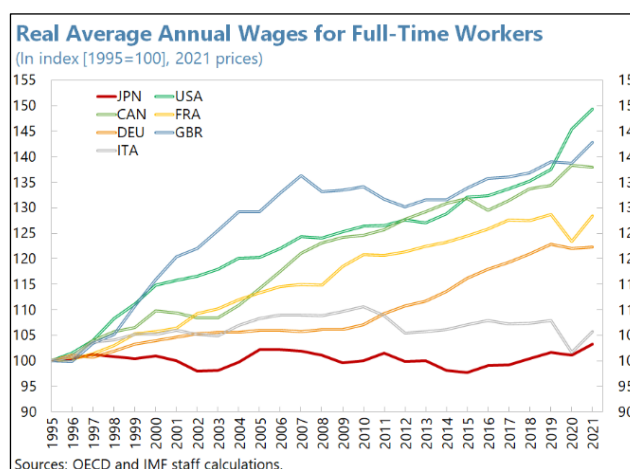
STRUCTURAL BARRIERS TO WAGE INCOME GROWTH IN JAPAN¹

Stagnant income growth has limited Japan's growth potential and reflation efforts. This paper dissects the wage dynamics of different labor groups and identifies the structural barriers to income growth. Although average income growth has been weak due to the rise of part-time workers and their declining hours, real wages per hour have risen across all labor groups, with the most gain seen among part-time and female workers. The weak income growth is largely driven by structural factors, including disincentives for second earners in the social security system, pension policies, and more broadly the dual labor market structure. Policies to address these structural barriers are key to boost income growth in Japan.

A. Introduction

1. Stagnant income growth has limited Japan's growth potential and depressed inflation for the last two decades.

Average wage income has not risen since 1995, making Japan the worst performing country among the G7. The weak income growth, combined with the ageing population, puts downward pressure on domestic demand. Weak domestic demand offsets some of the boost from fiscal and monetary policy accommodation during Abenomics, resulting in low inflation. A pessimistic demand outlook also discourages firms from investing in modern technology such as digitalization, lowering Japan's growth potential over the medium to long term.



2. However, the meager wage income growth is at odds with the tight labor market. By 2019, unemployment had dropped to below 2.5 percent while the female labor force participation rate rose to 54 percent. According to the Tankan survey, labor shortages were increasingly cited as binding constraints for firms' growth. For every job seeker, more than two new job openings were available. Under such a tight labor market, it was puzzling that wage income had been stagnant.

3. This paper resolves the puzzle by studying the wage dynamics in each labor group.

Mathematically, three factors could affect average wage income: composition of workers (e.g., part-time vs. full-time workers), hours worked in each group, and hourly wages in each group. Although a

¹ Prepared by Rui Xu (APD) and Kaustubh Chahande (APD).

tight labor market tends to raise hourly wages, *average monthly* income could still decline if the share of part-time workers goes up, or if existing workers reduce their hours.²

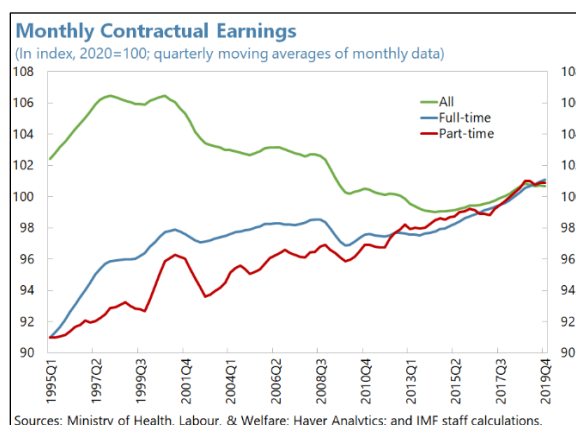
4. The paper finds that average monthly income has been stagnant due to the rise of part-time workers, while real hourly wage has grown across all labor groups. The weak income growth is largely caused by structural factors. First, the rise of part-time workers stems from higher labor force participation among female and senior workers. These trends reflect better childcare options and the gradual increase of the pension eligibility age, respectively. Second, the declining hours among part-time workers are at least partly caused by distortions in the tax system for the second income earners (e.g., spousal deductions and exemption of pension contributions). Since the income thresholds are in nominal terms and rarely adjusted, higher hourly wage would force the second earners to reduce hours. And third, there seems to be a college “discount” in terms of wage growth and that is driven by life-long employment practices in Japan. The lack of mobility and flexibility reduces workers’ bargaining power as well as their incentives to reskill.

5. Addressing these structural barriers is key in boosting income growth in Japan. The top priority remains comprehensive labor market reform to break down the dualism. A more flexible labor market with merit-based pay could boost income of both regular and non-regular workers. Second, disincentives to employment in the benefit policies should be removed. In particular, the health care and pension coverage should be redesigned to avoid any specific threshold that distorts labor supply. Third, worker training and reskilling, especially for non-regular workers, should be encouraged to improve labor mobility and productivity. And lastly, further progress on work-style reforms and family care services is needed to encourage women to keep their regular jobs after childbirth.

B. Resolving the “Wage Puzzle”

6. Average monthly earnings statistics are misleading due to significant structural changes in the Japanese labor market (Figure 1).

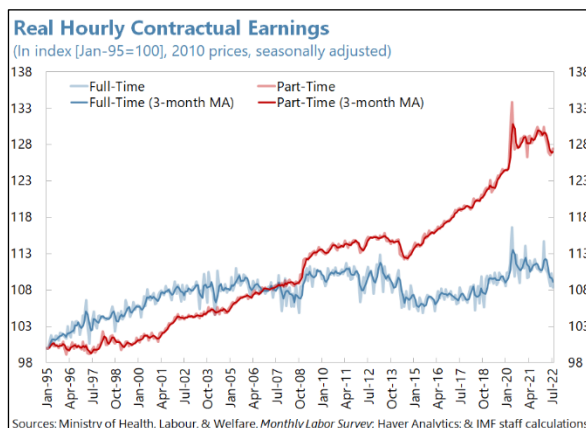
- First, the share of part-time workers increased from 30 percent in 2010 to 38 percent in 2020. These part-time workers are typically paid much less than full-time workers due to fewer hours and lower hourly wages. Therefore, more part-time workers would drag down the average statistics of monthly earnings. As shown in the chart, monthly earnings have been rising among full-time workers as well as part-time workers when looked separately.



² This paper uses contractual monthly earnings for all analysis. Compared with total cash earnings, contractual earnings exclude one-off bonuses which are volatile and lumpy.

- Second, monthly working hours by part-time workers dropped by about 10 percent from 2010 to 2019. The reduced labor input would offset higher hourly wages.

7. Wages per hour have been rising rapidly among part-time workers, and to a lesser extent among full-time workers. To remove the biases related to part-time workers, we construct two separate wage indices for part-time and full-time workers using hourly wages. Both wage indices have been rising since 1995. The real wage growth among part-time workers was especially strong, averaging 1.8 percent from 2015-2019.



8. Even among full-time workers, there is significant heterogeneity regarding wage growth. To tease out the effects of other structural changes in the labor market, we calculate hourly wages for each demographic group by employment type, gender, and education. The data are from the Basic Survey on Wage Structure.³ A few patterns stand out:

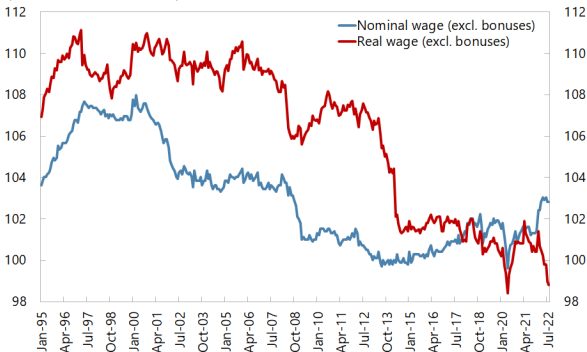
- **Female workers experienced faster wage growth than the male ones.** This is true for both regular and non-regular workers, and for each level of education. Since male workers tend to have higher level of wages, faster growth among women implies a shrinking gender pay gap. Notably, the overall wage growth among female workers is faster than each segment, reflecting improving education attainment among female workers.
- **Less educated workers experienced faster wage growth, in contrast to the trend in the United States.** Among regular workers, colleague-educated workers had the least wage increase while those with technical and junior college degrees had the most wage increase. Among non-regular workers, the least educated group experienced the highest wage growth. This could reflect the rapidly ageing society, where demand for services related to old-age care rises whereas manufacturing activity is increasingly outsourced.

³ The data are at annual frequency, compiled by the Ministry of Health, Labour, and Welfare.

Figure 1. Japan: Wage Dynamics

Wage Index: Nominal vs. Real

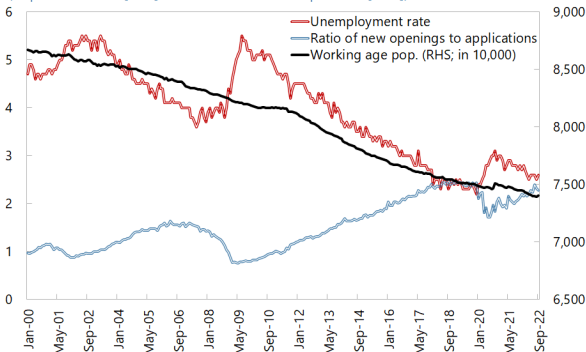
(In index, Jan 2013 = 100)



Sources: Ministry of Health, Labour & Welfare; Haver Analytics; and IMF staff calculations.

Japan Labor Market

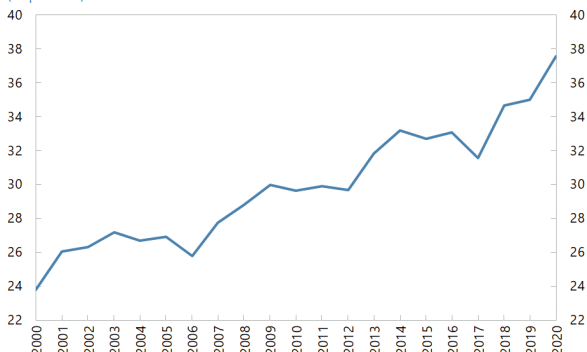
(In percent, ratio [LHS]; tens of thousands of persons [RHS])



Sources: Ministry of Internal Affairs & Communications; Ministry of Health, Labour, & Welfare; Haver Analytics.

Share of Part-Time Workers

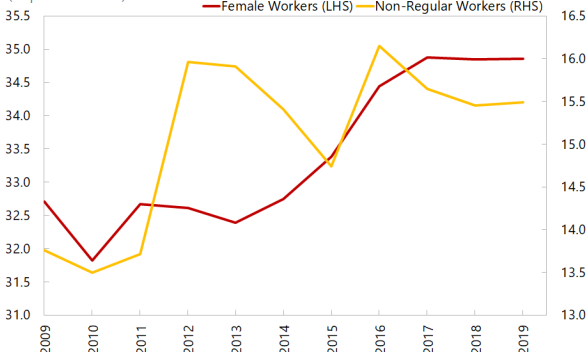
(In percent)



Sources: International Labour Organization.

Full-Time Workers: Share of Female & Non-regular Workers

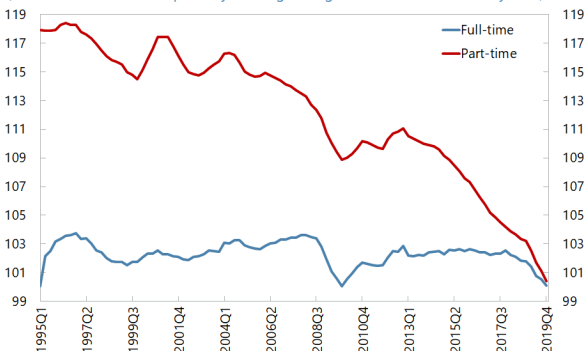
(In percent share)



Sources: Ministry of Health, Labour, and Welfare, Basic Survey on Wage Structure, and IMF staff calculations.

Monthly Working Hours

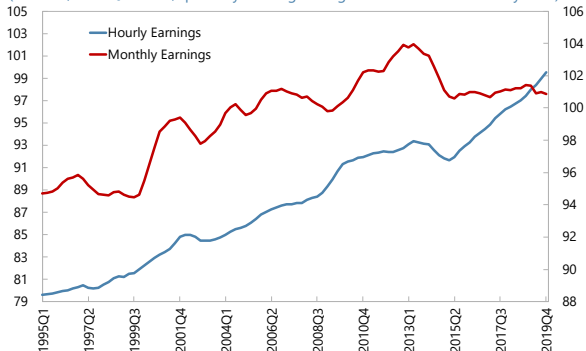
(In index, 2020Q1=100; quarterly moving averages of normalized monthly data)



Sources: Ministry of Health, Labour, & Welfare; Haver Analytics; and IMF staff calculations.

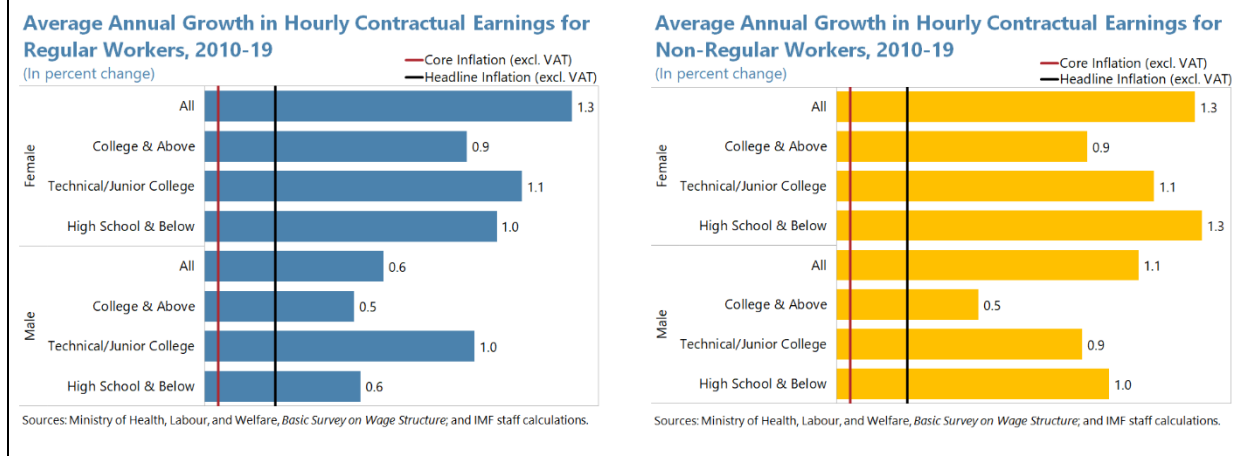
Real Wages for Part-Time Workers

(In index, 2020Q1 = 100; quarterly moving averages of normalized monthly data)



Sources: Ministry of Health, Labour, and Welfare; Haver Analytics; and IMF staff calculations.

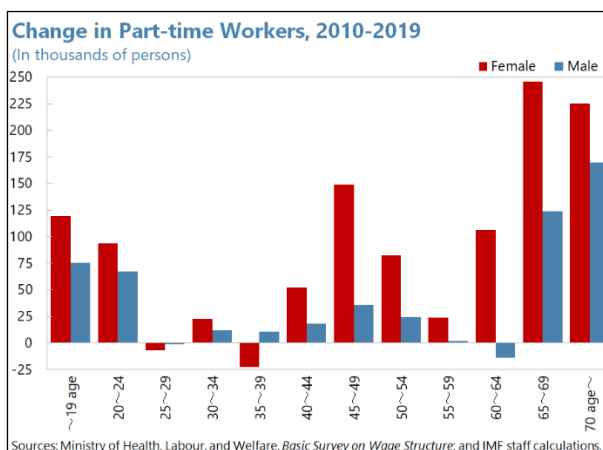
Figure 1. Japan: Wage Dynamics (concluded)



C. The Rise of Part-Time Workers and Their Reduced Hours

9. Higher labor force participation rates among women and seniors contributed to the rise of part-time workers.

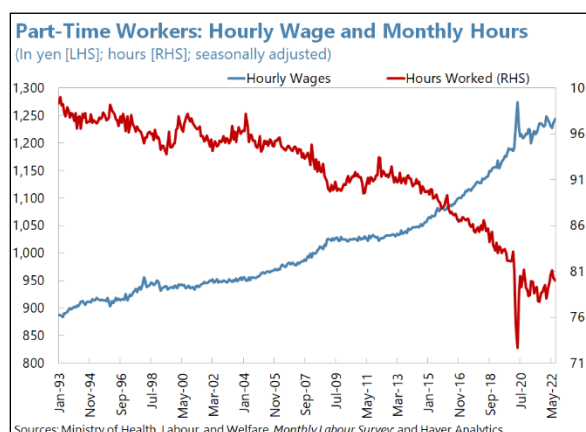
- *Japan has added 2.5 million women to the labor force since 2013, of which half were part-time workers.* The increase is primarily a result of labor shortages resulting from demographic factors and the economic recovery. At the same time, structural reforms during Abenomics, notably the increase in childcare capacity since 2013, has also helped women return to the labor force after childbirth.
- *Employment among senior citizens has also increased due to rising life expectancy and pension eligibility age.* Many firms still set a mandatory retirement age at 60 while the pension eligibility age has been raised to 65 for men. The government introduced the continuous employment system in 2006 which required firms to provide employment to workers until their pension eligibility age.⁴ However, only about one-fifth of firms extend regular employment for workers above 60. The remainder rehire senior workers as non-regular workers. Those rehired non-regular workers tend to



⁴ In 2006, firms were allowed to screen workers based on ability or service record. Since 2013, such screening is no longer allowed, and firms are required to provide employment until age 65 for everyone who wants to remain in the firm.

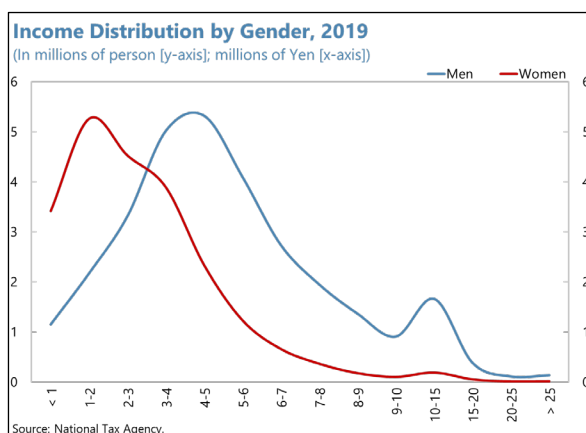
experience a significant pay cut compared to their pre-retirement wages. Lower wages, to some extent, are consistent with changes in job responsibilities, and many workers choose to work part-time.

10. Among part-time workers, hours have declined over time. In fact, our analysis suggests that hours and hourly wages have a strong negative correlation since 1995. Higher wages could increase labor supply as it raises the opportunity cost of leisure, but it may also reduce labor supply due to income effect. The literature (e.g., in Kimball and Shapiro, 2008) suggests that labor supply tends to be inelastic with permanent wage increases. Therefore, the declining hours among part-time workers point to distortions in the labor market.



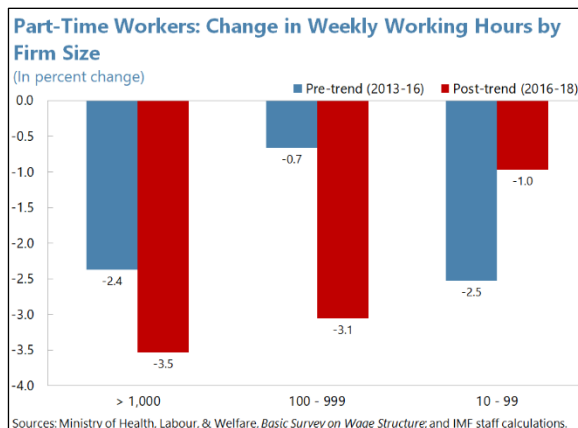
11. The declining hours among part-time workers are mainly caused by various distortions in the tax and social security system. Three policies are relevant here.

- *The first one is the spousal deduction.* Japan's tax system is based on individuals rather than families. Originally introduced in 1961, the spousal deduction exempts up to JPY 380 000 from the main earner's taxable income, if the second earner's income is below some nominal threshold (JPY1.03 million before 2018 and JPY1.5 million after 2018). The taxable income deduction would go down when the second income is above the threshold. This would imply a discount on the second earner's marginal contribution to family income that is equal to the main earner's marginal tax rate, which is about 20-33%. The discount would reduce the labor supply for those second earners whose income level is close to the threshold.

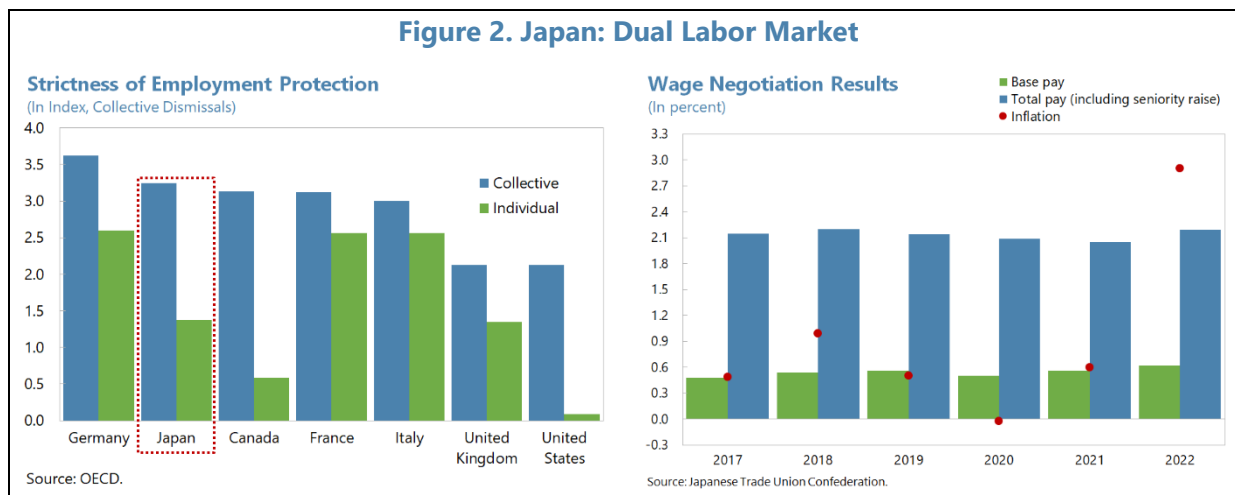


- *The second distortion relates to the social security contribution.* Second earners are eligible for the national pension without paying the premium if their income is below JPY 1.3 million. This further discourages female labor supply and became more binding after 2018 when the income threshold for the spousal deduction was increased to 1.5 million yen.
- *And last, the newly expanded Health Insurance and Employee's Pension Insurance coverage has unintended consequences in limiting working hours.* Before 2016, firms only paid Health Insurance and Employee's Pension Insurance for those working more than 30 hours a week.

Since October 2016, the government gradually expanded social security coverage to those working more than 20 hours a week and earning more than 1.06 million per year. Initially the policy was enforced in large companies employing more than 500 people. Over time, the policy is being extended to smaller firms, with expansion to those hiring more than 100 people in 2022 and those hiring more than 50 people planned in 2024. Although designed with good intention, the policy led many large firms to limit part-time workers' hours to 20 to avoid paying the social security contribution (see text chart).



12. The relatively weaker wage growth among full-time workers is due to the dual labor market structure in Japan. Japan's lifetime employment system is an implicit long-term contract for regular workers. Under this system, firms hire new graduates with the promise of a job until the mandatory retirement age. The long-term commitment encourages employers to develop company-specific skills by investing in their workers. However, such a system discourages labor mobility of regular workers due to seniority pay structures, firm-specific skill sets, and high dismissal costs. Labor unions also tend to focus more on maintaining employment than requesting higher salaries during the annual *shunto* negotiations. On the other hand, the labor market for non-regular workers is more flexible and responds more to labor market conditions. As a result, regular workers' hourly wages have been increasing much slower than non-regular workers (who are mostly part-time).



D. The Absence of a Wage-Price Spiral

13. As inflation has risen sharply around the world, central banks have tightened monetary policy to anchor inflation expectations and prevent wage-price spirals. If workers

expect inflation to accelerate in the future, they will demand higher wages, which will push businesses to raise prices further, leading to a “wage-price” spiral.

14. However, our analysis suggests that wages in Japan have not responded to inflation expectations in the past. Given the potential biases of average earnings data mentioned above, we analyze monthly earnings and hourly wages separately for full-time and part-time workers (Table 1). Neither monthly earnings nor hourly wage respond to any measure of inflation expectations. Instead, wages respond to core inflation, with a larger coefficient for hourly wages than monthly earnings. Monthly earnings of part-time workers do not respond to core inflation due to the distortions from the tax system mentioned above. Hourly income is also affected by labor market tightness, but not potential growth.

15. The lack of a response to inflation expectations could be partly attributed to the structural issues in the labor market mentioned above. Wages for regular workers are mostly determined by the annual *shunto* negotiation between corporates and labor unions. And unions mostly cover workers in large corporations, with the other 80 percent of the workforce un-ionized. Given the much higher pay level and better job security enjoyed by unionized regular workers, the unions tend to put more weight on maintaining regular employment than bargaining for higher wages. Extremely low mobility among regular workers also implies few outside option and low bargaining power. Regarding part-time workers who are second income earners, the distortions in the benefit policies discourage labor supply and prevent monthly income from growing despite higher hourly wages.

Table 1. Japan: Determinants of Wage Growth

	(1)	(2)	Monthly earnings growth				Hourly wage growth			
	All		Full-time		Part-time		Full-time		Part-time	
	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)		
Imputed HH inf expectations (LT)	-0.13 (0.20)		-0.03 (0.17)		-0.30 (0.35)		0.17 (0.39)		0.37 (0.25)	
Consensus forecast (LT)		0.38 (0.34)		-0.04 (0.29)		0.32 (0.61)		-1.09 (0.66)		-0.23 (0.45)
Core inflation last year(excl. VAT)	0.50*** (0.11)	0.50*** (0.11)	0.39*** (0.09)	0.39*** (0.10)	-0.04 (0.20)	-0.04 (0.20)	0.66*** (0.22)	0.68*** (0.22)	0.85*** (0.14)	0.85*** (0.15)
Unemployment gap	-1.27*** (0.34)	-1.03*** (0.25)	-0.93*** (0.29)	-0.90*** (0.21)	-0.66 (0.61)	-0.22 (0.44)	-0.77 (0.67)	-1.19** (0.48)	-0.94** (0.44)	-1.46*** (0.32)
Potential growth	0.75*** (0.17)	0.70*** (0.17)	0.74*** (0.14)	0.75*** (0.15)	0.50 (0.30)	0.45 (0.31)	-0.07 (0.33)	0.05 (0.33)	0.07 (0.22)	0.11 (0.22)
Constant	-0.52*** (0.11)	-0.98** (0.42)	-0.16* (0.09)	-0.12 (0.36)	0.15 (0.20)	-0.23 (0.75)	0.43* (0.22)	1.73** (0.81)	1.27*** (0.14)	1.55*** (0.55)
Observations	64	64	64	64	64	64	64	64	64	64
Adjusted R-squared	0.400	0.408	0.414	0.414	-0.002	-0.010	0.108	0.144	0.409	0.391

Standard errors in parentheses
 =** p<0.10

** p<0.0; *** p<0.010"

E. Policy Implications

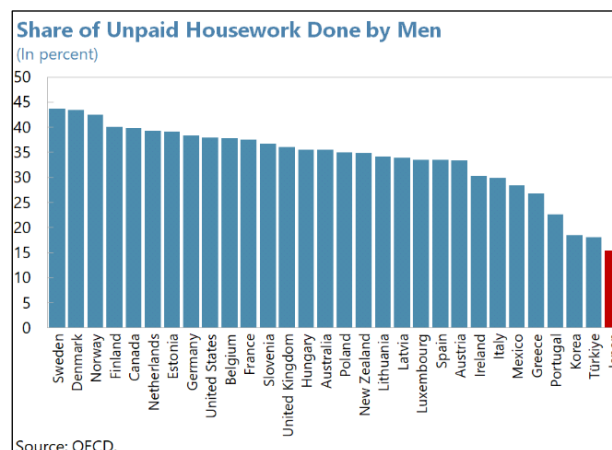
16. Despite strong growth of hourly wages, overall wage income has been stagnant, preventing Japan from reaching the two-percent inflation target in a sustainable manner.

The slow income growth reflects structural barriers in the labor market. For part-time workers who

are typically second income earners, monthly income was implicitly capped by the distortions in the social security system. Among full-time workers, hourly wages have been growing slowly due to the rigid labor market. Since core inflation responds mostly to family income, it is essential to boost overall income to achieve the inflation target in a sustainable manner.

17. To boost overall wage income, the government needs to address the structural barriers.

- First, disincentives to labor supply in the social security system should be eliminated.* In the near term, income thresholds should be harmonized to reduce such distortions. Although the income threshold for the spousal deduction was raised from 1.03 to 1.5 million yen in 2018, the effect is muted as the income threshold for a dependent spouse (of an insured employee) who can be exempted from Health Insurance and Pension Insurance contribution remains at 1.3 million yen. Over the medium term, the tax incentives should be reviewed regularly and streamlined to ensure compatibility, especially in the current environment of surging inflation. As shown in Kitao and Mikoshiba (2022), eliminating those distortions would significantly raise women’s labor supply and earnings and boost government revenues. The expansion of Health Insurance and Employee’s Pension Insurance to part-time workers since 2016 is a welcome step in mitigating the distortions in the social security system. But the partial coverage has the side effect of limiting labor supply within 20 hours per week for some workers. A new design that avoids thresholds in hours or nominal income should be adopted to eliminate distortions to labor supply.
- Second, further progress on work-style reforms, including through teleworking, is needed to improve career prospects and income of female workers.* Since 2013, significant progress has been made on work-style reforms and childcare services, which helped boost female labor force participation. However, most of the female workers re-enter the labor force as part-time workers taking on jobs that under-utilize their skills. While the rigid labor market plays a role, women also shoulder a disproportionate amount of housework. In this context, work style reforms can help women by providing more flexible work arrangements and allowing men to share more housework. Teleworking was found especially helpful for working mothers to retain their jobs while taking care of young children during the pandemic.
- Finally, a comprehensive strategy is needed to break down labor market dualism and improve flexibility.* Japan’s traditional model – simultaneous recruitment of new graduates, lifetime employment, seniority-based wage and promotion system, mandatory retirement and company-based training – needs to be modernized to adapt to the rapidly ageing society. A



more flexible labor market with merit-based promotions could boost productivity and raise labor income. As suggested in Aoyagi and Ganelli (2013), one reform option is to introduce a Single Open-Ended Contract for all newly hired workers, complemented by a shift towards a model that combines labor market flexibility and security.

References

Aoyagi, C. and G. Ganelli, 2013. "The Path to Higher Growth: Does Revamping Japan's Dual Labor Market Matter?" IMF Working Paper 13/202.

Kimball, M. S. and M. D. Shapiro. 2008. "Labor Supply: Are the Income and Substitution Effects Both Large or Both Small?" NBER Working Papers 14208.

Kitao, S. and M. Mikoshiba, 2022. "Why Women Work the Way They Do in Japan: Roles of Fiscal Policies." RIETI Discussion Paper Series 22-E-016

JGB YIELD CURVE AND MACRO-FINANCIAL STABILITY: HOW WOULD A STEEPER JGB YIELD CURVE AFFECT BANK PROFITABILITY?¹

Given that there is exceptionally high uncertainty around the domestic inflation outlook, allowing for greater flexibility in long-term Japanese Government Bond (JGB) yields by the Bank of Japan (BoJ) could be considered going forward. Against this background, this study empirically finds that a steeper JGB yield curve helps improve banks' profitability, especially after a year lag, and the overall impact hinges on macroeconomic and financial market responses. A steeper JGB yield curve could also have spillovers on global yields. Financial sector policies to mitigate short-term vulnerabilities in case the JGB yield curve steepens could be considered, including by further strengthening engagement with financial institutions with relatively high exposure to interest rate movements, to better harness the benefits in the medium term.

A. Introduction

1. The macroeconomic landscape recently has changed, compared to when the BoJ started its unconventional policies a decade ago. To fight decade-long deflation and support the financial system, the BoJ has employed a series of unconventional monetary policies (UMP) since 2013, including the Yield Curve Control (YCC) policy that caps the 10-year rates at 0 percent within a narrow band (Westelius, 2020). A key change in the macroeconomic landscape is the acceleration in inflation in 2022. While headline inflation has been above the central bank's target of 2 percent y/y since April, there continues to be considerable uncertainty around the inflation outlook given still uncertain spring wage negotiations and the implications of a potential global economic slowdown, which calls for greater policy flexibility going forward. Concurrently, continuing monetary policy divergence with other advanced economy central banks has led to deterioration in long-term JGB market functioning, prompting the BoJ to widen the target band for 10-year JGB yields in its Monetary Policy Meeting in December 2022. Depending on data realizations, achieving a sustained increase in prices and wages could imply allowing for higher long-term yields.

2. To this end, this note analyzes how changes in the slope of the JGB yield curve could impact profitability of banks in Japan. In particular, the note starts with characterizing the JGB yield curve with a few parameters (including the slope) using a state-space model. It then utilizes bank-level financial statements data and estimates how banks' profitability reacts to changes in the slope of the yield curve, using a fixed-effects panel estimation based on historical data. The note examines other issues, including lagged effects, heterogeneity across banks, spillovers from the JGB yield curve to the US Treasury yield curve (and vice versa), and concludes with policy implications.

¹ Prepared by Salih Fendoglu (MCM).

B. Data and Characterization of JGB Yield Curve

3. The JGB yield curve has in general been lower compared to earlier periods, with the curve flattening over time and then steepening more recently (Figure 1 chart 1). The data comprises of constant-maturity yields of JGBs, with maturities ranging from 3 months to 30 years, starting from January 2000 till October 2022.² Chart 1 shows that the JGB yield curve as a whole is lower compared to previous periods, and the slope of the curve (the difference between long- and short-end of the curve) flatter over time, especially after the BoJ's UMPs, but increasing more recently amid the rise in overseas yields.

4. The yield curve can be characterized by a small set of factors. Using a Nelson-Siegel representation of cross-section of yields at a given time, one can write a dynamic latent factor model that characterizes the level, slope, and curvature of the yield curve, following Diebold, Rudebusch, and Aruoba (2008). In particular, the following state-space model is estimated,

$$y_t(\tau) = L_t + S_t \left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau} \right) + C_t \left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau} \right) \quad (1)$$

$$\begin{pmatrix} L_t - \mu_L \\ S_t - \mu_S \\ C_t - \mu_C \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} L_{t-1} - \mu_L \\ S_{t-1} - \mu_S \\ C_{t-1} - \mu_C \end{pmatrix} + \begin{pmatrix} \eta_t(L) \\ \eta_t(S) \\ \eta_t(C) \end{pmatrix} \quad (2)$$

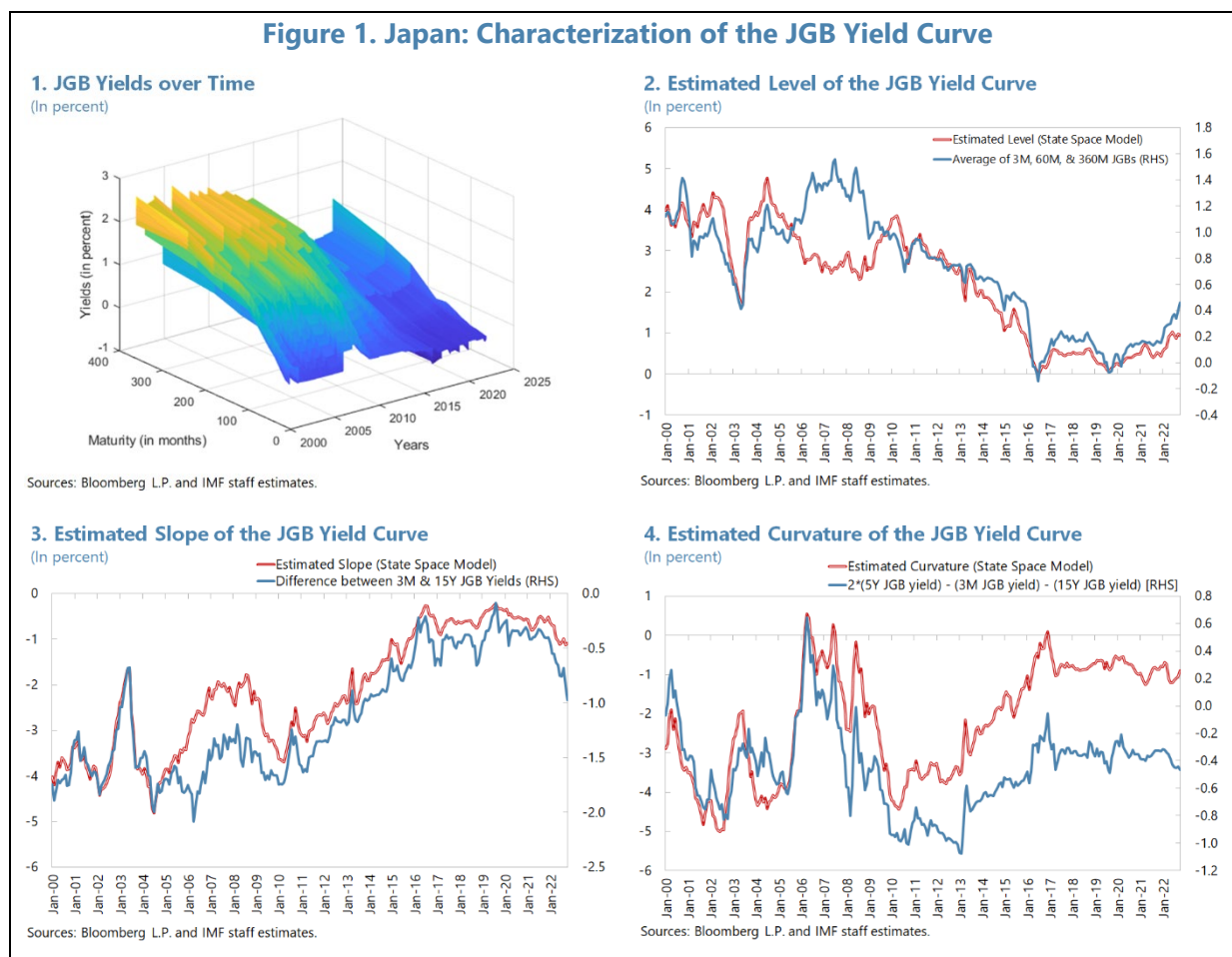
where $y(\tau)$ denotes the vector of yields, and τ denotes maturity. The yields are driven by three latent factors, L_t , S_t , and C_t , which can be interpreted as level, slope, and curvature of the yield curve at time t , respectively. The parameter λ governs the decay factor on factor loadings, which is estimated jointly with the latent factors.³ The model is estimated by maximizing Gaussian likelihood, with Kalman smoothing to extract the optimal values for the factors.

5. The estimated factors confirm declining yields, flattening of the yield curve over the past decade, and the steepening of the curve recently, and perform well in predicting yields (Figure 1 charts 2-5). The level factor recovers from historically low levels in 2016 after the introduction of the YCC and increases further since end-2021 amid rising longer-term yields

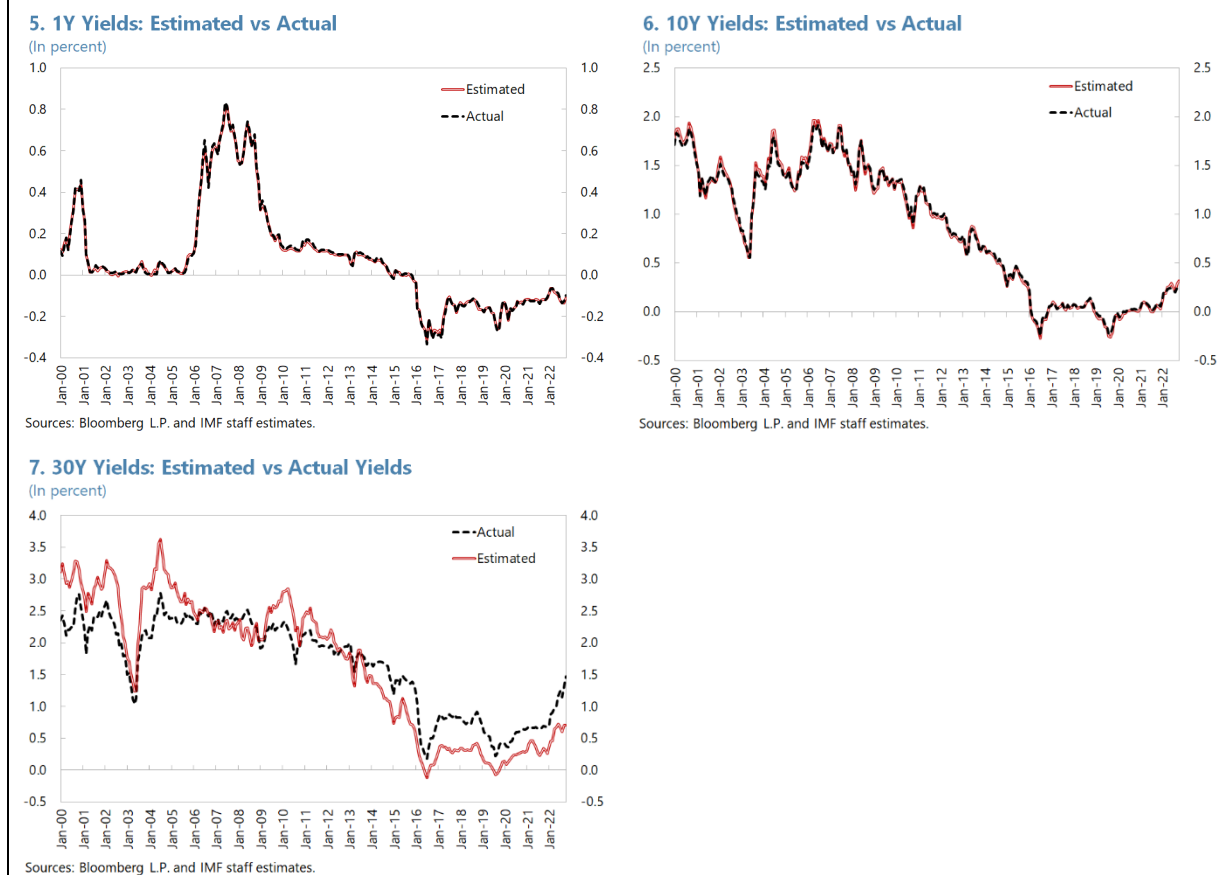
² The data source is Bloomberg and includes all available maturities (except 40 years, which is much less traded than shorter maturity bonds).

³ The loading on L_t does not decay (constant at 1), implying that L_t reflects long-term factors. The loading on S_t starts at 1 and decays monotonically and fast to zero as τ increases, hence can be viewed as a short-term factor. The loading on C_t has an inverse U-shape, starting at zero initially (hence not short-term), increasing up to a level of τ , and decaying to zero afterwards for higher τ s (hence not long-term). The slope in the model is defined as short minus long, and hence a negative slope factor means yields are increasing as maturity increases.

domestically and abroad. The estimated slope factor confirms that there had been sustained flattening of the yield curve over the past decade. Given YCC, the recent increase in the slope mostly pertains to the rise in yields for maturities beyond 10 years. The curvature of the yield curve (i.e., yields at medium-term maturities relative to short- and long-term maturities) has been negative over the sample period, and exhibits a sharp (and later sustained) increase with the introduction of YCC. The model also performs well in predicting yields, especially at shorter maturities.⁴



⁴ Based on the standard deviation of residuals from the fitted model, the in-sample forecast performance of the model is highest for 4-year yields (0.7 basis points). For 10-year yields, standard deviation of residuals is 3 basis points.

Figure 1. Japan: Characterization of the JGB Yield Curve (concluded)

C. Empirical Results

6. Bank profitability is tightly linked to the term structure of interest rates, given banks' maturity transformation. Yield curve flattening is generally associated with compressed interest margins (Claessens and others 2018; IMF, 2020), as deposit rates (a key component of funding) are generally sticky, whereas lending rates tend to reprice faster (with the pace depending on contractual environment and competition within the industry). However, a flatter yield curve, especially if not prolonged, can improve credit portfolio quality, bring in valuation gains on securities holdings, and improve the economic outlook, all of which would contribute positively to banks' capital (Altavilla and others, 2018; Demiralp and others, 2021). From this perspective, a steeper yield curve may improve net interest margins, but would lead to valuation losses on bond holdings in the short term and could induce higher provision expenses. The overall impact on profitability is ambiguous in principle and depends on how the overall economy (e.g., borrower creditworthiness and demand for credit) and financial markets react to a steeper yield curve.

7. This section presents evidence of how slope of the yield curve affects banks' profitability, with a focus on different drivers of profitability, potential lagged impacts, and heterogeneity across banks. The dataset includes annual unconsolidated financial statements for

95 banks for a sample period of 2003-2021, obtained from Fitch-Bankscope; macroeconomic variables from IMF World Economic Outlook database; and NIKKEI stock market volatility from Thomson Reuters. The following fixed-effects panel model is estimated:

$$Y_{i,t} = \beta Y_{i,t-1} + \gamma Slope_{t \text{ or } t-1} + \delta r_{i,t} + \theta X_{i,t-1} + \theta Z_{t-1} + \mu_i + \epsilon_{it}$$

where $Y_{i,t}$ denotes (i) net interest margin (relative to assets); (ii) net non-interest income (relative to gross revenues), (iii) provision expenses-to-total loans ratio; or (iv) return on assets, of an individual bank i at year t . $Slope_t$ is the (annual average of) slope of the JGB yield curve estimated above (Figure 1 chart 3), and $r_{i,t}$ denotes 3-month constant-maturity JGB yields (annual average).⁵ $X_{i,t-1}$ denote a large set of bank-specific controls ((log) total assets, equity-to-assets, liquid assets-to-total assets, non-performing loans-to-gross loans, securities-to-total assets, and deposits-to-total liabilities ratios, all one-year lagged to mitigate potential endogeneity). Z_t denote macroeconomic variables (real GDP growth, inflation) and financial market volatility (NIKKEI volatility index). The model also includes bank fixed effects (μ_i) which absorb any bank characteristics that do not change over time. The model is estimated via ordinary least squares, and standard errors are clustered at the bank level.⁶

8. The results suggest that a steeper yield curve improves bank profitability (Table 1). A higher slope of the JGB yield curve is estimated to improve net interest margins (NIMs), though weigh on banks' overall profitability by reducing net non-interest income (which mainly reflect valuation losses on securities holdings and commission/fee incomes reflecting in part aggregate demand conditions) and increasing provision expenses (reflecting higher credit risks going forward) (columns (1), (3), (5) and (7)). Economically, a 100-basis-points (close to 1-standard-deviation) increase in the slope of the JGB yield curve is estimated to improve NIMs by 2 basis points (or 8 basis points in the long-run) (column (3)).

9. The positive impact of a steeper yield curve on bank profitability is stronger after one-year lag. The impact of a steeper yield curve on non-interest income and provision expenses is moderated after a year (columns (2), (4), (6), and (8)), as losses on non-interest income and provisions expenses moderate. The results are robust to excluding large banks (available upon request).

10. That said, the impact hinges importantly on how real economic activity or financial market volatility reacts (Table 2). Lower economic growth or higher stock market volatility is associated with a reduction in the impact of a steeper yield curve on banks' profitability, mainly through lowering banks' non-interest income (e.g., lowering unrealized/realized gains on securities holdings) and increasing their provision expenses (amid potential rise in credit risks).

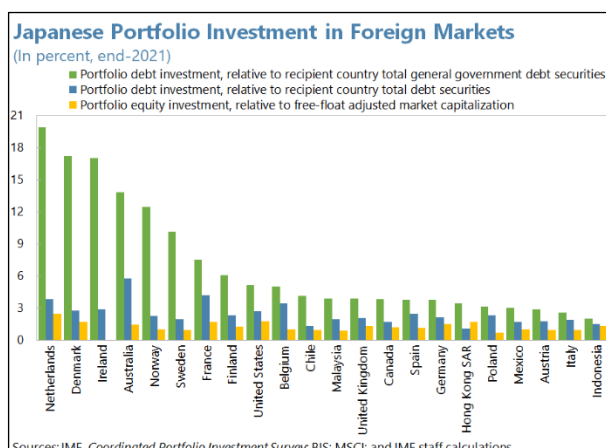
11. The results should be read with the limitation that a better identification requires granular data. While banks are assumed to have equal exposures to changes in the yield curve

⁵ Controlling for short-term yields helps to better identify the impact of a change in the slope.

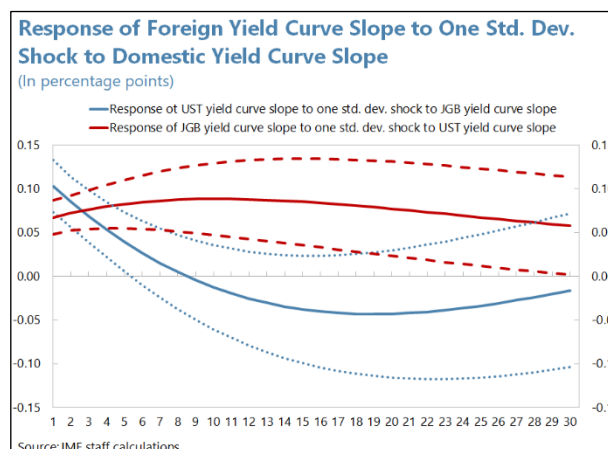
⁶ Given large T and low estimated persistence for the dependent variable (in most specifications), Nickel bias is less of a concern. The results are robust to saturating the model also with city fixed effects, and alternative clusterings, including double clustering by bank and city.

slope in the above analyses, there is a large heterogeneity across banks in the exposures (maturity gaps), especially with respect to different groups of banks (e.g., major vs regional banks). Such data would not only enable a better identification but would also allow measuring how different groups of banks would differentially be affected by changes in the yield curve slope. Moreover, comparing these estimated impacts with some other peer economies is left to future research.

12. A rise in the slope of the JGB yield curve could have global spillovers. Japan has the largest net foreign asset position in the world, which amounts to 3.2 trillion US dollars as of 2022Q3 (750 billion USD as net portfolio assets, 1.5 trillion USD as net FDI, and the rest including mainly reserve assets). Relative to destination markets, gross portfolio debt holdings are meaningfully large for several markets, including the United States (US).⁷ A portfolio re-allocation by Japanese investors in response to a change in the JGB yields could affect valuations of overseas assets. The impact could be larger if accompanied by elevated fiscal concerns or sharp decline in domestic equity prices (e.g., as the latter would deteriorate banks' risk-taking capacities and may force them to deleverage, including overseas positions (IMF, 2011)).



13. Analysis suggests moderate spillovers from JGB to the US Treasury yield curve slope, in line with earlier evidence (IMF, 2011; 2012), and assuming away potential non-linearities. For instance, IMF (2012) reports a 5-10 basis point increase in US and Euro-area Treasury yields in response to a 100-basis-points increase in JGB yields, assuming a mild impact on global risk aversion. A simple VAR of estimated yield curve factors (level, slope, and curvature) for JGBs and US Treasury bonds confirms this finding: a 100-basis-points increase in the JGB yield curve slope is associated with an increase in the US Treasury yield curve slope by close to 10 basis points on average (blue line). The impact appears short-lived, dissipating in five to six months. Estimated spillovers from the US Treasury to the JGB yield curve slope appear



⁷ Japan is the largest foreign holder of US Treasuries, accounting for about 15 percent of all holdings outside the US (<https://ticdata.treasury.gov/Publish/mfh.txt>) as of end-September 2022 (down from 17 percent a year ago).

more persistent and significantly higher beyond short term (black line).⁸ For instance, the one-year cumulative response of the US Treasury yield curve slope to a shock to the JGB yield curve slope is about one-third of the spillover from the US to Japan.⁹

D. Taking Stock and Policy Implications

14. The results underline that a steeper JGB yield curve would help improve banks' overall profitability,¹⁰ the strength of which hinges on macroeconomic and financial market response. The analyses underpin the importance of clear and careful communication by the central bank on the normalization strategy to avoid excessive market volatility, and stronger efforts by policy makers and supervisors to monitor potential vulnerabilities due to higher domestic interest rates (e.g., duration risk of financial institutions, strength of borrower cash flows --especially for those hit more strongly by the pandemic and those with variable rate loans).

15. There have been early signs that some large banks have started to embrace a scenario of higher domestic rates going forward, by reducing their duration risk. However, against the backdrop of fiscal stimulus during the pandemic, banks generally have higher JGB holdings on their balance sheets compared to before the pandemic, suggesting that yen interest rate risk could be larger on banking books, especially of smaller banks. Ensuring policies and supervisory efforts to help reduce potential short-term adverse impact would help better harness the benefits of a steeper yield curve on banks' profitability.

⁸ US Treasury term spreads also appear as a relevant driving factor in movements in the JGB yield curve slope. The JGB yield curve slope not explained by the state space model in Section B is significantly correlated with US term spread (proxied by the difference between 30-year and 3-month US Treasury yields, the longest and shortest tenors in the sample), with a statistically significant correlation of 0.30.

⁹ Incidentally, the relative size of cumulative responses (one to three) is in line with the relative size of the two economies. There are further channels through which changes in the slope of the JGB yield curve slope would have global spillovers, including via interbank exposures, foreign exchange rate, and output. Moreover, foreigners are active traders in the JGB market, and hold 7.1 percent of outstanding JGBs (14.1 percent including Treasury discount bills) as of end-September 2022. Depending on their risk-taking capacity, foreign investors could also be a source of global spillovers arising from changes in JGB yields.

¹⁰ It should be noted that the overall impact would depend on additional factors such as maturity ladder of bank balance sheets and the degree at which banks adjust deposit rates in response to changes in market rates.

References

Altavilla, C., Boucinha, M. and J. Peydro, 2018, "Monetary Policy and Bank Profitability in a Low Interest Rate Environment," *Economic Policy*, 33(96), October 2018, 531–86.

Demiralp, S., Eisenschmidt, J. and T. Vlassopoulos, 2021, "Negative Interest Rates, Excess Liquidity and Retail Deposits: Banks' Reaction to Unconventional Monetary Policy in the Euro Area," *European Economic Review*, 136, 1037-45.

Diebold, Rudebusch, and Aruoba, 2008, "The macroeconomy and the yield curve: a dynamic latent factor approach", *Journal of Econometrics*, 131, 309-338.

International Monetary Fund, 2011, "Japan: Spillover Report for the 2011 Article IV Consultation and Selected Issues", July 2011, Washington D.C.

_____, 2012, "2012 Spillover Report", July 2012, Washington D.C.

_____, 2020, "Banking Sector: Low Rates, Low Profits?," in *Global Financial Stability Report*, April 2020, Washington D.C.

Westelius, N., 2020, "Twenty Years of Unconventional Monetary Policies: Lessons and Way Forward for the Bank of Japan," IMF Working Paper No. 20/226 Washington D.C.

Appendix I. Tables

Table 1. The Impact of a Steeper JGB Yield Curve on Bank Profitability and Underlying Drivers

Dependent Variable:	Underlying Drivers							
	Profitability		Net Interest Margin		Net Non-Interest Income-to-Gross revenues		Provisions-to-gross loans	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slope of the JGB Yield Curve	0.045*		0.022***		-1.776**		0.105***	
	(0.025)		(0.007)		(0.717)		(0.019)	
Slope of the JGB Yield Curve (lagged)		0.135***		0.017***		1.905***		0.053***
		(0.022)		(0.006)		(0.493)		(0.017)
Short-term Interest Rate	-0.158**	-0.340***	0.025	0.004	5.286**	0.986	0.069	0.026
	(0.071)	(0.077)	(0.020)	(0.018)	(2.286)	(2.321)	(0.055)	(0.060)
Real GDP Growth	0.010*	0.004	0.003***	0.002	0.229	0.156	-0.012***	-0.016***
	(0.006)	(0.006)	(0.001)	(0.001)	(0.140)	(0.134)	(0.003)	(0.003)
Inflation	-0.018	-0.006	0.007**	0.005*	-1.796***	-0.924**	0.023**	0.006
	(0.019)	(0.016)	(0.003)	(0.003)	(0.446)	(0.382)	(0.009)	(0.008)
NIKKEI Volatility Index (log)	-0.315***	-0.232***	-0.005	0.013	-5.527***	-4.372**	0.128***	0.191***
	(0.049)	(0.049)	(0.009)	(0.009)	(1.832)	(1.906)	(0.041)	(0.045)
Bank Controls included	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank F.E.	Included	Included	Included	Included	Included	Included	Included	Included
Observations	1,296	1,296	1,565	1,565	1,565	1,565	1,544	1,544
R-squared	0.233	0.258	0.967	0.966	0.649	0.650	0.357	0.329
Number of banks	95	95	95	95	95	95	95	95

Notes. All columns include lagged dependent variable. Standard errors are clustered at the bank level, and provided in parantheses. *** p<0.01, ** p<0.05, * p<0.1.

**Table 2. Further Discussions:
How Macroeconomic and Financial Markets Respond May Matter.**

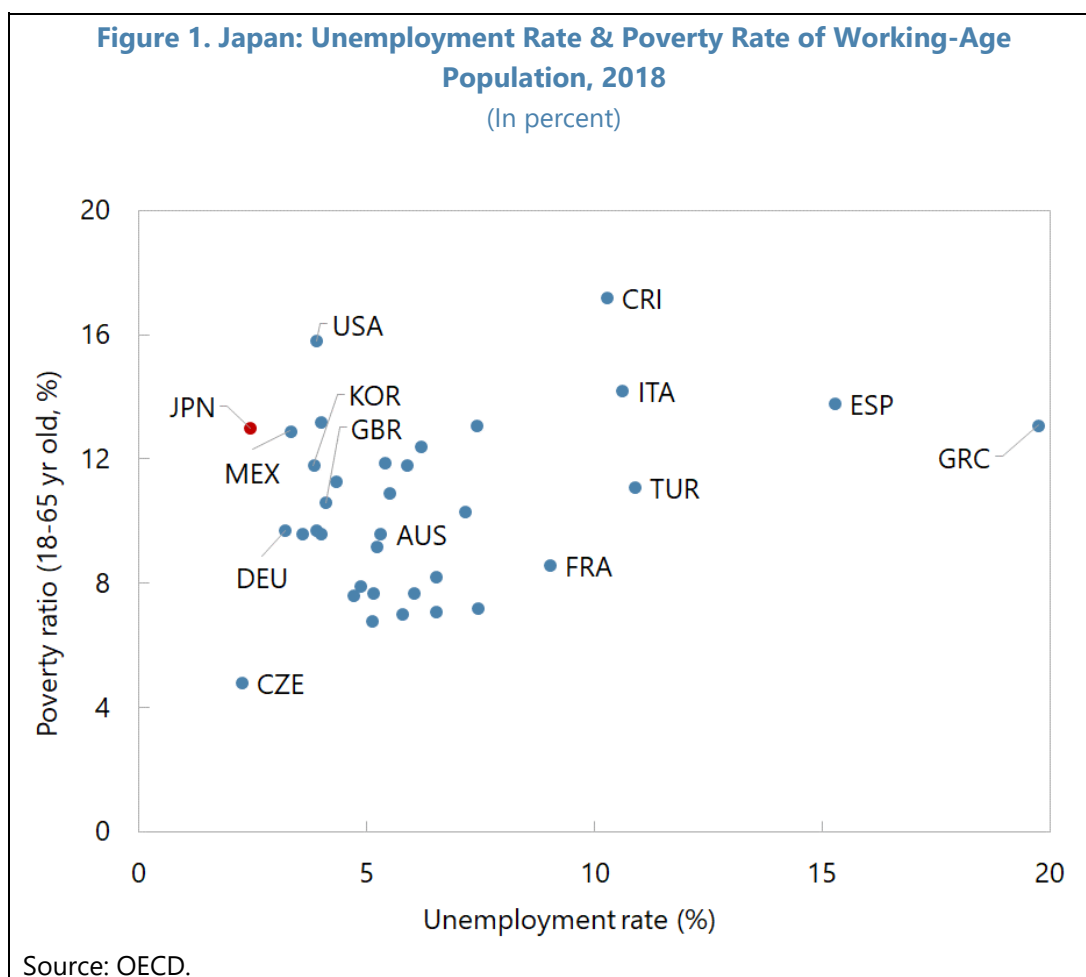
Dependent Variable:	Underlying Drivers							
	Profitability		Net Interest Margin		Net Non-Interest Income-to-Gross revenues		Provisions-to-gross loans	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Slope of the JGB Yield Curve	0.023	1.457***	0.022***	0.012	-1.600**	38.769***	0.101***	-0.318***
	(0.023)	(0.166)	(0.007)	(0.021)	(0.650)	(3.918)	(0.019)	(0.082)
Slope of the JGB Yield Curve* Real GDP Growth	0.050***		-0.001		1.353***		-0.013***	
	(0.007)		(0.001)		(0.152)		(0.002)	
Slope of the JGB Yield Curve*		-0.456***		0.003		-12.993***		0.136***
* NIKKEI Volatility Index (log)		(0.054)		(0.007)		(1.308)		(0.027)
Macro Controls (in levels)	Included	Included	Included	Included	Included	Included	Included	Included
Bank Controls	Included	Included	Included	Included	Included	Included	Included	Included
Bank F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,296	1,296	1,565	1,565	1,565	1,565	1,544	1,544
R-squared	0.372	0.281	0.967	0.967	0.698	0.672	0.385	0.365
Number of banks	95	95	95	95	95	95	95	95

Notes. All columns include lagged dependent variable. Standard errors are clustered at the bank level, and provided in parantheses. *** p<0.01, ** p<0.05, * p<0.1.

OPTIONS TO STRENGTHEN THE SOCIAL SAFETY NET IN JAPAN¹

A. Introduction

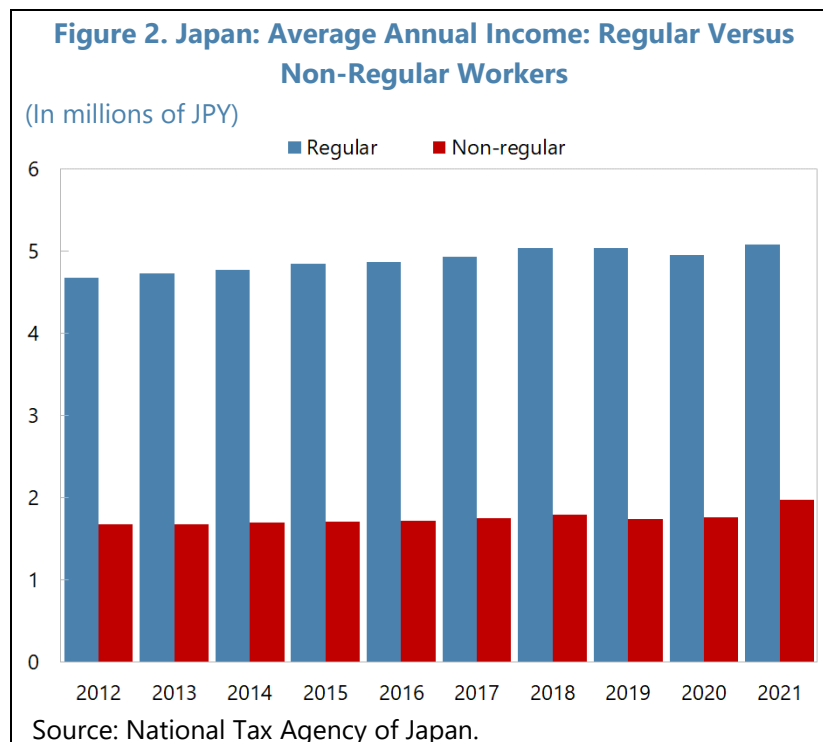
1. **The high poverty rate of the working-age population is a long-standing social and economic issue in Japan.**² Japan's unemployment rate continues to remain relatively low compared to other OECD countries. However, Japan's poverty rate of the working-age population is one of the higher ones among OECD countries after a gradual rise since the 1980s, despite a deduction in recent years (Figure 1).³



¹ Prepared by Zhiyong An (FAD) and Kohei Asao (APD).

² The working-age population refers to those people between 18 and 65 years old.

³ The poverty rate is defined as the share of the people whose income falls below half of the median household income. Japan's poverty rate is derived from the Comprehensive Survey of Living Conditions conducted once every three years by the Ministry of Health, Labour, and Welfare (MHLW) of Japan.



2. This high poverty rate in Japan is closely linked with the widespread non-regular employment.⁴ The number of non-regular workers such as fixed-term contract workers, part-time workers, and dispatched workers has increased in recent decades, accounting for about 40 percent of total employment (IPSS, 2019). Non-regular workers suffer from a variety of problems like unstable employment, low wages, and poor development opportunities. The average annual income of non-regular workers falls below 2 million JPY and is less than half of that of regular workers (Figure 2).⁵

3. The public assistance program in Japan does not provide adequate income support for the working poor and creates inherent work disincentives (Box 1). First, more than half of the public assistance recipients are elderly households, and the share of the recipients with a disabled or sick individual is also large. This suggests that the public assistance program may not provide adequate income support for the working poor. Second, because the amount of assistance is calculated by subtracting the household income from the minimum living expenses, the public assistance program creates inherent work disincentives for the working poor. For example, if a worker's annual income is less than the minimum living expenses, he may be induced to not work at all by the public assistance program.

⁴ Regular/non-regular employment and permanent/temporary employment are, in general, synonymous.

⁵ The working poor in Japan is domestically understood to be those whose annual income is less than 2 million JPY.

Box 1. The Public Assistance Program in Japan

The public assistance program has its legal basis on the Public Assistance Act enacted in 1950. It is founded on four fundamental principles. First, public assistance to all citizens in poverty is a responsibility of the State. Second, all citizens may receive public assistance in a nondiscriminatory and equal manner if they satisfy the requirements prescribed by this Act. Third, the State guarantees a minimum standard of living where a person can maintain a wholesome and cultured standard of living. Finally, the provision of public assistance is conditioned on a person who is living in poverty shall utilizing his/her assets, abilities, and every other thing available to him/her for maintaining a minimum standard of living.

The public assistance program in Japan comprises eight types of assistance, namely, livelihood, education, housing, medical, long-term care, maternity, occupational, and funeral assistance, among which the livelihood assistance is the major one. The amount of assistance is calculated by subtracting the household income from the minimum living expenses that can be different depending on region, family structure, etc. The livelihood assistance is provided as cash transfers.

Public assistance is means-tested just as suggested by the fourth principle mentioned above. Assets such as land, houses, and farms must be sold, except in the case where the person is living in or utilizing them and the value of the assets is higher when being utilized than being sold. Regarding the ability to work, if a person can work and there is an adequate job for him/her where he/she is living, he/she must use that ability in precedence over public assistance. However, the person can receive public assistance if household income including working income does not reach the minimum living expenses. After receiving an application from a household in poverty, public assistance is provided upon passing the means test.

The number of public assistance recipients has been increasing since the mid-1990s. As of July 2016, about 1.6 million households received public assistance, among which elderly households take the largest share (over 50 percent) which has been increasing over the past several decades. Households with a disabled or sick individual also take a large share at about 26 percent. Single-mother households contribute to about 6 percent of recipients. Regarding the duration of receiving assistance, the average duration is long with merely about 10 percent of the recipients having been on the program for less than a year but about 30 percent having been on the program for more than ten years. The long duration is probably not surprising because most of the recipients are elderly people.

Note: This box draws heavily from IPSS (2019).

4. The Earned Income Tax Credit (EITC) warrants consideration to relieve poverty of the working poor in Japan. The prior discussions suggest that the Japanese economy faces the following four problems: (1) low unemployment rate but high poverty rate of the working-age population; (2) widespread non-regular employment; (3) limited income support provided by the public assistance program for the working poor; and (4) inherent work disincentives created by the public assistance program for the working poor. These problems all suggest that EITC warrants consideration in Japan given the following background:

- **EITC programs have grown in popularity in advanced economies (AEs) in recent decades.** Both the United States (US) and the United Kingdom (UK) have had EITC programs for a long period, about four or more decades. In Germany, it was included as part of the country's broader labor market reforms in the early 2000s. Denmark and Sweden have implemented EITC programs since 2004 and 2007, respectively. As of 2009, 16 of the 30 OECD countries have

operated EITC programs (Immervoll and Pearson, 2009). Some AEs have also substantially expanded their EITC programs over time. For example, since its inception in 1975 as a modest program aimed at offsetting the social security payroll tax for low-income families with children, the EITC in the US has grown to become one of its largest anti-poverty programs.

- **The increasing popularity of EITC programs reflects growing concerns about the work disincentives inherent in means-tested anti-poverty programs and the need to support the working poor.** Many AEs have long relied on means testing of anti-poverty transfers as a way of reducing the fiscal cost of such programs (Friedman, 1962; Tobin, 1966; Brewer et al., 2009; Coady et al., 2021). However, the use of such programs has also resulted in concerns about the work disincentives inherent in such means testing and a growing awareness of the need to support the incomes of the working poor. The EITC is seen as a way of addressing these dual concerns.
- **Introducing an EITC in Japan can additionally help address ageing population by boosting employment and labor supply.** The Japanese population is ageing thanks to both declining fertility rate and steadily increasing life expectancy (IPSS, 2019). In 2017, the elderly (i.e., aged 65 years or over) accounted for about 27.6% of the total population, the highest in the world. Plus, the share of the elderly has been projected to reach as high as about 38.4% in 2065.
- **The idea of EITC is also consistent with Prime Minister Fumio Kishida’s proposal for a “New Form of Capitalism”.** The key concept of the “New Form of Capitalism” proposed by Prime Minister Fumio Kishida is to achieve a virtuous cycle for economic growth mainly through labor market policies and a more equitable distribution of the accruing benefits. Because an EITC can facilitate redistribution to low-income workers and boost employment and labor supply, it can be an important policy instrument to advance this initiative.

5. This paper provides an overview of the theoretical and practical issues of a EITC, aiming to support its potential introduction in Japan. We start by providing a brief review of the theoretical literature on the role of an EITC. The experience in OECD countries is then covered in the form of a summary of a review by Immervoll and Pearson (2009). Finally, we identify key design and implementation issues that country authorities need to consider when introducing an EITC.

B. The EITC in Theory

6. The theoretical analysis suggests that an EITC can be part of the optimal income tax schedule. The standard optimal income taxation model pioneered by Mirrlees (1971) did not support any role for an EITC because in this model the optimal marginal income tax rate is always non-negative. Numerous papers have since extended the standard model in four distinct directions. First, it has been extended to allow individual labor supply to respond along both the intensive (i.e., hours of work) and extensive (i.e., labor force participation) margins (Diamond, 1980; Saez, 2002).⁶ Second, it has been extended to allow for two-dimensional informational asymmetry between the

⁶ See also Jacquet et al. (2013) for a similar model based on a continuum of earnings and skill levels.

government and individuals (Choné and Laroque, 2010).⁷ Third, it has been extended to allow for individual failures (Gerritsen, 2016; Farhi and Gabaix, 2020; Lockwood, 2020). Finally, it has been extended to allow for non-welfarist social welfare functions (Kanbur et al., 1994; An and Coady, 2022). These four distinct extensions all suggest that an EITC can be part of the optimal income tax schedule.

7. Standard labor supply theory suggests that there is likely to be a trade-off between the employment and poverty alleviation objectives motivating an EITC. The introduction of an EITC will tend to increase aggregate employment by inducing some non-workers to enter the labor force thereby shifting the labor supply curve downwards to the right. This in turn will tend to increase the post-EITC wages facing workers but decrease the post-EITC wages facing employers.⁸ The more elastic the labor demand curve, the greater (smaller) the share of the EITC benefit that is captured by workers (employers).⁹ In addition, the greater the share of the EITC benefit captured by workers (and thus the greater the poverty alleviation impact) the lower the employment impact and vice versa.

C. The EITC in OECD Countries

8. Evidence for OECD countries shows that EITC programs can take many forms involving different design features. According to the review by Immervoll and Pearson (2009), EITC programs differ along many relevant dimensions. For example, tax concessions or social contribution reductions are in place for some countries (e.g., Belgium, Finland, Germany, Netherlands), while many other countries provide refundable tax credits (e.g., Canada, France, the US, the UK). To target the EITC benefit to relevant groups (e.g., the unemployed or low-income individuals), eligibility and benefit amounts can depend on a range of characteristics and circumstances including having children, working a minimum number of hours, receiving income from work, or entering employment. All EITC programs use at least one of these conditions or they feature gradual phase-ins or phase-outs as a means of targeting individuals at specific earning levels or working hours. It is notable that for about half of EITC programs eligibility is restricted to working families with children, reflecting a particular concern for child poverty and wellbeing. To target low-income individuals, incomes can be assessed individually for the benefit recipient or jointly for the couple or the family.

9. The EITC is a critical income support for working families. For example, in the US in 2019, 25 million working households received about \$63 billion nationwide, with an average benefit

⁷ See also Sandmo (1993), Cuff (2000), and Boadway et al. (2002) for early models, and a more recent contribution by Lockwood and Weinzierl (2015).

⁸ What's more, because recipients of an EITC benefit compete in the same labor market as others who are ineligible for the benefit (even when they are not perfect skill substitutes), these wage rate declines can extend to many workers who are ineligible for the benefit. See Leigh (2010), Rothstein (2010), and Azmat (2019) for more discussions.

⁹ A basic result in the economics of taxation is that the economic incidence of taxes depends on the relative elasticities of supply and demand for the good being taxed, and not on their statutory incidence (Fullerton and Metcalf, 2002). In the Mirrlees (1971) model, wages are assumed to be fixed so that the EITC benefit is fully captured by the worker.

of approximately \$2,500 (Linos et al, 2022). In the UK in 2016-17, 2.9 million working families received about £19.3 billion, with an average benefit of around £6,700 (Brewer and Hoynes, 2019).

D. Key Policy Issues¹⁰

10. Articulating the primary objective. The decision on whether to adopt an EITC and how to design and implement it should be based on well-defined policy objectives, especially regarding whether the primary objective is to address in-work poverty or promote employment. In particular, the theoretical literature highlights that there is likely to be a trade-off between these two objectives in practice. Therefore, the primary objective needs to be carefully articulated at the very beginning. In this regard, given the low unemployment rate but high poverty rate of the working-age population in Japan, addressing in-work poverty could be set as the primary objective at least in the short run. That said, as ageing population will likely become even more severe over time, the primary objective may need to shift to boosting labor force participation in the long run.

11. Addressing existing policy anomalies. Existing policies can run counter to the policy objectives of an EITC. Therefore, it is important to first examine ways of addressing existing policy anomalies. These include:

- **Labor taxes.** High existing labor income taxes (e.g., payroll taxes) at low earnings levels run counter to the poverty alleviation and employment promotion objectives. In such cases, consideration should be given to using tax reductions targeted at low earners. Reducing the cost of labor to the employer can increase labor demand as well as after-tax wages for low-income workers. In this regard, it would be essential for the Japanese authorities to examine the country's personal income tax system, including both its base and rate schedule. The theoretical literature suggests that the optimum depends on the distribution of individual skills (i.e., wage rates), individual labor supply responses, the government's preference for redistribution, the differences in social and individual work preferences, etc.
- **Out-of-work benefits.** Where eligibility criteria for out-of-work benefits are not strict and benefit levels are generous, reforms should focus on strengthening the link between benefit levels and earnings. To this end, it would be essential for the Japanese authorities to assess the country's public assistance program, including both its eligibility criteria and benefit levels. For example, the eligibility for the public assistance program in Japan is independent of employment status; but this may need to be reformed.

12. Designing an EITC. EITC programs can take many forms involving different design features, suggesting that there are difficult design issues that need to be resolved in developing an EITC program. Resolving these design issues in general hinges on the primary objective articulated at the beginning. Specifically, if the primary objective is to address in-work poverty, then EITC benefit levels should be linked to family structure (e.g., the number of children) and household income rather than individual income, but not to working hours or earnings thresholds. In addition, for the purposes of

¹⁰ This section draws heavily on the discussion in An and Coady (2021).

addressing in-work poverty, EITC benefits should be delivered in real time (e.g., monthly), and the self-employed be included. We discuss these design issues in detail as below:

- **Definition of income.** From the perspective of alleviating poverty, benefit levels should be linked to total household income including, for example, capital income and earnings arising from employment or self-employment. However, if the primary objective is to promote employment, then individual earnings may be the more appropriate income base for determining benefit levels.
- **Linking benefits to family structure.** Since welfare depends on family per capita income (rather than just individual earnings), poverty alleviation objectives are best achieved by linking benefit levels to family composition, such as the number of children, as well as to individual earnings. For example, one may not wish to use scarce public resources to provide income support to the spouse of a highly paid executive. Consistent with this, many countries provide more generous benefits for workers with children. For example, in the US, the level of EITC benefits increases with family size, with the maximum possible credit for families with three or more children and childless workers receiving substantially lower benefits. In many countries (including the UK), while income tax is levied on an individual basis, benefits are linked to family income. Experience shows that it is possible to deliver a tax credit based on family circumstances in a tax system that uses individuals as the basic unit of personal income taxation. Therefore, although the levy of income tax is based on the individual in Japan, the possibility of linking EITC benefits to family structure cannot be excluded. However, in such systems it is important that the difficulties of claiming a family-based credit in an individual-based tax system does not undermine take-up rates.
- **Use of working hours or earnings thresholds.** On one hand, linking eligibility for EITC benefits to working hours or earnings thresholds provides stronger incentives to work more hours. Such restrictions can also reduce fiscal costs since payments do not need to be made to workers with working hours or earnings under the thresholds. On the other hand, such restrictions can impose a significant additional administrative burden.¹¹ In addition, as a flip side of lowering fiscal costs, the use of working hours or earnings thresholds is not likely attractive from a poverty alleviation perspective since those excluded will not receive benefits. If this is the case, it may be possible to target such restrictions at less vulnerable workers (e.g., single adults) and condition the receipt of additional benefits on job search and training participation.
- **Frequency and timing of payments.** The frequency and timing of payments are also often seen as important both in terms of alleviating poverty (low-income workers may face liquidity constraints) and incentivizing employment (so individuals recognize labor supply incentives). In the UK, tax credits are reflected in the withholding from wages so that the credit appears in the regular paycheck. This has the advantage of allowing recipients to receive their benefits contemporaneously with their earnings to finance regular basic needs, as well as of tightening

¹¹ This may be particularly true for working hours limits since hours information is typically not required to implement an income tax and accurately monitoring hours can prove to be overburdensome.

the perceived link between income and labor supply decisions. In the US, while it was previously possible for beneficiaries to receive frequent payments, this option was removed since most opted for annual payments. However, such behavior possibly reflected information constraints rather than individual preferences.

- **Treatment of the self-employed.** Self-employed workers present a special challenge for all income tax and transfer systems since it can be difficult to verify their income for the purposes of determining net income tax payments. Therefore, where self-employment is prevalent, adopting a refundable tax credit invites fraudulent claims and raises difficult administrative issues. At the same time, for the purposes of addressing in-work poverty, it is important to include the self-employed, and leaving them out can result in pressures to introduce some other tax benefit for them which can result in overly complex systems. It is therefore important that the extension of EITC eligibility to the self-employed is accompanied by effective measures to ensure adequate levels of tax compliance among this group.

13. Implementing an EITC. The effectiveness of an EITC in achieving underlying policy objectives requires that country authorities have the capacity to implement the program. Implementation of a comprehensive EITC programs requires high levels of tax filing among the target population and a strong system of assessment for the personal income tax. If most taxpayers are required to lodge income tax returns or an effective withholding tax system is already in place, then a EITC program should be relatively inexpensive to administer. Otherwise, the cost of introducing an EITC can be substantial. In terms of implementation, introducing an EITC in Japan would entail three administrative challenges.¹² First, most employees in Japan do not file annual tax returns. This is because labor income taxes are withheld at source and adjusted annually by their employers, and investment income is withheld at source in many cases. Second, information sharing is insufficient among the ministries, local governments, and public corporations. For example, although Japan's National Tax Agency collects employees' income information from employers, its coverage is partial. Local governments gather data of residents' incomes, but such data are not aggregated by a central agency. The last challenge is delivery of payments. This is because transfers between bank accounts are widely-accepted means of payment, but taxpayers do not register information of their bank accounts with Japan's National Tax Agency yet. However, these three administrative challenges can be overcome by: (1) making annual tax returns mandatory while providing individuals with pre-filled tax returns; (2) utilizing the My Number taxpayer identification system launched in 2016 to improve information collection, sharing and management; and (3) linking the bank account to the My Number of each taxpayer for the purpose of delivering benefits.

14. Overcoming information constraints or knowledge barriers. The effectiveness of an EITC in achieving underlying policy objectives also requires that those eligible are aware of these benefits and understand the inherent incentives for increasing their labor supply. Country authorities should therefore take measures to overcome any information constraints or knowledge barriers through

¹² Japanese researchers proposed the idea of introducing an EITC in Japan as early as 2009 (e.g., Morinobu, 2009). Probably due to administrative challenges, proposals failed to receive positive responses from Japanese authorities. However, conditions have changed since then.

informational outreach efforts or other sources such as peer networks (Maag, 2005; Chetty et al., 2013). It is also important to simplify the broader tax and benefit system within which an EITC is embedded and ensure that potential beneficiaries can easily understand how various components of the tax and benefit system interact (Azmat, 2014).

15. Monitoring and evaluating the impact of an EITC. Adequate resources need to be allocated to monitoring and evaluating how the EITC is impacting employment and wage levels to ensure the policy is achieving its objectives and to avoid unintended adverse consequences. This requires careful analysis of employment and wage outcomes for different household and skill types both before and after the policy is introduced.

References

An, Zhiyong, and David Coady, "Wage Subsidies in Theory and Practice," *mimeo*, 2021 (Washington, DC: International Monetary Fund).

An, Zhiyong, and David Coady, "Social versus Individual Work Preferences: Implications for Optimal Income Taxation," *FinanzArchiv/Public Finance Analysis*, 2022, 78(4), 393-421 .

Azmat, Ghazala, "Evaluating the Effectiveness of In-Work Tax Credits," *Empirical Economics*, 2014, 46, 397-425.

Azmat, Ghazala, "Incidence, Saliency and Spillovers: The Direct and Indirect Effects of Tax Credits on Wages," *Quantitative Economics*, 2019, 10, 239-273.

Boadway, Robin, Maurice Marchand, Pierre Pestieau, and Maria Del Mar Racionero, "Optimal Redistribution with Heterogeneous Preferences for Leisure," *Journal of Public Economic Theory*, 2002, 4, 475-498.

Brewer, Mike, Marco Francesconi, Paul Gregg, and Jeffrey Grogger, "Feature: In-Work Benefit Reform in a Cross-National Perspective - Introduction," *Economic Journal*, 2009, 119(535), F1-F14.

Brewer, Mike, and Hilary W. Hoynes, "In-Work Credits in the UK and the US," *Fiscal Studies*, 2019, 40(4), 519-560.

Chetty, Raj, John N. Friedman, and Emmanuel Saez, "Using Differences in Knowledge across Neighborhoods to Uncover the Impacts of the EITC on Earnings," *American Economic Review*, 2013, 103(7), 2683-2721.

Choné, Philippe, and Guy Laroque, "Negative Marginal Tax Rates and Heterogeneity," *American Economic Review*, 2010, 100, 2532-2547.

Coady, David, Samir Jahan, Riki Matsumoto, and Baoping Shang, "Guaranteed Minimum Income Schemes in Europe: Landscape and Design," *IMF Working Paper No. 2021/179*, 2021.

Cuff, Katherine, "Optimality of Workfare with Heterogeneous Preferences," *Canadian Journal of Economics*, 2000, 33, 149-74.

Diamond, Peter, "Income Taxation with Fixed Hours of Work," *Journal of Public Economics*, 1980, 13, 101-110.

Farhi, Emmanuel, and Xavier Gabaix, "Optimal Taxation with Behavioral Agents," *American Economic Review*, 2020, 110(1), 298-336.

Friedman, Milton. *Capitalism and Freedom*. 1962. Chicago: University of Chicago Press.

Fullerton, Don, and Gilbert E. Metcalf, "Tax Incidence," In: *Handbook of Public Economics*, Alan J. Auerbach and Martin Feldstein (eds.), 2002, Vol. 4, 1787-1872. New York: North-Holland.

Gerritsen, Aart, "Optimal Taxation when People Do Not Maximize Well-Being," *Journal of Public Economics*, 2016, 144, 122-139.

Immervoll, Herwig, and Mark Pearson, "A Good Time for Making Work Pay? Taking Stock of In-Work Benefits and Related Measures across the OECD," *IZA Policy Paper No. 3*, 2009.

Jacquet, Laurence, Etienne Lehmann, and Bruno Van der Linden, "Optimal Redistributive Taxation with Both Extensive and Intensive Responses," *Journal of Economic Theory*, 2013, 148(5), 1770-1805.

Kanbur, Ravi, Michael Keen, and Matti Tuomala, "Optimal Non-linear Income Taxation for the Alleviation of Income-Poverty," *European Economic Review*, 1994, 38, 1613-1632.

Leigh, Andrew, "Who Benefits from the Earned Income Tax Credit? Incidence among Recipients, Coworkers and Firms," *B.E. Journal of Economic Analysis & Policy*, 2010, 10(1), Article No. 45.

Linos, Elizabeth, Allen Prohofsky, Aparna Ramesh, Jesse Rothstein, and Matthew Unrath, "Can Nudges Increase Take-Up of the EITC? Evidence from Multiple Field Experiments," *American Economic Journal: Economic Policy*, 2022, 14(4), 432-452.

Lockwood, Benjamin B., "Optimal Income Taxation with Present Bias," *American Economic Journal: Economic Policy*, 2020, 12(4), 298-327.

Lockwood, Benjamin B., and Matthew Weinzierl, "De Gustibus non est Taxandum: Heterogeneity in Preferences and Optimal Redistribution," *Journal of Public Economics*, 2015, 124, 74-80.

Maag, Elaine, "Paying the Price? Low-Income Parents and the Use of Paid Tax Preparers," *New Federalism: National Survey of America's Families*, 2005, No. B-64.

Mirrlees, James A., "An Exploration in the Theory of Optimal Income Taxation," *Review of Economic Studies*, 1971, 38(2), 175-208.

Morinobu, Shigeki, "From Cash Handouts to Refundable Tax Credits," 1/21/2009 (Tokyo, Japan: The Tokyo Foundation for Policy Research).

National Institute of Population and Social Security Research (IPSS), "Population and Social Security in Japan," *IPSS Research Report No. 85*, 2019.

Rothstein, Jesse, "Is the EITC as Good as an NIT? Conditional Cash Transfers and Tax Incidence," *American Economic Journal: Economic Policy*, 2010, 2(1), 177-208.

Saez, Emmanuel, "Optimal Income Transfer Programs: Intensive versus Extensive Labor Supply Responses," *Quarterly Journal of Economics*, 2002, 117(3), 1039-1073.

Sandmo, Agnar, "Optimal Redistribution When Tastes Differ," *FinanzArchiv/Public Finance Analysis*, 1993, 50(2), 149-163.

Tobin, James, "On Improving the Economic Status of the Negro," *Daedalus*, 1966, 94(4), 878-898.

THE FINANCIAL IMPACT OF CARBON TAXATION ON CORPORATES¹

Japan's commitment to achieve net zero emissions by 2050 will likely require substantial carbon pricing. Corporates appear to be able to absorb a sharp increase in carbon taxes on average, but there is a substantial weak tail of firms that could face financial stress. The analysis underscores the need to align the private sector and public policies with Japan's climate targets to ensure a smooth transition to net zero.

A. Introduction

1. Japan's transition to net zero carbon emissions will require a transformation of the economy. Japan is committed to reaching net zero greenhouse gas (GHG) emissions by 2050, with an upgraded interim target for a 46 percent reduction in GHG emissions by 2030, relative to 2013 levels. These targets will require a substantial transformation of the Japanese economy, presenting risks and opportunities to businesses, and associated policies will have distributional consequences. Pricing carbon emissions at much higher rates than currently will likely be necessary, either through a carbon tax or an emission trading scheme, as part of a green transformation policy package (IMF 2022a).²

2. Companies and by extension the financial sector face risks from the transition to net zero. Climate transition risk drivers are public policy shifts including carbon pricing, technology shifts, and changes in investor and consumer preferences (IMF 2019a). Parts of the economy with large GHG emissions are most exposed. In Japan, this includes the electricity and power, transport, and industrial sectors (see next section). Decarbonization of the electricity and power sector is particularly important in Japan given the large contribution of this sector to total emissions and its continued high usage of fossil fuels.

3. This note presents a simple approximation of the impact of higher carbon taxes on Japanese firms. Our calculations assume that firms fully absorb a carbon tax levied on their emissions. In practice, output prices and quantities, production processes, inputs, and the overall structure of the economy would all adjust. Modeling this is highly complex and requires a general equilibrium approach with strong assumptions that is beyond the scope of this note. Our results should be interpreted as a likely upper bound of the impact of carbon pricing on firms and a complement to the Bank of Japan/Financial Services Agency climate stress scenario analysis (2022) and banks' efforts to quantify climate risk exposures. The analysis provides insights into which sectors and firms are vulnerable. It underscores the need to prepare the most exposed corporates

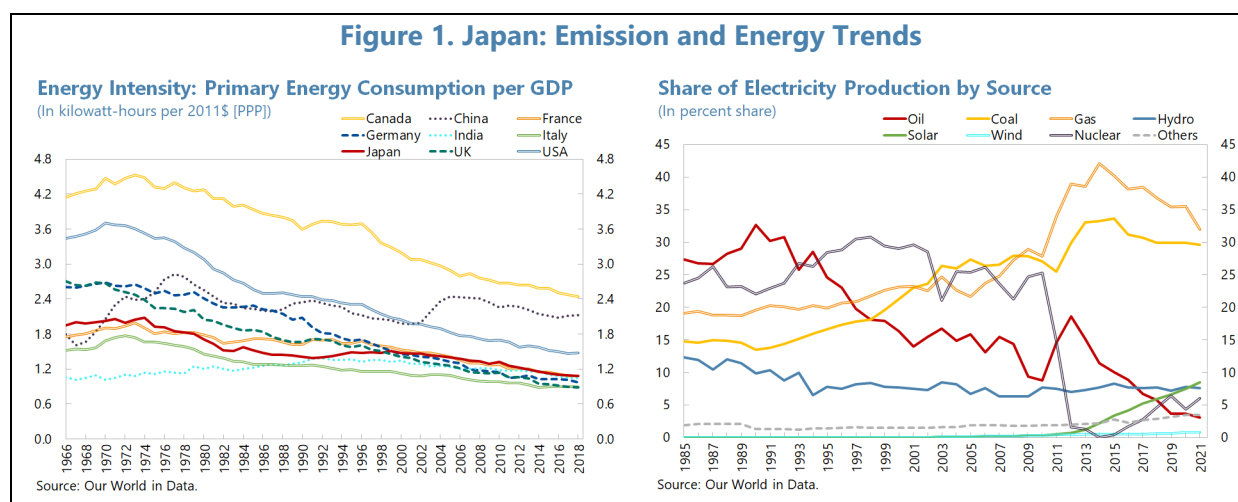
¹ Prepared by Jochen M. Schmittmann (OAP). Yun Gao (OAP) provided excellent research assistance.

² In addition to petroleum and coal taxation, in 2012 Japan introduced a carbon pricing mechanism, the Tax for Climate Change Mitigation (TCCM), on fossil fuel. The current TCCM tax rate is 289 yen (about \$2) per ton of CO₂. Voluntary cap-and-trade emission trading mechanisms are in place in Tokyo Metropolitan City and Saitama Prefecture.

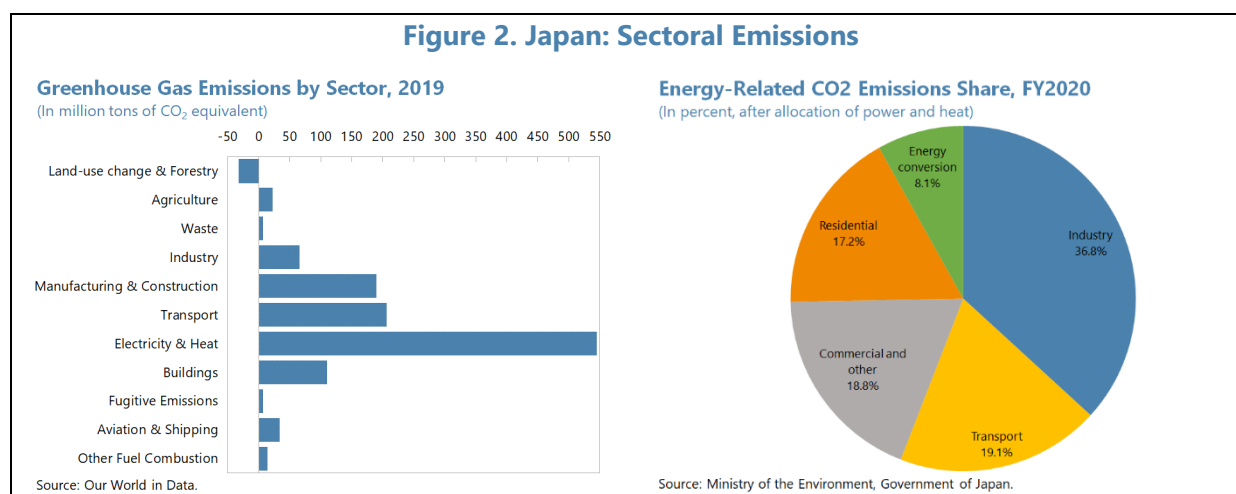
for the transition to reduce risks. This requires firms to develop strategies to comply with lower emissions. The financial sector plays a role in monitoring and pricing risks, and in working with corporates to address transition risks. Public policy needs to support firms in the transition through investment in decarbonization and green technologies, clarity on mitigation policies to enable corporate planning, support for green and transition finance, and climate risk assessments and management.

B. Emission Trends in Japan

4. Reliance on fossil fuels remains high (Figure 1). The emission-intensity of GDP has fallen less over the last three decades in Japan than in most other major advanced economies. Decarbonizing energy production is particularly challenging—the emission intensity of energy production has been stagnant since the 1960s and is now higher in Japan than in most other major advanced economies. Fossil fuels account for about 85 percent of primary energy production. Renewable energy production has almost doubled since 2011, but at the same time nuclear energy production dropped following the accident at the Fukushima Daiichi nuclear power plant in 2011.



5. Electricity and heat production are the largest sources of emissions, but they mostly serve as inputs for other sectors (Figure 2). Electricity and heat production account for close to half of Japan’s GHG emissions underscoring the need to decarbonize this part of the economy to achieve carbon neutrality. Transport, manufacturing and construction, buildings, and industry are also important emission sources, even when not counting emissions from purchased electricity and heat in these sectors. Since electricity and heat are mostly inputs for other sectors, another way to look at the sectoral emission profile is to allocate electricity and heat related emissions to the sectors that use these as inputs (right hand side chart, CO₂ only). With this, industry is the largest source of emissions at 36.8 percent followed by transport, commercial activities (commerce, services, offices, etc.), and residential.



C. Methodology and Data

6. We approximate the financial impact of carbon tax scenarios on Japanese firms. We use firm level emission and balance sheet data to calculate changes in listed firms' interest rate coverage ratios (ICR) for two carbon tax levels: \$75 and \$150 per ton of CO₂ equivalent.³ The \$75 carbon tax corresponds to the level estimated by IMF staff as necessary on average by 2030 to limit global warming to 2° Celsius (IMF 2019b). The \$150 scenario stands for the higher carbon tax levels that could be required if climate action continues to be delayed and climate policies are not fully credible (IMF 2022c). ICRs are defined as earnings before interest and taxes (EBIT) divided by interest payments. We calculate current ICRs and ICRs under the two carbon tax scenarios. ICRs under carbon tax scenarios are calculated by subtracting the product of the assumed carbon tax level and a firm's GHG emissions from EBIT.

7. The approach makes the simplifying assumption that firms fully absorb any carbon tax. The assumption implies that firms do not adjust output prices and quantities, and production inputs. In practice, the entire production chain and consumers' choices would adjust to carbon taxation which should lead to lower carbon emissions. The no-pass-through assumption should therefore imply that our estimates of the firm level impact of carbon taxation provide an upper bound of the financial impact on firms.

8. The scope of measurement of firms' emissions affects the assessment of the impact of carbon pricing. Scope 1 emissions cover direct emissions from owned or controlled sources. Scope 2 emissions cover indirect emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the reporting company.⁴ We present results for firms' combined scope 1 and 2 GHG emissions and scope 1 emissions only. For firms that generate emission intensive inputs

³ Our approach follows the analysis in Grippa and Mann (2020) conducted in the context of the Norway Financial Sector Assessment Program. A methodological difference is that we use actual firm level emissions data instead of applying industry level average emissions.

⁴ Scope 3 emissions cover firms' entire upstream and downstream value chain. This measure of emissions is difficult to compile, and data availability is limited.

for other industries, the analysis overstates the carbon pricing impact. For example, the scope 1 emissions of a utility company will mostly appear as scope 2 emissions of other firms that purchase electricity from the utility. On the other hand, only including scope 1 emissions would downward bias the results for downstream industries that purchase most of their power inputs. In addition, the analysis does not consider any foreign carbon pricing or border adjustment mechanisms which would affect imported inputs and exports.

9. Our sample includes listed Japanese firms. Financial and emission data are obtained from Bloomberg. The sample is close to the entire universe of Japanese listed firms excluding financials for which ICR as a measure of financial health is not comparable. For about half the dataset by revenues and assets, we have firm level emission data. For another 20 percent of firms by revenues and assets, we have at least one year of emissions data. For these firms we fill in missing years by assuming that the ratio of emissions to revenue remains constant. For the remaining 30 percent of firms that do not report emissions, we assume that emission intensities are equal to the average of their respective industries. We confirm the robustness of our results for the full sample in unreported results for emission reporting firms only.⁵

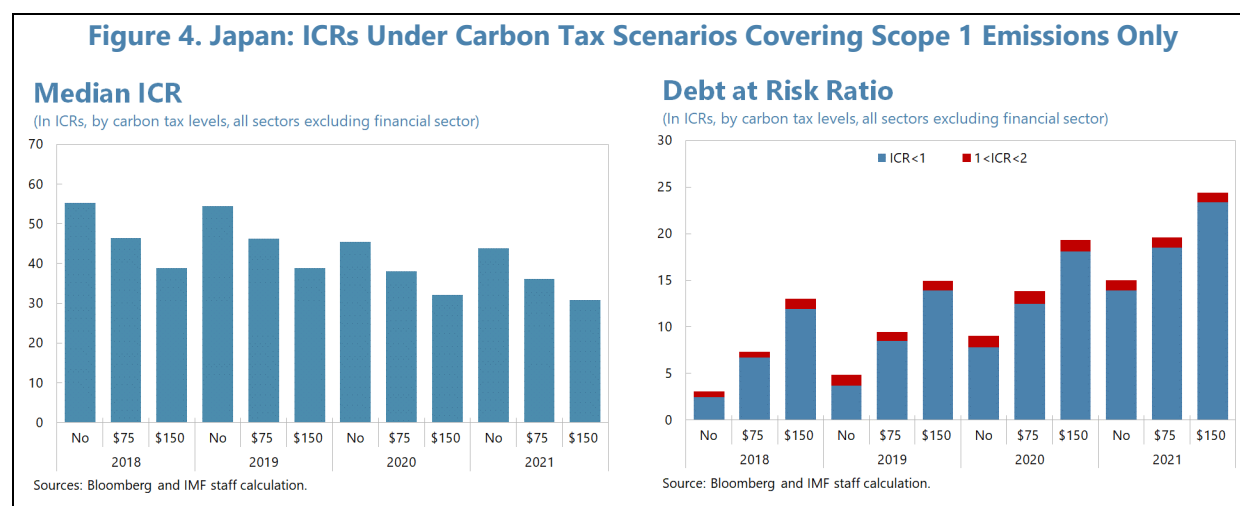
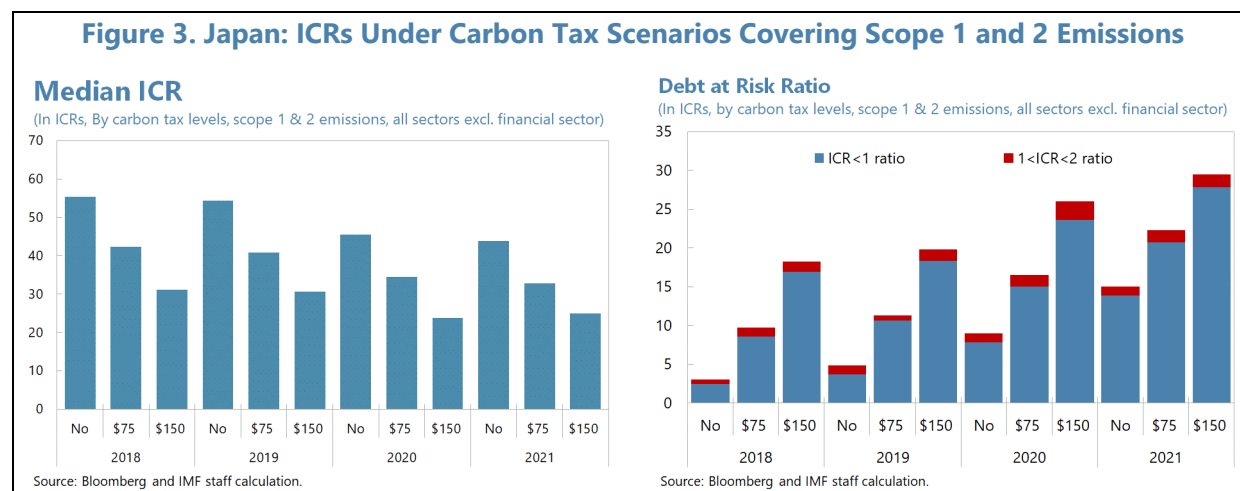
D. Results

10. Median ICRs across all sectors remain high even under a \$150 carbon tax, but there is a significant weak tail of firms with high debt at risk (Figure 3). The median actual ICR in 2021 for Japanese listed firms is high at 44, although below pre-pandemic levels (55 in 2018). With a carbon tax at \$75 on scope 1 and 2 emissions, the ICR for the sample drops to 33, and with a tax at \$150 in declines to 25. These median ICR numbers with carbon taxation fully absorbed by firms are still comfortable—averages are even much higher—but there is a sizeable tail of firms in a weak financial situation. The share of firms in 2021 for which EBIT does not cover interest payments (ICR < 1) is 14 percent and another 1 percent of firms have an ICR between 1 and 2. This weak tail of firms has substantially increased as a consequence of the pandemic—in 2018 only about 2.5 percent of firms had an ICR below 1. With a carbon tax at \$75 on scope 1 and 2 emissions, the share of firms with an ICR below 1 increases to 21 percent and with a carbon tax at \$150, the share increases to 28 percent. In a scenario where only scope 1 emissions are taxed, the impact on firms is expectedly smaller (Figure 4). In this case, the share of firms with an ICR below 1 increases to 19 percent with a carbon tax at \$75 and to 23 percent with a carbon tax at \$150.

11. At a sectoral level, energy, materials, and utilities are severely affected by carbon pricing (Figure 5). This is unsurprising given high scope 1 emissions in these sectors, and it suggests a particular vulnerability in these sectors to transition risks. In practice, companies in these sectors would at least partially pass on higher carbon taxes to firms in other sectors and consumers. At the same time, demand would also shift, for example, toward renewable energy, so that even if our strong full cost absorption assumption is relaxed, these sectors are likely most at risk from the

⁵ Results are qualitatively similar, and conclusions remain unchanged. For the smaller sample of emission reporting firms, ICRs tend to be higher.

net zero transition.⁶ Carbon pricing would have a smaller but still substantial effect on firms in other industries. The percentage of firms with debt at risk with a carbon price at \$150 on scope 1 and 2 emissions would be 35 percent in the consumer discretionary classification, 27 percent for industrials, 19 percent for communication services, and 15 percent for consumer staples. For firms in these industries, a substantial part of the impact stems from scope 2 emissions.



12. Banks’ exposure to transitions risks is determined by their lending portfolio and other asset holdings. While a translation of our firm-level results of exposure to carbon taxation into banks’ risk exposures is beyond the scope of this note, sectoral lending data can provide some insights. Japanese G-SIBs’ exposure to energy and utilities is in the 6-8 percent range, and most smaller banks have smaller exposures to these sectors (IMF 2022b). There are substantial bank loan exposures to other, less affected sectors, and a full analysis would require detailed loan exposure

⁶ The high transition risk exposure assessment for the energy and utilities sectors is in line with recommendations by the Task Force on Climate-Related Financial Disclosures (TCFD), stock market pricing of climate risks (see IMF 2022b), and the assessment of Japanese G-SIBs.

data. Scenario-based analysis by the Bank of Japan and the Financial Services Agency (2022) suggests that “the annual average of estimated transition risk credit costs [...] is considerably lower than the average annual net profits of each bank”. The analysis also shows that transition risk credit costs are concentrated in high emission sectors including energy, power, steel, and automotive.



E. Conclusion and Policy Implications

13. The simple analysis demonstrates the need for parts of Japan's corporate sector to step up readiness to comply with the country's net zero emission commitment. There is a significant weak tail of firms following the pandemic that is not able to cover interest payments out of profits. With carbon taxes at \$75 or \$150 on scope 1 and 2 emissions, the share of firms with ICRs below 1 would increase by 7 percent and 14 percent, respectively. On a sectoral level, energy, utility, and materials companies are most exposed to carbon pricing given their high direct emissions, while downstream sectors are significantly impacted through emissions related to purchased power and electricity.

14. Policies should focus on aligning companies with national level emission reduction targets and managing climate transition risks. At the firm level, efforts are needed to incorporate public policies that will require much lower emissions into business strategies. This should be complimented by better climate related corporate disclosures. The financial sector and particularly banks need to consider transition risks in their lending decisions which will help to allocate capital in line with climate targets. The efforts aimed at quantifying and managing climate financial risks by Japanese policymakers and financial institutions are appropriate in this context. Beyond risk management, the public sector plays a pivotal role in helping the economy transition to net zero. Important elements are investments into decarbonization, support for green technologies, predictable emission pricing pathways, and support for green and transition finance. Some hard-to-abate and high-emission sectors may find the transition particularly challenging and government policies to support emission reductions in these sectors will likely be needed.

References

Bank of Japan and Financial Services Agency, 2022, "Pilot Scenario Analysis Exercise on Climate-Related Risks Based on Common Scenarios", August 2022. Available at https://www.boj.or.jp/en/announcements/release_2022/rel220826a.htm/

Grippa, P., and S. Mann, 2020, "Climate-Related Stress Testing: Transition Risks in Norway", IMF Working Paper WP/20/232, Washington DC.

International Monetary Fund, 2019a, "Sustainable Finance", Global Financial Stability Report, Chapter 6, October 2019, Washington DC.

_____, 2019b, "How to Mitigate Climate Change", Fiscal Monitor, October 2019, Washington DC.

_____, 2022a, "Climate Change Policy Options", Japan Selected Issues, IMF Country Report No. 22/100, Washington DC.

_____, 2022b, "Climate Finance in Japan", Japan Selected Issues, IMF Country Report No. 22/100, Washington DC.

_____, 2022c, "Near-Term Macroeconomic Impact of Decarbonization Policies", World Economic Outlook, Chapter 3, October 2021, Washington DC.