



FRANCE

SELECTED ISSUES

January 2022

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European Department

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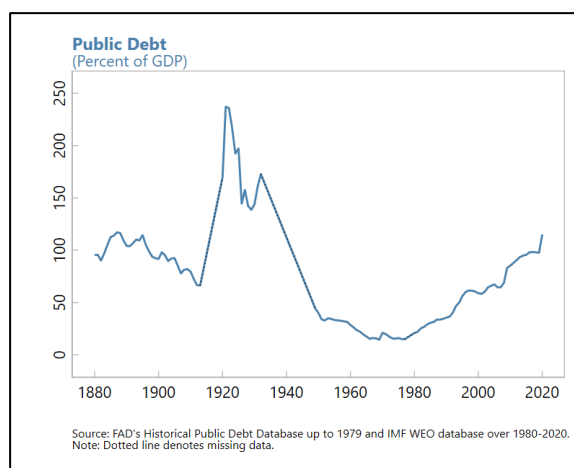
REBUILDING FISCAL BUFFERS AFTER COVID-19: ANCHOR, PATH, AND INSTITUTIONAL FRAMEWORK¹

France's public debt has increased uninterruptedly over the last four decades as fiscal expansions during recessions were only partially redressed amid systematic over-optimism in public finance projections. The appropriate fiscal response to the COVID-19 pandemic led to another large addition to its debt stock. While the secular decline in interest rates has contained refinancing costs, France's debt ratio is projected to remain high and increasingly diverge from its euro area peers. The objective of this note is twofold: First, it uses a structural stochastic model to shed light on what can be an appropriate anchor to redress France's public finances, what is a prudent horizon to reach that anchor, and what should be the pace of fiscal consolidation. The model simulations suggest France should embark on a significant consolidation effort starting in 2023 and aim at reaching a primary surplus of ½ percent of GDP—which would be aligned with its pre-crisis medium-term objective—over a period of about seven years. Second, the note analyzes features of fiscal frameworks across countries that can attenuate the over-optimism bias in fiscal projections, which is a source of low compliance with EU fiscal rules. The findings suggest that a multiyear spending rule for the general government, with strong political backing and a mechanism to clearly monitor deviations and assure compliance with the medium-term objectives, supported by an expansion of the capabilities of the fiscal council, can help France achieving the needed fiscal adjustment.

A. Introduction

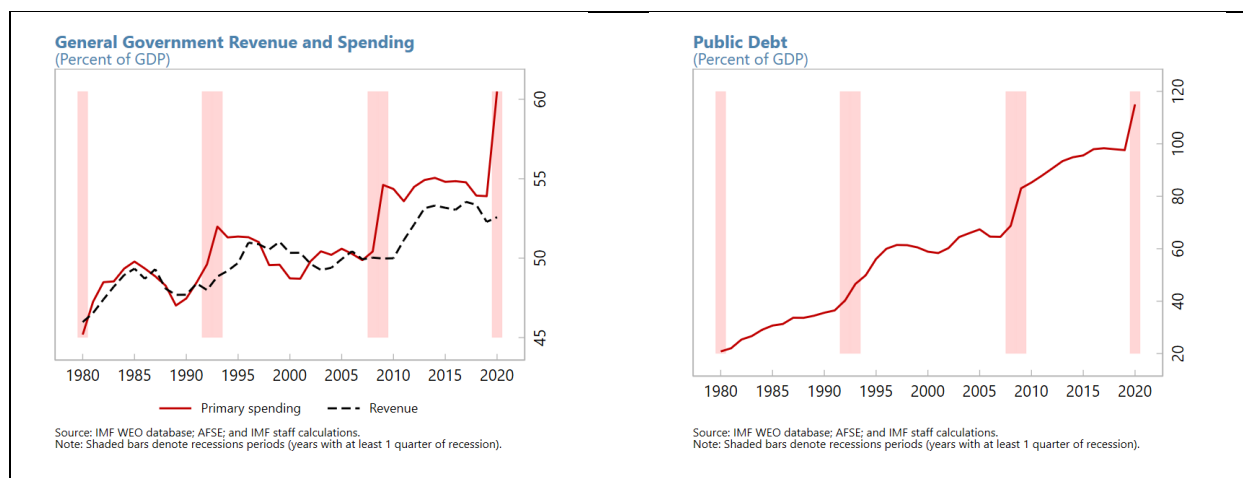
1. France's debt has been on a rising path for more than four decades. After hovering around 15 percent of GDP in the 1970s and reaching about 20 percent of GDP in 1980, the debt ratio in France has increased almost uninterruptedly and reached close to 100 percent of GDP—a level not seen since the interwar period—just before the COVID-19 crisis erupted.

2. The sustained increase in the debt ratio since the 1980s largely reflects recurrent spending expansions during recessions which were only partially reversed or offset with revenue increases in subsequent years. Episodes of steep increases in spending, mostly during recessions, were followed by timid consolidation efforts that only managed to stabilize debt before the next spending-increase cycle kicked in.² A notable exception is the sustained reduction in the spending ratio in the mid to late 1990s, leading to the euro adoption, when the primary balance registered a surplus for a few years.

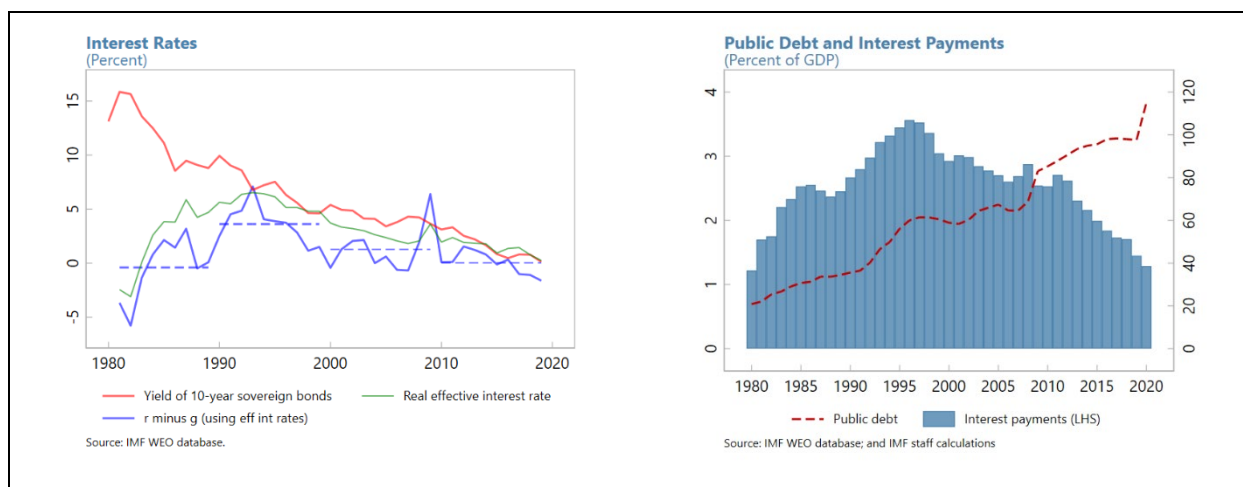


¹ Prepared by Bertrand Gruss (AFR, formerly EUR) and Sebastian Weber (MCM, formerly EUR).

² The source for recession dates is the French Business Cycle Dating Committee, created by the *Association Française de Science Economique* (AFSE).

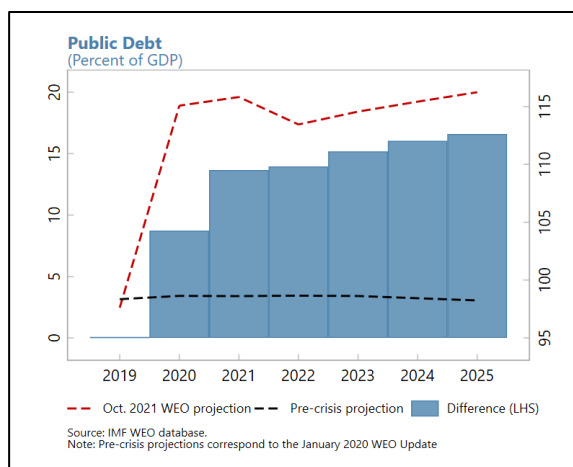


3. Despite the continued increase in debt, France's interest expenses have declined over the past two decades. Nominal interest rates have registered a secular decline over the past 40 years, with the yield of 10-year sovereign bonds declining from above 10 percent in the early 1980s to -0.1 percent in 2020. The effective interest rate has also registered a declining trend, reaching an historical minimum of 1.1 percent in 2020. The interest rate-growth differential (i.e., the difference between the effective interest rate and nominal GDP growth), however, increased between the early-1980s and mid-1990s, as economic growth was slowing. Together with rising debt levels, this led to an increase in the ratio of interest rate expenses to GDP up to the late-1990s. Since the late-1990s, interest expenses have been declining as a share of GDP as the increase in the level of public debt was more than offset by the decline in the interest rate-growth differential.



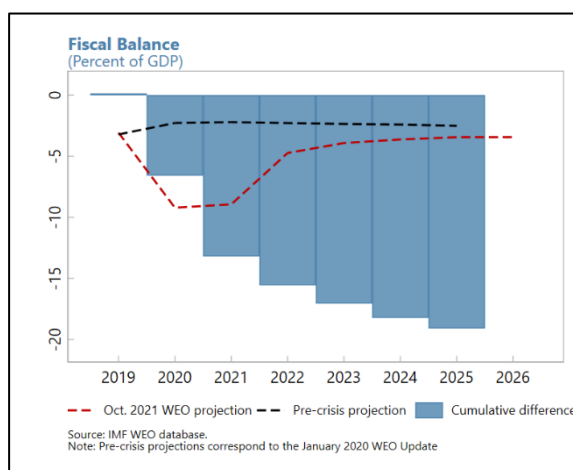
4. The economic contraction related to the COVID-19 pandemic and the associated policy response pushed public debt to a new high, reaching 115 percent of GDP in 2020-21.

The authorities deployed a significant fiscal policy response to the crisis, comprising both emergency and recovery programs, with a total envelope of around 28 percent of GDP (including below-the-line measures and public guarantees). The response included above-the-line measures with impact on the fiscal balance of more than 3 percent of GDP in 2020 and 4 percent of GDP in 2021. Together with the effect of the collapse in activity on revenues, the debt ratio is expected to have increased by about 17 percentage points of GDP between 2019 and 2021.

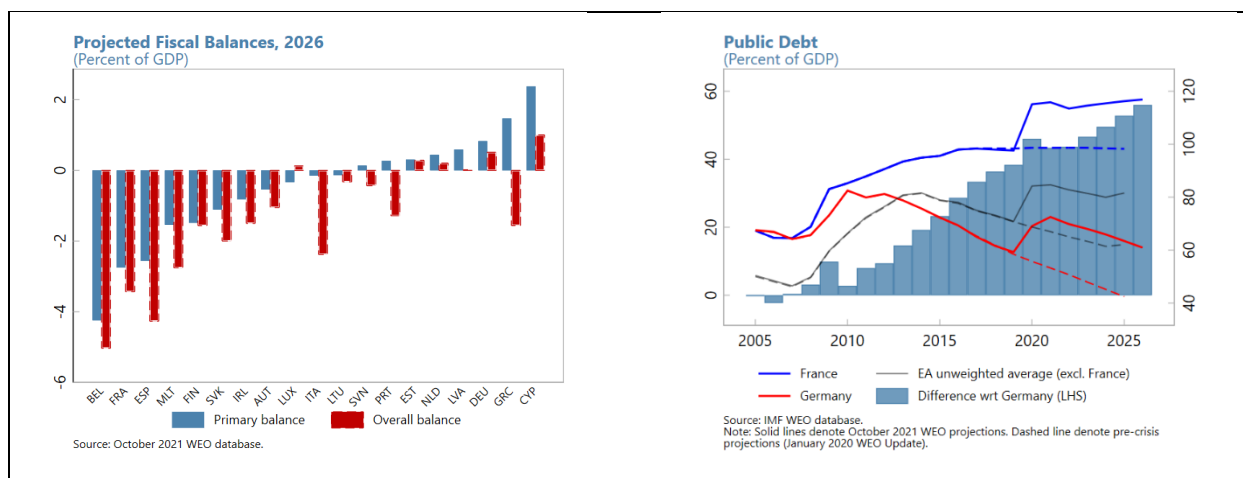


5. Under unchanged policies, the deficit would decline moderately while remaining above 3 percent over the medium term, and public debt would remain on a mildly increasing path.

In the October 2021 WEO staff projected that under unchanged policies, the medium-term primary deficit would remain about 1¼ percent of GDP larger, compared to pre-crisis projections, mainly due to the permanent tax cuts to production taxes included in the recovery plan (*Plan de Relance*), the increase in the remuneration of public health workers approved in 2021 (*Séjour de la santé* negotiations), and the persistent decline in economic activity. The overall balance was projected to remain ¾ percent of GDP worse than before the crisis, given the offsetting effect from lower projected interest rates.



6. France's fiscal position would continue worsening relative to euro area peers, posing risks to the smooth operation of the union. Prior to the Global Financial Crisis, France's debt to GDP ratio was about 60 percent of GDP and comparable to Germany's. Debt trajectories for France and Germany started to diverge thereafter, reflecting France's weaker fiscal balances. As per projections in the October 2021 WEO, France's overall fiscal deficit would remain one of the largest among euro area countries by 2026, behind only Belgium and Spain. The debt ratio difference with respect to the average across euro area countries was projected to continue increasing over the medium term and the difference with respect to Germany's debt ratio in 2026 was projected to exceed 50 percentage points of GDP.



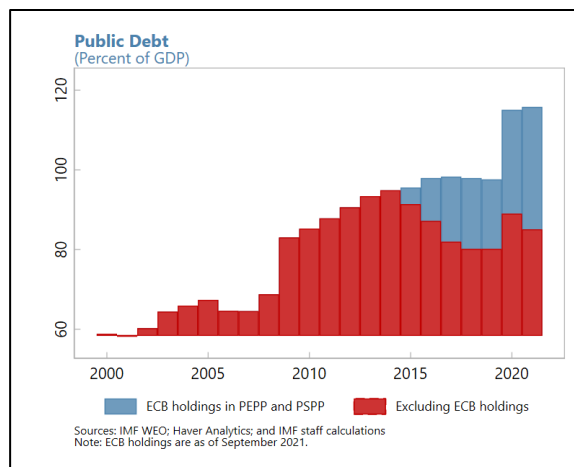
B. Anchor, Timing, and Pace of Fiscal Consolidation

7. There is broad consensus on France’s need for a gradual yet significant spending-based consolidation effort over the medium term to redress its public finances. The [Arthuis commission](#), appointed by President Macron to shed light on medium-term fiscal challenges, concluded that France should embark on a gradual spending-based consolidation effort to put debt on a downward path. A report by the [Cour des Comptes](#) concluded that absent a consolidation plan, even under favorable growth scenarios, public debt would continue to rise over the next decade, which could weaken the trust of economic agents in France’s ability to honor its commitments. Both set of experts emphasized that a key condition to redress France’s fiscal finances is to resume high economic growth, noting the importance of improving the targeting and quality of public investment across areas (including investment on social and education areas). They argued that while low interest rates provide fiscal space in the near term, this mitigating factor cannot be taken for granted—especially as it is partly the result of central bank interventions over the last years, with the Eurosystem holding close to 30 percent of France’s sovereign debt. Low interest rates also need to be assessed against a broader context of a secular decline in output growth and inflation. They also pointed to risks to euro area stability from continued divergence in fiscal positions among member countries, which can lead to political discord, especially during major crises, and trigger sudden changes in interest rates. The authorities have also manifested the need to redress France’s public finances over the medium term.³

8. However, pinning down an appropriate medium-term fiscal anchor, and the timeframe to reach it, is challenging given the high level of uncertainty. The authorities’ medium-term objective before the crisis was a (structural) deficit of 0.4 percent of GDP. The further decline in France’s sovereign yields registered since mid-2019 and the expectation for continued low rates, especially since the pandemic, suggests that, all else equal, a lower primary fiscal balance could be

³ See, for instance, the 2021 Stability Program and the *Rapport Economique, Social et Financier* accompanying the draft 2022 budget.

targeted—while maintaining the same objective for the overall balance and, consequently, for debt dynamics. However, prospects for interest rates in France and elsewhere are uncertain—as evidenced by the reaction of US long-term rates at the time of the Biden’s administration fiscal announcements in early 2021. The fact that a large fraction of net debt issuance of France and other euro area countries since the onset of the pandemic was absorbed by the ECB, together with discussions about the possibility of earlier-than-expected normalization of monetary conditions, tilts the balance of risks toward potentially higher interest rates.



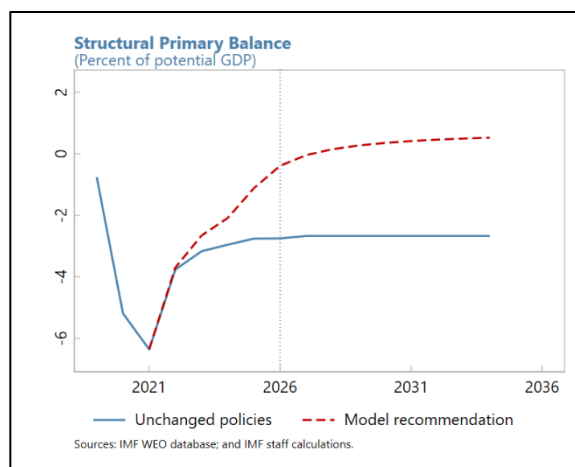
9. A structural stochastic model of the general government can help shed light on what can be a reasonable anchor for France’s public finances and the timeline to get there.⁴ The model features a forward-looking benevolent government that needs to set the fiscal policy path to smooth the cycle given the initial level of public debt, the cyclical position of the economy, and the distribution of future shocks that may hit the economy. The government aims to strike a balance between the objectives of economic stabilization and debt sustainability in a context in which: fiscal policy affects output (via the fiscal multiplier); shocks to output affect the primary balance (via automatic stabilizers); recessions can reduce potential output (via hysteresis effects on the level of physical and human capital); and the stabilizing role of fiscal policy is constrained by implementation lags and high debt (as the interest rate is an increasing function of debt and, at high debt levels, the government faces a stochastic risk of losing market access).⁵

⁴ The model, described in Fournier (2019) and Fournier and Lieberknecht (2020), was used in 2019 to investigate France’s historical fiscal stance and to assess the appropriate fiscal stance before the COVID-19 pandemic erupted ([Country Report No. 19/246](#)). It was also featured in IMF staff reports of Belgium, Israel, Lithuania, and the United States. See Appendix Table 1 for baseline and alternative calibrations considered here.

⁵ The risk of losing market access, which is a function of debt, rules out unbounded debt paths. Losing market access implies the debt would need to remain constant when the economy is hit by a negative shock, limiting the ability of fiscal policy to smooth the cycle.

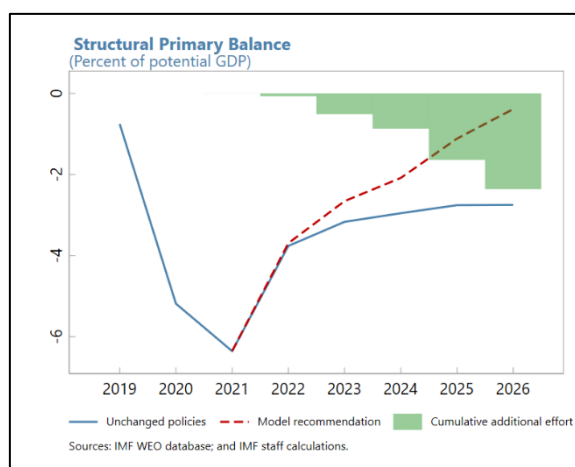
10. The solution of the model indicates a strong need to rebuild fiscal space, with medium-term fiscal policy anchored at a surplus of ½ percent of GDP for the primary balance.

The model takes into account the historical distribution of shocks to economic activity, the effect of recessions on growth, the role of automatic stabilizers, and potential constraints to fiscal policy from high debt levels, to calibrate the appropriate fiscal space for the economy. The solution of the model under the baseline calibration implies targeting a primary surplus of about ½ percent of GDP in the steady state. The recommended medium-term target for the primary balance is significantly higher than staff's medium-term projection in the October 2021 WEO (a primary deficit of about 2½ percent of GDP by 2026).⁶ Given the starting conditions in 2021, however, the model recommends a gradual transition to the medium-term anchor, extending to around 2029-30.⁷



11. Turning to the pace of consolidation, the model's recommendation for the fiscal stance in 2022 is aligned with staff's projection under unchanged policies.

In the October 2021 WEO, staff projected that, under unchanged policies, the structural primary balance would improve by 2.6 percent of GDP between 2021 and 2022, largely reflecting the phasing out of COVID-related emergency programs.⁸ The model recommendation for 2022 (based on the October 2021 projections for 2021 outturns) is almost the same, an improvement of 2⅔ percent of GDP which, netting out the effect of expiring COVID-related programs, represents a moderately expansionary fiscal stance.



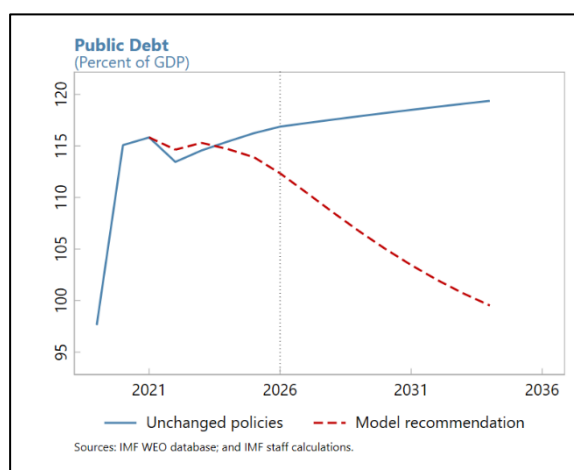
⁶ For the purpose of the model simulations, the historical data (up to 2021) and the comparison with projections under unchanged policies for 2022-26 are based on staff estimates and projections as of the October 2021 WEO. The unchanged policies scenario beyond 2026 assumes that the fiscal balance, the growth rate of real output, and the growth rate of the output deflator, remain at the levels projected for 2026.

⁷ A surplus of ½ percent of GDP by 2029 would be broadly in line with France's pre-crisis medium-term objective (a structural overall deficit of 0.4 percent of GDP).

⁸ Netting out the effect of temporary programs in response to the COVID-19 crisis, the structural primary balance was projected to deteriorate further, by about 0.4 percent of GDP.

12. Starting in 2023, the model recommends a consolidation effort of more than 4 percent of GDP, with about $\frac{3}{4}$ of the recommended adjustment by 2026. Beyond 2022, the model recommends an annual average improvement of about 0.8 percent of GDP over 2023–26 (a cumulative improvement of 3.3 percent of GDP). Compared to staff projections under unchanged policies in the October 2021 WEO, the model recommended annual pace is slightly more than $\frac{1}{2}$ percent of GDP larger (about 0.4 percent of GDP per year larger over 2023–24 and around $\frac{3}{4}$ percent of GDP per year larger over 2025–26).⁹ The model recommends fiscal efforts continue beyond the medium term, albeit at a softer pace (an average annual pace of about $\frac{1}{4}$ percent of GDP over 2027–29 and falling below 0.1 percent thereafter), until the primary balance stabilizes at a surplus of about $\frac{1}{2}$ percent of GDP.¹⁰ The total effort required over the medium term would be around $4\frac{1}{4}$ percent of GDP. The profile recommended is relatively frontloaded, with about $\frac{3}{4}$ of the recommended adjustment falling within 2023–26.¹¹

13. Under the fiscal path recommended by the model, public debt would get on a clear downward path over the medium term and reach its pre-crisis level by around 2036. The level of public debt under the model recommended scenario would peak in 2023 and start declining thereafter.¹² By 2029, when the recommended primary deficit has broadly stabilized (i.e., the annual recommended effort is less than 0.1 percent of GDP), public debt would reach about 107 percent of GDP and would reach its pre-crisis level by 2036.



14. The recommended path is somewhat sensitive to the long-run interest rate assumption, but all alternative calibrations imply a significant consolidation with respect to the unchanged policies scenario. A key parameter to pin down the steady-state solution of the model is the real effective interest rate assumed for the long run.¹³ The baseline parametrization assumes that the real effective interest rate will eventually converge to 1.9 percent, a level

⁹ The cumulative additional effort (i.e., relative to projections under unchanged policies) recommended by the model by 2026 is about $2\frac{1}{3}$ percent of GDP.

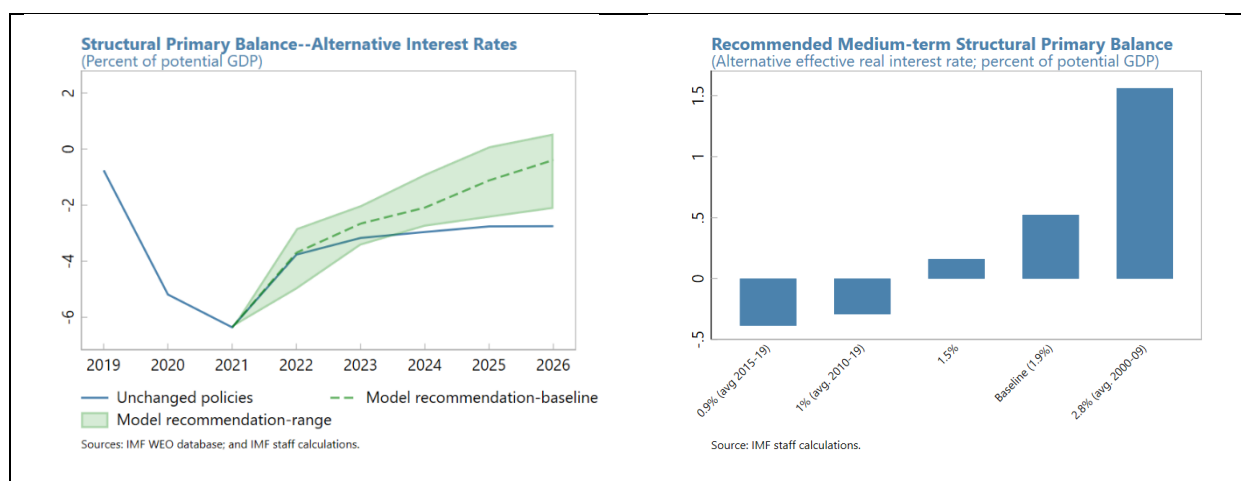
¹⁰ The recommended structural primary balance reaches 0.5 percent of GDP by 2033, but the average annual effort over 2030–33 is already very low (around 0.05 percent of GDP).

¹¹ While the model takes into account the historical distribution of shocks, it cannot consider exceptional uncertainty in the aftermath of the pandemic that may call for a less frontloaded consolidation over the near term.

¹² The apparent disconnect of public debt in the model simulations and the unchanged-policies scenario in the near term is largely explained by debt-reducing stock/flow adjustments in 2022–23, in line with projections in the 2021 Stability Plan, which cannot be captured by model simulations.

¹³ This parameter is the real effective interest rate that the economy would face in the long run (from around 2036 onwards). In the near term, the model interest rate is centered around staff WEO projections until 2026, and around a linear interpolation between its 2026 level and the assumed long-run parameter thereafter. In any particular year, the model interest rate would still differ from this baseline path to reflect eventual changes in debt as a result of shocks.

comparable to the average observed over the two decades preceding the COVID-19 pandemic.¹⁴ There is, however, high uncertainty regarding how interest rates will evolve in the future. In order to assess how the model recommendation would vary under different interest rate scenarios, five alternative calibrations for the long-term real effective interest rate were considered, ranging from the low levels registered over 2015–19 (an average of slightly less than 0.9 percent) to the average observed over 2000–09 (an average of 2.8 percent). The medium-term recommendation for the structural primary balance ranges between a deficit of 0.4 percent of GDP to a surplus of 1½ percent of GDP—in all cases higher than projected under unchanged policies. The near-term recommendation (i.e., for the stance in 2022) would be somewhat looser than under unchanged policies but, beyond 2023, all model calibrations yield a tighter fiscal stance than under the unchanged policies scenario.



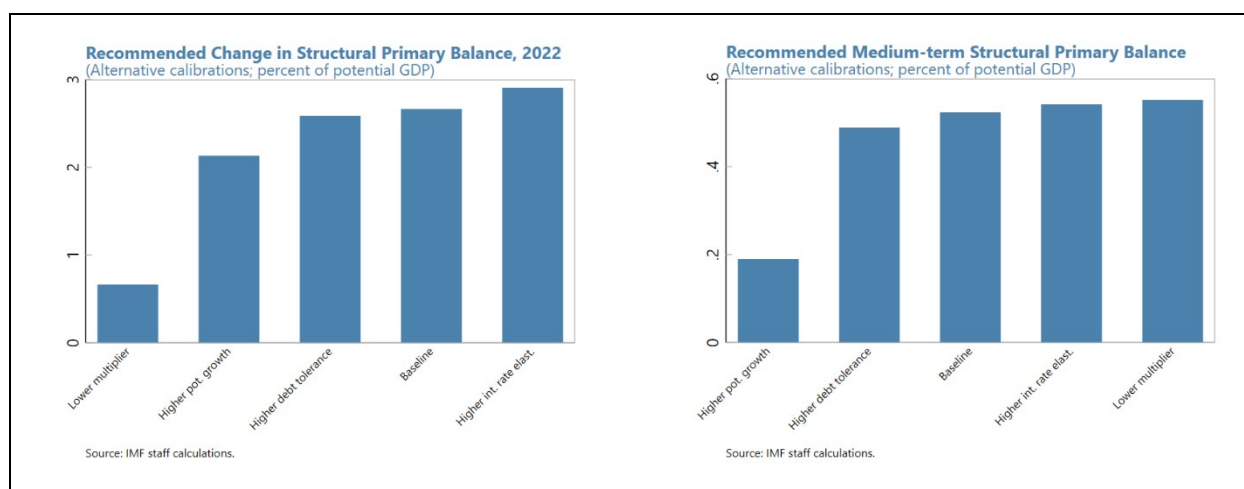
15. Other calibration choices yield somewhat different recommendations for the near-term fiscal path but the medium-term objective for the primary balance is only marginally affected. A set of alternative deep parameter assumptions was considered:

- **Debt and interest rates.** Another relevant set of parameters of the model are those that govern the risks from high debt levels, notably the sensitivity of interest rates to debt levels and the debt threshold beyond which the risks of losing market access is equal or higher to 50 percent. If the interest rate is assumed to be more sensitive to the debt level than under the baseline (i.e., a sensitivity of 2.5 percent rather than 1.5 percent), the medium-term recommendation for the primary balance would be broadly unchanged. The model recommendation for the 2022 would be slightly tighter (by close to 0.1 percent of GDP). Regarding the debt threshold, the baseline parameterization assumes that the debt level beyond which there is a 50 percent probability of having issues of market access is 150 percent of GDP. However, the fact that yields remained very low despite debt reaching about 115 percent of GDP during the pandemic suggests that threshold may be too conservative. The recommendation of the model under a higher threshold,

¹⁴ In the 2021 Stability Program, the authorities' projected the nominal 10-year bond yield would reach 0.8 percent in 2022 and continue increasing over the medium term, reaching 2.7 percent by 2027 (about 1.1 percent in real terms). The updated yield projection for 2022 in the draft 2022 budget documents is 0.75 percent.

200 percent of GDP, implies both a lower medium-term primary balance and a looser stance in 2022, but the quantitative differences with respect to the recommendations under the baseline are small (by 0.03 and 0.08 percent of GDP, respectively).

- **Fiscal multiplier.** If the fiscal multiplier is assumed lower than under the baseline calibration (a multiplier of 0.5 instead of 0.98)¹⁵, the recommended target primary balance over the medium term would be slightly larger. However, the model would recommend a more gradual consolidation over the near term (with the recommended stance 2 percentage points of GDP looser than under the baseline in 2022) as stronger support would be required to bring activity back to potential.
- **Long-term growth.** The baseline calibration assumes that long-term growth is 1.3 percent, or about 1 percent in per capita terms. If instead, long-term growth were higher, at 1.6 percent, the recommended fiscal stance would be looser (by 0.5 percent of GDP in the near term) than under the baseline, as debt dynamics would be more favorable (requiring a smaller fiscal effort to attain the same reduction in debt).



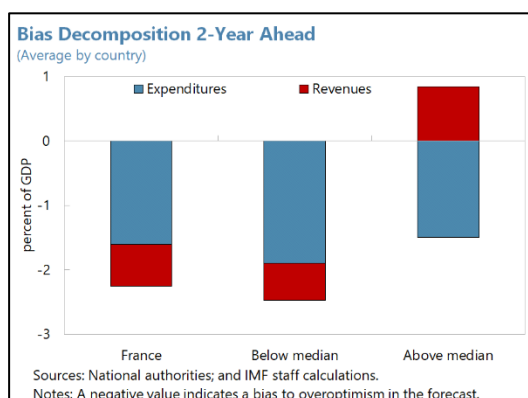
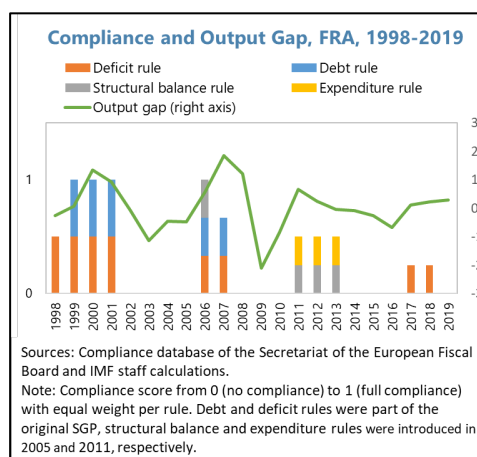
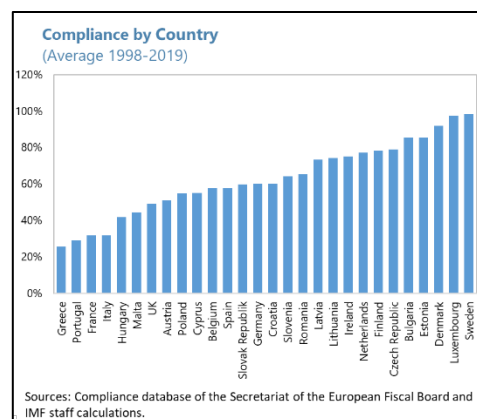
¹⁵ The assumption for the fiscal multiplier under the baseline is inspired in the bucket approach by Batini et al. (2014), in which the multiplier is a function of a country's exchange rate regime, labor market rigidity, and trade openness. The multiplier is also assumed to vary over the business cycle, with higher multiplier in downturns (consistent with Baum et al, 2012; Auerbach and Gorodnichenko 2013).

C. Fiscal Planning

16. A strong fiscal framework should help achieving the ambitious medium-term fiscal consolidation that France needs. The fiscal framework includes the set of fiscal rules and targets and the institutions responsible for the design, implementation, and oversight of fiscal policy. The analysis that follows focuses primarily on the fiscal rules and the institutions charged with oversight.

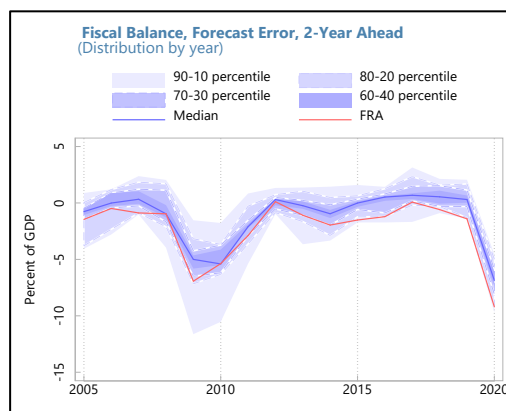
17. France has historically fallen short of its commitments to fiscal targets under the EU rules. France ranks low in terms of notional compliance with the EU fiscal rules since 1998. Replicating the analysis in Larch and Santacroce (2020) for all four rules of the EU (expenditure, fiscal deficit, structural balance, and debt rules), France has complied on average in about 1/3 of the cases with a strict definition of the numerical targets, comparable to Italy and Portugal.¹⁶ This contrasts with a high notional compliance by, for instance, Sweden, Luxembourg, Denmark, and Estonia, and is also well below compliance rates in large European countries, including Germany, Spain, Poland and the Netherlands. While low compliance tended to be concentrated in cyclical downturns during the early-2000s and the GFC (which was less concerning as it in part reflected limited counter-cyclicality allowed for by the rules) missing the targets has become unrelated to the business cycle in the last decade.

18. The low compliance with EU fiscal targets is partly explained by a tendency to under predict expenditures in the near-term and over predict revenues over a longer horizon. While France's average under projection of spending is not dissimilar to most EU countries, its revenue over-projections over the medium-term put it in the group of countries with consistent upward bias for the projected fiscal balance beyond the current year.

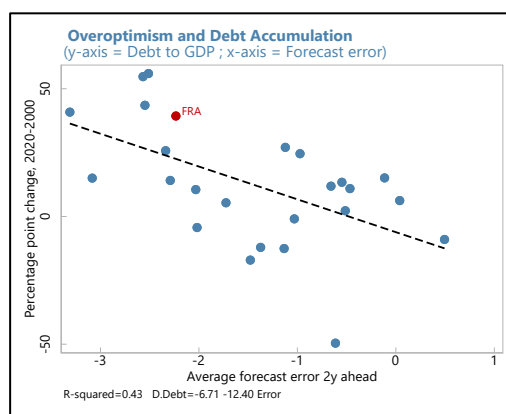


¹⁶ While the SGP allows for deviations from the numerical targets under certain conditions, a strict numerical definition is considered here, in line with Larch and Santacroce (2020).

19. Medium-term fiscal projections have been consistently more optimistic compared to outcome and to peers. As is true for most other member states, the *extent* of over-optimism is related to economic surprises as reflected by the business cycle. At the same time, the *direction* of the 2-year ahead forecast error (bias) is in almost all years toward over-optimism, consistently more than for the median country in the EU (see also Pina and Venes 2011 for a related finding on France). The latter appears unbiased in non-recession years.



20. Countries that show an overoptimism bias in fiscal projections tend to have higher debt. While higher fiscal deficits translate mechanically into higher debt, under *prediction* of the budget deficit need not imply higher *actual* increases in debt. However, there is empirically a robust strong relationship between overoptimism in the medium-term and higher debt, which is robust to conditioning on the actual budget balances and the output growth surprises.



D. Determinants of Overoptimism

21. Analyzing the determinants of overoptimism could help define policies to support a credible fiscal consolidation plan and limit risk from high debt. The literature on the determinants of fiscal forecast errors has pointed to three main determinants: (1) fiscal institutions, (2) political factors, and (3) economic conditions.

22. A panel regression framework is used to assess the contribution of fiscal institutional and other factors to the observed variation in forecast errors:¹⁷

- A first OLS regression estimates the effect of fiscal rules on the extent of the forecast bias:

$$\Delta Y_{i,t}^{t+k} = c^k + \alpha^k \cdot FR_{i,t} + \beta^k \cdot POL_{i,t} + \gamma^k \cdot ECO_{i,t} + \delta^k \cdot X_{i,t} + \varepsilon_{i,t}^k$$

where $\Delta Y_{i,t}^{t+k} = Y_{i,t}^{t+k} - Y_{i,t-1}^{t+k}$ is the k -years ahead forecast error of variable Y (fiscal balance, expenditure, and revenue to GDP ratios, respectively) in country i ; c^k is a constant; $FR_{i,t}$, $POL_{i,t}$ and $ECO_{i,t}$ are covariates describing the presence of the fiscal rules (expenditure rule dummy, number of fiscal rules in place and fraction of national fiscal rules), political factors (extent of government majority and election year dummy), and economic conditions (current account

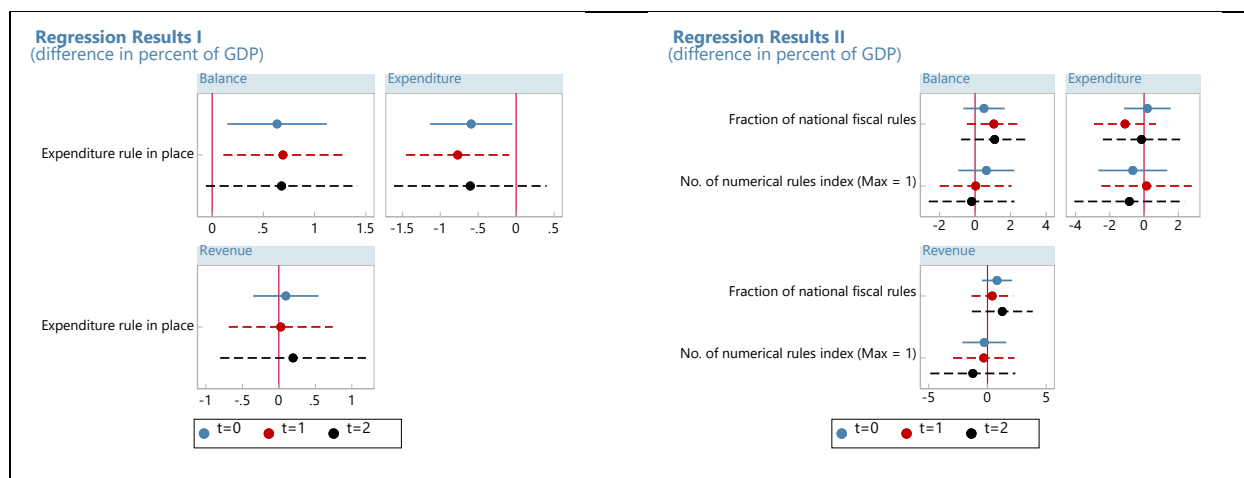
¹⁷ For more details on this and related analysis see IMF (forthcoming).

openness and GDP growth forecast error), respectively; $X_{i,t}$ describe other controls (education level and year dummies); and $\varepsilon_{i,t}^k$ is an error term.¹⁸

- A second regression is employed to analyze the forecast error of the fiscal balance depending on the design elements of the fiscal rule, conditional on an expenditure rule being in place (which diminishes the sample size):

$$\Delta FB_{i,t}^{t+k} = \mu^k + \eta^k \cdot FIS_{i,t} + \theta^k \cdot X_{i,t} + v_{i,t}^k$$

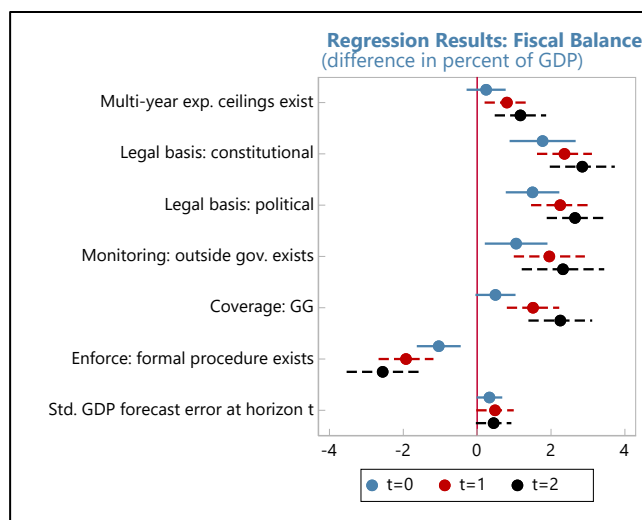
where $\Delta FB_{i,t}^{t+k}$ is the k -years ahead forecast error of the fiscal balance in country i ; μ^k is a constant; $FIS_{i,t}$ are covariates describing the characteristics of the fiscal rule and supporting institutions—specifically, dummies for (1) existence of multi-year expenditure ceilings, (2) legal basis of fiscal rules, (3) existence of monitoring of rules mechanism outside the GG, (4) sectoral coverage of the fiscal rule and (5) existence of a formal enforcement procedure of the rule; $X_{i,t}$ describe other controls (GDP growth forecasts error and year dummies); and $v_{i,t}^k$ is an error term.¹⁹



¹⁸ Since there is a high degree of collinearity amongst the covariates concerning the presence of the fiscal rule, two separate regressions are estimated. A first regression with the dummy for the presence of an expenditure rule and a second regression including the index from 0 to 1 reflecting the number of fiscal rules that exist (where 1 reflects the maximum of the sample) and a variable reflecting the fraction of these rules which are national. All other variables remain unchanged. Results for the coefficient estimates on the controls can be found in the Appendix.

¹⁹ The database for the forecast errors has been compiled by the IMF's Fiscal Affairs Department drawing on the national forecasts published in the context of the Stability and Convergence Program, and the IMF World Economic Outlook data for realized data. The information on fiscal rules and institutions is taken from the IMF Fiscal Rules Dataset, 2021.

23. The results suggest an important role for fiscal rules in general, and certain design elements in particular, to reduce optimism bias in fiscal projections. There is no clear evidence that the complexity of the fiscal rules (measure by the number of fiscal rules in place) reduces the forecast bias. In turn, the ownership of the rules in place (proxied by the fraction of national rules to all existing rules in a country) potentially reduces overoptimism in fiscal balance projections— though the estimates are not significant at conventional confidence levels after controlling for all other determinants.²⁰



Having a national expenditure rule in place significantly reduces the forecast error bias by limiting under-projection of expenditures. In terms of features of the fiscal rules, and the institutions underpinning them, multi-year expenditure ceilings help reduce the overoptimism bias. Moreover, rules backed by constitutional legal nature or based on political/collation agreements perform better than rules based on statutory law (base group). Monitoring of rules outside the government (i.e., by non-government bodies) and a wider coverage of expenditure rules (including the whole general government, GG, as opposed to, for instance, covering only the central government) are associated with lower over-optimism.²¹ The presence of a formal enforcement procedure appears counter-productive. However, this result does not hold when looking at enforcement individually in a regression, suggesting that the coefficient may be driven by collinearity among regressors.²² All the effects get compounded at longer forecast horizons.

E. Implications for the Design of Rules and Policy Institutions

24. Despite many commonalities, Europe's fiscal institutional framework is diverse in many respects (see table). Similar to European peers, France has multiple fiscal rules in place, including expenditure, fiscal balance, debt and revenue rules—with the latter rule applying only to a subset of items and unrelated to specific EU rules. While France's authorities set multiyear targets in

²⁰ These results are for estimations including all control variables. Eliminating the covariate most correlated with the variables of interest turns estimates significant.

²¹ The use of underlying assumption by independent bodies also appears to contribute to better forecast projections but is highly collinear in this regression and only significant in a regression with a smaller set of controls.

²² Enforcement is the variable with highest pairwise correlation in the sample, and the correlation is particularly high with respect to the coverage indicator. When included individually in the regression, coverage remains positive and statistically significant. Furthermore, the significant coefficient estimate on enforcement in the fiscal balance regression when an expenditure rule is in place is due to its correlation with over-projecting revenues rather than with under-projecting expenditures. Although further analysis is needed, this could be indicative of "strategic" use of medium-term budget forecasts (see Jonung and Larch 2006, Heinemann 2006, and Cimadomo 2016 for related arguments). It should also be noted that the enforcement procedure may only apply to the current year budget, without effectively binding for medium-term forecasts.

their Stability Programs, these multiyear targets were found to be treated as non-binding in the past and important deviations from targets were observed (Daban Sanchez et. al. 2003, EC 2012, 2020).²³ Furthermore, the coverage of some of France’s fiscal rules is incomplete, both in terms of the levels of government covered (e.g., only covering the central government) and instruments (e.g., tax expenditures are not included), undermining the effectiveness to affect the overall balance and debt of the general government. While the High Council of Public Finances (*Haut Conseil des finances publiques*, [HCFP](#)), a non-government entity, monitors compliance with fiscal rules, its full-time staffing, powers, and its budget involvement (primarily of an ex-post assessment nature) are limited.

Comparison of Fiscal Frameworks											
		FRA	DEU	ITA	ESP	NLD	DNK	SWE	GBR	FIN	EST
Rules in place	Revenue rule	X				X					
	Expenditure rule	X	X	X	X	X	X	X	X	X	X
	Budget balance rule	X	X	X	X	X	X	X	X	X	X
	Debt rule	X	X	X	X	X	X	X	X	X	X
# of rules	All	7	4	5	6	7	6	6	6	7	5
	Strictly national	3	2	1	2	3	2	2	2	3	1
Exp. rule (national)	Legal basis	Stat.	Pol. Com.	n.a.	Stat.	Coal. Agr.	Const.	Stat.	n.a.	Coal. Agr.	n.a.
	Coverage	CG	GG	n.a.	GG	GG	GG	CG+SocSec	n.a.	CG	n.a.
	Monitoring outside GG exists	Yes	No	n.a.	Yes	Yes	Yes	Yes	n.a.	No	n.a.
	Formal enforcement procedure exists	No	No	n.a.	Yes	Yes	Yes	No	n.a.	No	n.a.
BB rule (national)	Legal basis	Stat.	Const.	Const.	Stat.	Stat.	Const.	Stat.	Stat.	Coal. Agr.	Coal. Agr.
	Coverage	GG	GG	GG	GG	GG	GG	GG	GG	CG	GG
	Monitoring outside GG exists	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
	Formal enforcement procedure exists	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes
Other feature	Multiyear expenditure ceilings	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
	Independent body sets budget assumption	No	No	No	No	Yes	No	No	Yes	No	No
	Fiscal Responsibility Law	No	No	No	Yes	No	No	No	Yes	No	No

Source: IMF Fiscal Rules Dataset
Note: Stat. = Statutory; Pol. Com. = Political Commitment; Coal. Agr. = Coalition Agreement; Const. = Constitutional; CG = Central government; GG = General Government; SocSec = Social Security.

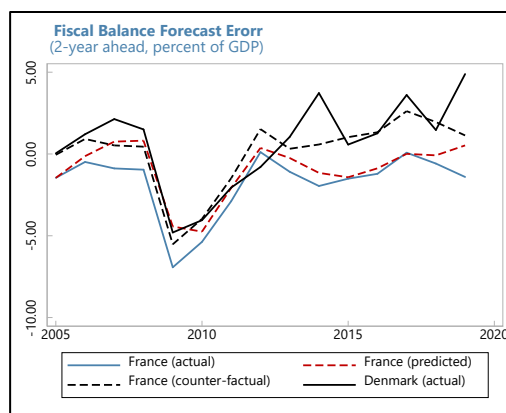
Comparison of Fiscal Councils											
		FRA	DEU	ITA	ESP	NLD 1)	DNK	SWE	GBR	FIN	EST
Analysis	Forecast preparation	No	No	No	Yes	Yes	Yes	No	Yes	No	No
	Forecast Assessment	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
	Normative analysis	No	No	No	Yes	Yes	Yes	Yes	No	Yes	No
	Recommendations	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes
	Costing of measures	No	No	Yes	No	Yes	No	No	Yes	No	No
	Monitoring of rules	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Long-term sustainability	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Budget process	Forecasts used in Budget	No	No	No	No	Yes	No	No	Yes	No	No
	Binding Forecasts	No	No	No	No	Yes	No	No	No	No	No
	Comply or Explain	No	No	No	Yes	No	No	No	Yes	Yes	Yes
Admin	Right to select staff	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Members and other FTE staff	11	16	21	36	120	46	12	20	147	8

Source: IMF Fiscal Council Dataset
1) Includes both the Netherlands Bureau for Economic Policy Analysis and the Raad van Staade

²³ The EC (2020) concludes that “medium-term budgetary dimension does not seem to have been an anchor for annual budgets [and] the reputational cost for not meeting medium-term plans is low [...] medium-term budgetary plans have been volatile: targets [...] lost their initial ambition [...] and annual finance bills have systematically loosened the structural balance targets for the following year.”

25. A revamped expenditure rule, covering the entire general government over a longer horizon and subject to monitoring by a fiscal entity with enhanced powers, could improve France’s compliance with its fiscal objectives. The effectiveness of France’s expenditure rule could be strengthened by ensuring strong political and legal endorsement for explicit multi-year nominal targets and by covering the entire general government. The process of voting multi-year objectives during the annual budget cycle could explicitly account for how deviations from previous years’ objectives are offset, including in the current budget, in order to ensure enforcement of medium-term commitments. An effective application of the rule would require timely execution data for all subsectors of the general government, as well as having in place a comprehensive monitoring mechanism by a non-government entity, such as the fiscal council. To bolster the fiscal oversight and planning, a strong integration of the fiscal council into the budget process would be helpful, so that it can provide timely assessment of macroeconomic and fiscal forecasts. The ability of the fiscal council to endorse government projections could be enhanced by extending its role into providing independent forecasts, estimates of the yields of planned discretionary policies, and debt sustainability analysis—all of which would require adequate staffing and resources (see also Darvas et al 2018).²⁴ Providing debt sustainability analysis beyond the five-year horizon—as suggested by the OECD (2021)—would also help underpin the multi-year expenditure ceilings and the budget planning.

26. Staff analysis suggests that reforming France’s fiscal framework along these lines should help contain debt going forward. Counter-factual analysis—keeping in mind its caveats and limitations—suggests that if France had adopted a system comparable to the one in Denmark—the country in the sample with the lowest medium-term forecast errors—the average forecast bias over 2005–19 implied by the coefficient estimates would have been zero. Together with the observation that less biased forecasts are associated with lower debt build-up, this suggests that a reform of the fiscal framework could help in containing debt in the future.



F. Conclusion

27. France’s public debt has been on an increasing path for over four decades and is projected to remain high and continue diverging from its euro area peers over the medium term. The sustained buildup of debt over time reflects that increases in spending during recessions were only partially redressed thereafter. Successive governments were excessively optimistic compared to peers when projecting medium-term fiscal balances, leading often to breaches of fiscal commitments under EU rules.

²⁴ These suggestions are broadly aligned with EFB recommendations and recent advice by the Arthuis commission.

28. Simulations using a structural stochastic model suggest that France should aim at achieving a primary surplus of about ½ percent of GDP over a period of seven to eight years.

The model solution indicates that aiming for a medium-term primary surplus of ½ percent of GDP would provide sufficient space for fiscal policy to stabilize economic cycles given the historical distribution of shocks in France. Taking into account initial conditions in 2021, the model recommends a mildly expansionary stance in 2022 (net of the projected withdrawal of crisis-related support) followed by significant consolidation efforts until the medium-term target is reached, around 2029-30.

29. Reforming the fiscal framework would help credibly underpin such a medium-term consolidation strategy. While France's fiscal framework has evolved over the past decades, further strengthening could help improve medium-term fiscal planning and thereby support the ambitious multi-year expenditure-based consolidation that will be needed. Cross-country evidence suggests that a national medium-term expenditure rule, backed by political consensus, covering the whole general government, and combined with a strong external monitoring mechanism, can help reducing the overoptimism bias in government fiscal projections. To strengthen the monitoring mechanism, the scope and resources of the Fiscal Council could be bolstered to ensure it can provide timely inputs into the formulation of macroeconomic and fiscal forecasts, including by conducting independent debt sustainability analysis.

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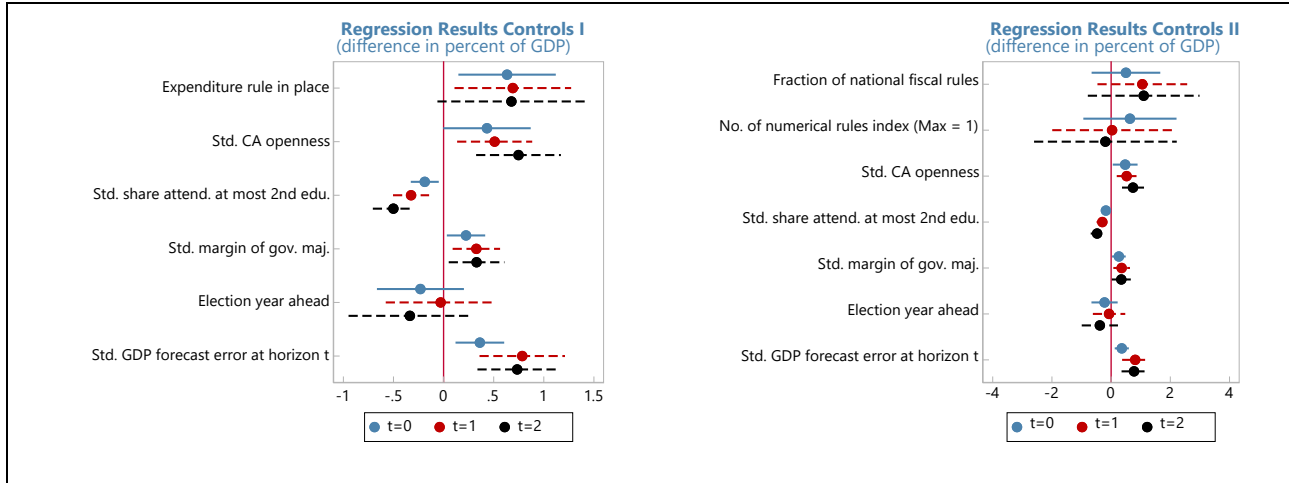
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Appendix I. Model Calibration and Additional Results

Appendix Table 1- Model Calibration

Parameter 1/	Baseline	Alternative
Discount factor β	0.99	
Risk aversion σ	2	
Labor elasticity η	1/0.3	
Weight of labor ξ	1	
Fiscal multiplier when the gap is null m_1	0.98	0.5
Fiscal multiplier sensitivity to shocks m_2	3	
Automatic stabilizers (semi-elasticity of primary balance to gap) a	0.61	
Adjustment cost of fiscal policy χ	3	
Real effective interest rate (steady state)	1.9%	0.9% (average 2015-19); 1% (average 2010-19); 2.8% (average 2000-09)
Effect of debt level on the risk premium α	1.5%	2.5%
Effect of debt change on the risk premium α_2	0.5%	
Debt level at which the risk to lose market access is 50% \bar{d}	150%	200%
Debt limit accuracy d_1	3	
Effect of debt change on the risk to lose market access is d_2	1	
Adverse scenario coefficient in case of loss of market access d_3	-1%	
Potential GDP growth	1.3%	1.6%
Shock persistence ρ	0.66	
Shock size	2.6%	
Hysteresis	10%	0%
Hysteresis threshold	-1%	

1/ See [Country Report No. 19/246](#) for model equations and definitions of the different parameters.



AN ANATOMY OF OCCUPATIONAL PATHWAYS FOR THE CLIMATE TRANSITION IN FRANCE¹

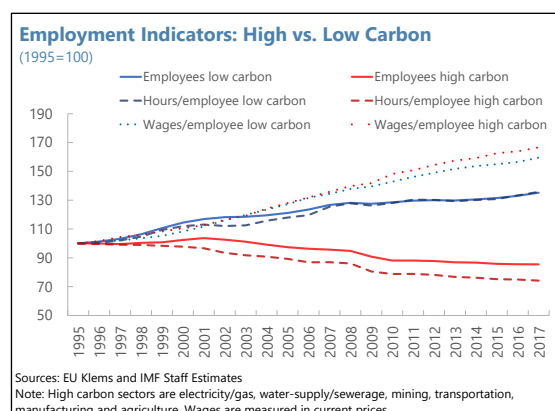
The accelerated push towards carbon neutrality will involve structural transformations in the labor market with potentially large displacement costs for workers in affected sectors. While France has a low concentration of jobs in carbon-intensive sectors, there may be indirect employment effects in other sectors from supply and demand linkages. Jobs related to the greening of the economy, currently estimated at 15 percent of total employment, are growing, with demand outstripping supply. An analysis of skill matches shows that occupations in high carbon sectors are more locked-in with fewer transition possibilities, but training and work experience are associated with improved job mobility.

A. Introduction

1. France has made important progress towards achieving its climate goals and set an ambitious policy agenda over the next decade. France's total greenhouse gas emissions in 2019 represented a 17.7 percent decline from 1990 levels.² In addition to its 2019 climate law, which lays out emission reduction targets, France shares the collective European Union (EU) target of a net greenhouse gas emissions reduction of at least 55 percent by 2030 compared to 1990 levels. The government has outlined broad strategies for their long-term 2050 carbon neutrality goal, including achieving a carbon-free energy system by 2050, increasing energy efficiency to halve energy consumption and decreasing non-energy emissions (by 38 and 60 percent in farming and industry respectively, compared to 2015 levels), and increasing carbon sinks. In terms of social impact, the [national energy and climate plan](#) (NECP) envisages that the energy transition will create up to 500,000 new jobs by 2030, mostly in tertiary sectors. However, the transition could also threaten certain jobs in carbon-intensive sectors³.

2. The accelerated multi-decadal transition to net-zero will likely perturb the labor market.

Climate mitigation efforts, while having already commenced since the early 2000s, have so far been slow-moving. The introduction of the EU-wide Emissions Trading Scheme (ETS) in 2005 as well as carbon taxation policies in France have imposed binding constraints on production for a select few sectors. Behavioral preferences have also been changing, with environmentally conscious consumers moving away from the consumption of high-carbon content products. These changes have likely impacted the overall structure of



¹ Prepared by Manasa Patnam (EUR).

² See also Selected Issues Paper 21/16 for an account of sectoral emission policies in France and associated policies.

³ For instance, the [European Association of Automotive Suppliers](#) estimate about half a million automotive jobs losses under EU plans to ban combustion-engine cars by 2035.

production in carbon-intensive sectors, where employment – in terms of the number of employees and labor hours – has been secularly declining relative to low-carbon sectors. On the other hand, trends related to the compensation per employee have so far remained similar between the two types of sectors. While it is difficult to precisely attribute any shifts to climate transitions given aggregate data, these trends are suggestive of extensive-margin adjustments in high carbon sectors, which reduced labor requirements while preserving overall wages. Jobs growth in low carbon sectors also suggests a net-neutral employment impact in the aggregate, through possible reallocations.

3. Environmental policies could induce costly reallocations that depend on complex wage-unemployment dynamics. Several studies have documented significant labor market effects of environmental policies in regulated firms (Greenstone, 2002; Walker, 2011). Walker (2013) finds, for instance, significant reallocative costs of the clean air policy in the United States; workers in newly regulated plants incurred an earnings loss of 20 percent, driven by nonemployment and lower future earnings. However, affected workers experienced a more rapid earnings recovery relative to typical displacements, with job transitions occurring inter-sectorally within the same geographic region. A related strand of literature finds that, as a result of such inter-sectoral labor movements, employment effects are weak in the aggregate with a net-neutral economy-wide impact (Hafstead and Williams, 2018; Castellanos and Heutel, 2019; Yamazaki, 2017; Vona et. al, 2018).⁴ Recent evidence on labor market dynamics from the carbon-tax applied (only) in British Columbia, Canada provides insight on the tension between large displacement costs but weak aggregate effects. Yip (2020) finds that the provincial carbon-tax resulted in a short-lived increase in unemployment, but mostly by increasing unemployment spells rather than the duration. However aggregate wages in the province fell gradually through a lowering of wages for new hires, with incumbent worker wages remaining stable.

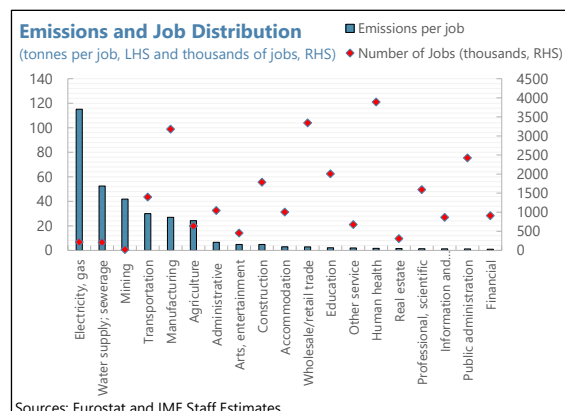
Overall, previous evidence suggests that while the aggregate cost of climate reallocations may be limited, the costs to certain sectors/workers could be large, operating mainly through displacement challenges to affected workers from weak job matches. The following sections explore the extent of displacement costs by examining the scope of at-risk jobs, the potential of green jobs creation, and skills-related job matches to facilitate reallocations.

B. The Sectoral and Occupational Dimension of the Climate Transition

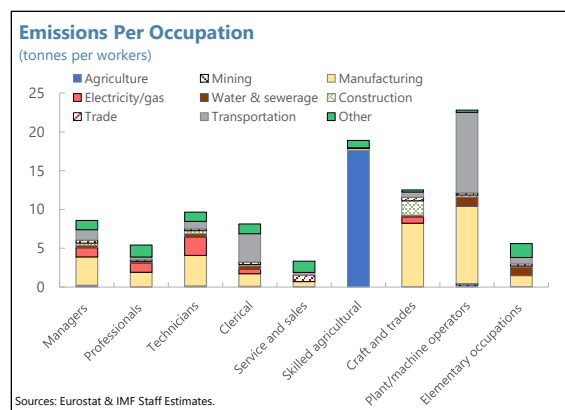
4. Jobs within carbon-intensive sectors could be at risk during the net-zero transition. Policy changes to meet climate targets, together with demand shifts away from carbon-intensive sectors, will place jobs within polluting sectors at risk. As shown in the text figure, the average carbon intensity per worker is disproportionately higher in certain sectors such as electricity/gas,

⁴ For instance, a report in the [Wall Street Journal](#), illustrated how a policy of taxing carbon-intensive energy sources in California affected coal-mining jobs in Utah as their power-plant clients switched to cleaner fuels, leading to green jobs creation elsewhere. This seeming tension between low employment losses in the aggregate but large displacement effects for workers in carbon-intensive industries, unable to easily find replacement jobs, highlights the regional and skills mismatch difficulties associated with the climate transition.

water sewerage, mining, and transportation sectors. However, these sectors employ less than a tenth of all workers, suggesting that the overall reallocation needs could concern a small number of workers relative to the total labor force. Further, as documented in the next section, not all jobs within these sectors will be threatened if some occupations contribute to sector-specific green transformation (e.g., workers engaged in R&D of green technologies within the transportation sector). At the same time, growth in low-carbon and jobs-rich sectors could offer employment reallocation opportunities for the potentially displaced workers.



5. The high concentration of specialized occupations within carbon-intensive sectors can make transitions difficult. The climate transition will require firms to make production adjustments for reducing carbon emissions that will disproportionately affect certain occupations. The extent of occupational concentration varies across sectors, possibly presenting an impediment to labor mobility. The text figure shows the average carbon intensity for workers in different occupations, based on select sectors in which they work.⁵ Craft and machinery workers are more prevalent in high carbon sectors, reflecting higher employment rates in agriculture, mining, manufacturing, electricity, and water sectors. Inter-sectoral transitions for these occupational groups could be more difficult reflecting some specialization of sector-specific skills.



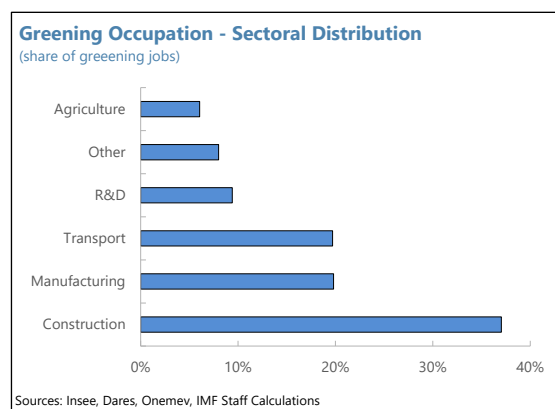
C. Green Jobs in France

6. Green jobs encompass about 15 percent of employment in France. France's National Observatory of Green Economy Jobs and Trades (Onemev)⁶ identifies economic activities, trades and professions related to the green economy. It provides a taxonomy of two types of occupations relevant for the green transformation of the economy: "green" and "greening". Green occupations are classified as those that directly aim to protect the environment (e.g., forest ranger, water technician). On the other hand, greening occupations do not have a direct environmental purpose but occupy a potentially green profession, whose skills evolve or will evolve to integrate

⁵ This assumes that all types of roles within each sector are equally affected by the exposure to carbon.

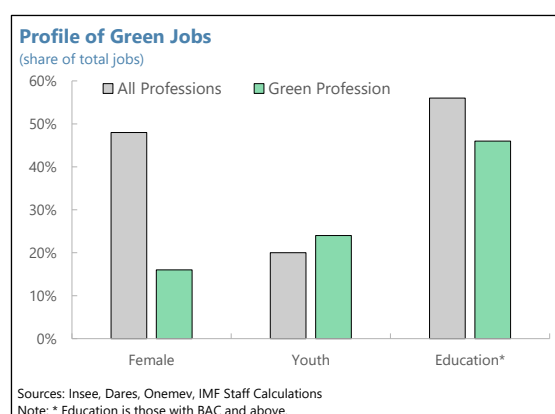
⁶ Onemev was created in 2010 by the Ministry of Environment with the aim of analyzing employment shifts in the green economy. The observatory produces methods and analyses for disseminating knowledge about jobs and trades in the green economy and brings together representatives of various agencies, including the statistical institute (INSEE), the labor ministry (Dares), the General Delegation for Employment and Vocational Training (DGEFP), the Directorate General of the Treasury (DGT), and the employment assistance agency (Pôle emploi).

environmental issues (e.g., architect, thermal insulation installer) (DARES, 2017).⁷ Together, these account for sixty-two occupations – ten green occupations representing about 0.5 percent of total employment and fifty-two greening occupations representing about 14 percent of total employment.⁸ It should be noted that greening occupations encompass a broad variety of jobs and are mainly concentrated in the sectors of construction, manufacturing and transport (text figure).



7. Green jobs are more prevalent amongst men and require less educational qualifications.

While there is considerable heterogeneity across occupations, women represented only about 17 percent of green and greening jobs. The share of women is however larger in skilled green occupations⁹, where it has also been increasing over time; for instance, the share of women increased from 15 to 21 percent since 2008 in the energy and water sector. About 24 percent of green jobs were occupied by the youth, slightly above the average of 20 percent across all jobs. In terms of education, about 54 percent of green jobs require a qualification of the bacalaureate or above compared to 62 percent across all jobs.



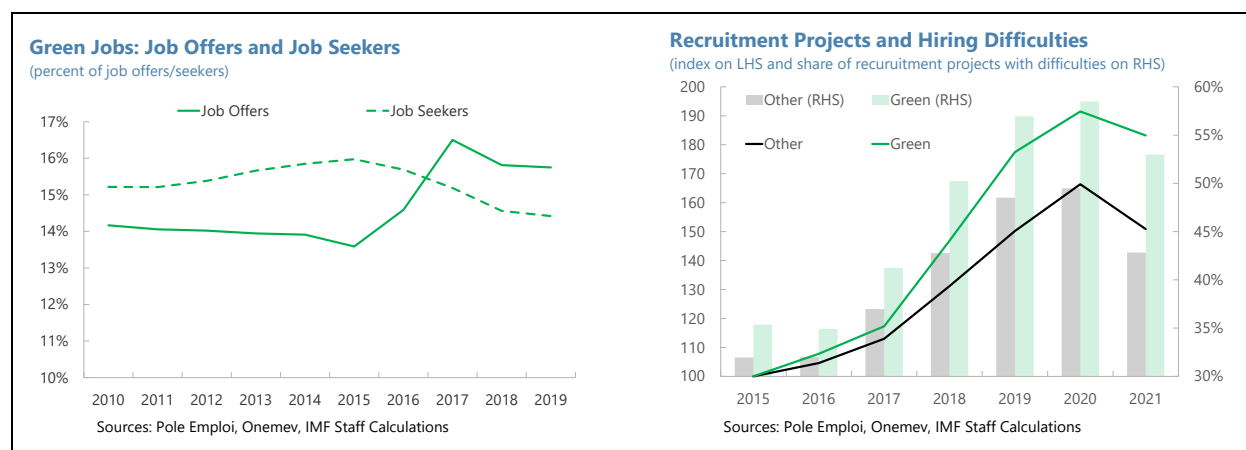
8. Job offers for green occupations have risen over time, but labor supply is increasingly becoming constrained. In 2019, vacancies pertaining to green occupations represented about 17 percent of all job offers, while 14 percent of all jobseekers belonged to green occupations. The positive job recruitment gap for green occupations – the difference between the share of green job-offers and job-seekers – reflects the changing dynamics of the green job market as the share of green job offers steadily increased over time, and at a rate higher than that of available green job seekers. This suggests some supply-side difficulties on the part of employers in meeting their green hiring needs. This is confirmed by the survey of firms, who report substantial difficulties in hiring

⁷ As a comparison, O*NET in the US classifies green occupations based on (i) existing occupations that are expected to be in high demand due to the greening of the economy; (ii) occupations that are expected to undergo significant changes in task content due to the greening of the economy; and (iii) new occupations in the green economy (Vona et. al., 2018). Using O*NET's broad definition of green jobs, Bowen et. al. (2019) find that US employs about 19 percent of total workforce in green jobs.

⁸ Occupations correspond to the *ROME* operational directory of trades and jobs classification managed by *Pôle emploi* and can be matched granularly to the ESCO or 5-digit ISCO occupation codes.

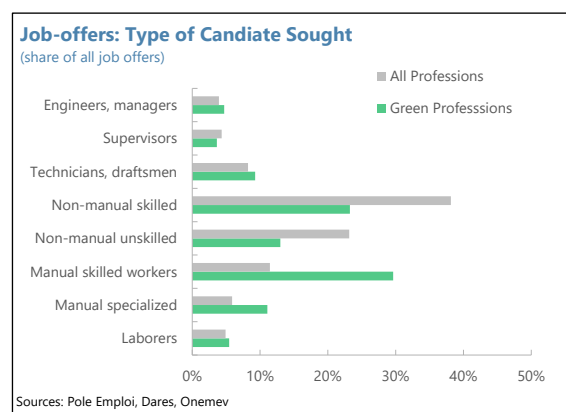
⁹ Henceforth, the reference to "green occupations" encompasses the broad classification, including both green and greening occupations.

workers from green professions relative to other jobs; on average, in 2019, firms reported that 60 percent of all green-related recruitment projects as difficult recruitments relative to 50 percent for all occupations combined.



9. Employers typically seek skilled workers to fill green job vacancies.

In 2019, compared to other vacancies, green job offers were directed at a higher proportion of manual skilled and specialized workers. This could reflect the high concentration of green job-offers in the sectors of construction (46 percent) and transport (23 percent). It is important to note that the concept of skilled here refers to knowledge of specialized tasks needed to perform a specific job and is not necessarily linked to higher education qualifications.¹⁰ In fact, the share of job offers for higher education professionals (engineers, managers, supervisors) is relatively similar between green and other occupations, in line with the profile of green occupations documented earlier (117). The next section focuses on skills matching across occupations that can aid labor mobility and fulfill increased demand for green occupations.



D. Occupational Mobility Networks to Analyze Job Transition Pathways

10. An analysis of skills associated with each occupation provides insight on possible labor reallocation pathways for jobs-at-risk during the climate transition. To understand the extent of jobs-at-risk and possible reallocation patterns, the paper focuses on the skills and competence content of each occupation and assembles the following information:

- *Occupation Types:* To analyze labor mobility in the context of the climate transition, occupations are first classified into "green", "polluting" and "other" and then overlaid on the occupation

¹⁰ For instance, construction workers typically have low education qualifications but are considered skilled as they possess a high level of manual skills specific to their occupation.

mobility network. The list of green and greening occupations by Onemev is used to define whether an occupation is green; polluting occupations are defined by whether they have a high probability of occurring in polluting industries (Vona et. al., 2018)¹¹; all non-green and non-polluting occupations are classified as other.¹²

- *Skills and competence*: To examine occupational matches more granularly, we rely primarily on the European Commission’s skills database – the European multilingual classification of Skills, Competences, Qualifications and Occupations (ESCO).¹³ The ESCO classification system identifies and categorizes skills¹⁴, competences and qualifications for about 3000 occupations relevant for the EU labor market.
- *Work characteristics*: Information on skills is supplemented with information on work-context for matched occupations from the United States Occupational Information Network (O*NET). These are physical and social factors that influence the nature of work, such as interpersonal relationships (e.g., team coordination), physical work conditions (e.g., physical proximity) and structural job characteristics (e.g., duration of work, degree of automation).

The codification of occupation-specific skills, competencies and work characteristics allows to measure the similarity between pairs of occupations.¹⁵

¹¹ These occupations are those with a probability of working in polluting sectors seven times higher than in any other job. Polluting sectors are those in the 95th percentile of (NACE) sector-wise pollution intensity (measured in terms of emissions per worker) for at least three pollutants including CO₂.

¹² There is a very small level of overlap between green and polluting occupations (about 3 percent of all ESCO occupations classified as green or polluting). These overlapping occupations are classified as brown given the sectoral risk facing these occupations, and also to reflect that they are likely to be impacted by changing skill-sets.

¹³ An occupation in ESCO is defined as a set of jobs whose main tasks and duties are characterized by a high degree of similarity. Each ESCO occupation is related to essential and optional knowledge, skill and competence concepts. *Essential* are those knowledge, skills and competences that are usually relevant for an occupation, independent of the work context, employer or country, while *Optional* occur when working in an occupation depending on the employer, working context. Qualifications in ESCO come from the national qualifications databases of EU Member States.

¹⁴ ESCO skills are described as the ability to apply knowledge and use know-how to complete tasks and solve problems. They can be either cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). “Competence” is broader and refers to the ability of a person, facing new situations and unforeseen challenges, to use and apply knowledge and skills in an independent and self-directed way.

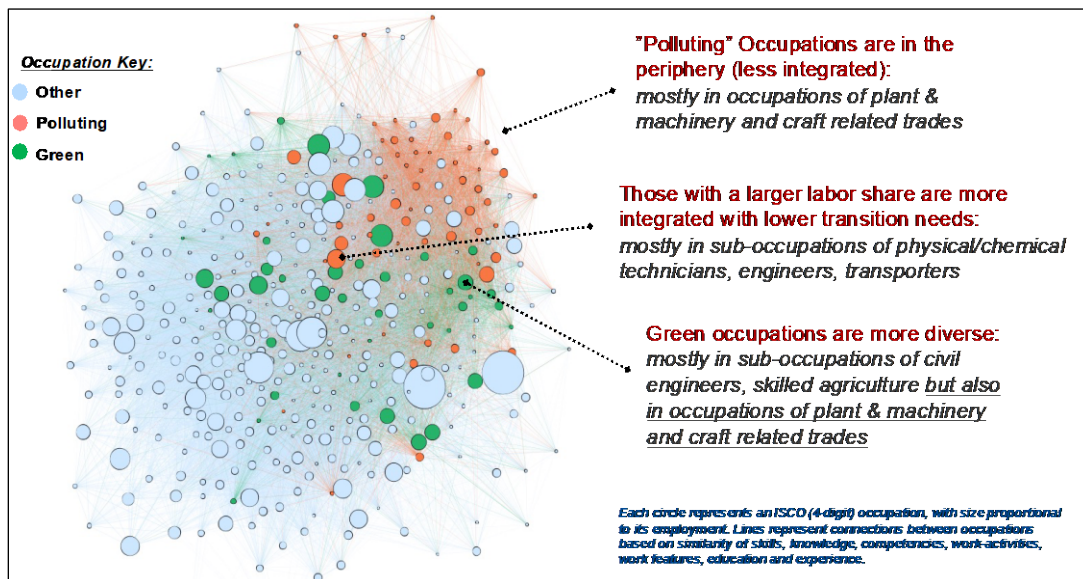
¹⁵ It should be noted that several attributes, especially those from Onemev and O*NET, are matched to ESCO occupations through crosswalks of various classifications. As such, an important caveat to the analysis is that the matching of attributes to occupation is not fully perfect and should be regarded as approximate.

Box 1. Measuring Occupation Similarity

Kanders et. al. 2020 provide a methodology for measuring occupation similarity based on skills information in ESCO as well as work characteristics of matched occupations in O*NET. Briefly it consists of:

- Using natural language processing techniques - a subfield of machine learning – to measure the overlap of essential and optional skills for each occupation pair. Essential skills are those skills that are usually required when working in an occupation, independent of the work context or the employer. Optional skills refer to skills that may be required or occur when working in an occupation depending on the employer, working context or country.
- Using vector similarity metrics, to measure the alignment of typical work activities performed in each occupation, provided by the ESCO skills hierarchy. The ESCO hierarchy specifies a categorization of skills at several levels so that skills in the same hierarchical category can be inferred to belong to the same type of work activity.
- Using vector similarity measures, to measure the overlap between physical, interpersonal and structural work characteristics for each occupation pair.
- Taking a simple average of the above-three similarity measures for each occupation pair.

11. The skills-based occupational mobility network shows that polluting occupations tend to be clustered in the periphery, whereas green occupations are more dispersed. In the text figure below, we use the occupational similarity matrix (Kanders et. al., 2021, see Box 1)–where each element represents the pairwise job-match value between occupations–to construct an occupational mobility network. The network is plotted at a slightly higher level of aggregation to ease visualization; each circle in this network represents an ISCO 4-digit occupation, with the size proportional to its employment. Lines represent connections between occupations based on similarity of skills, knowledge, competencies, work-activities, work features, education and experience. The network shows that polluting occupations (e.g., plant & machinery and craft related trades) are clustered in the periphery and less integrated. However, those with a larger labor share (e.g., physical/chemical technicians, engineers, transporters) are more integrated with lower transition needs. On the other hand, green occupations are more diverse (civil engineers, skilled agriculture), and some are situated alongside polluting occupations (e.g., plant & machinery and craft related trades) suggesting some overlap and feasible occupational pathways.



12. Green occupations have higher job transition possibilities, relative to polluting and other occupations. While the above network provides a good visualization of how locked in each occupation type might be, it is also useful to compute the number of job transition possibilities across occupations based on their similarity with other occupations. The number of job-matches per occupation is calculated by taking the sum of pair-wise occupational similarity across each different type of occupation (green, polluting, and other). The left panel of the text figure show the range of possible job-matches across occupation type for transiting into a green occupation. The median job match for a polluting to green occupation transitions is low – about 4 matches (but there is some heterogeneity). For instance, mining engineers have a low (below-median) job-transition match into green occupations compared to chemical engineers who have high (above-median) matches.¹⁶ As expected, it is easier to transition between green occupations and from other occupations to green. Similarly, the right panel of text figure plots the range of possible job-matches across occupation type for transiting into an “other” occupation. Here as well, polluting occupations tend to have relatively lower job matches, but they are higher than their transition possibility into green occupations.

¹⁶ To illustrate further, mining engineers (polluting occupation) have the highest job-match with geologists (green occupation) and mechanical engineers (other occupation) but no match with that of horticulturalists (green occupation) or dentists (other occupation).



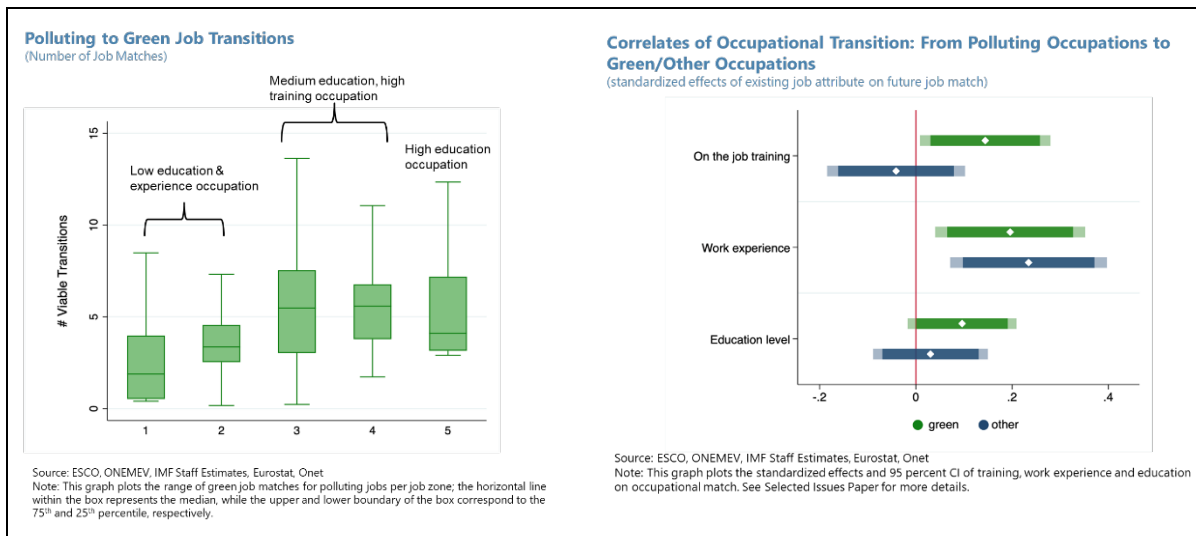
13. On-the-job training and work experience increase job transition possibilities. To examine the extent to which polluting occupations can switch to green occupations based on certain pre-existing occupational characteristics, we conduct two exercises:

- First, we plot the range of job matches by the polluting occupation's job zone. O*NET classifies an occupation's job-zone based on the average education, work-experience, and on-the-job training needed to do the work. Occupations in job-zones 1 and 2 typically require low education (up-to a high school diploma), some previous work experience and a low-level of training (a few months or through an apprenticeship program). Occupations in job-zones 3 and 4 typically require a vocational or bachelor's degree, requisite previous work experience and a high level of training (several years of on-the-job and/or vocational training). Occupations in job-zone 5 typically require a graduate degree or more, high level of work experience and some training (if skills were not acquired through education or experience). Text figure (left panel) shows that the median number of polluting to green job matches are relatively higher for polluting occupations in job zones 3 and 4, i.e., those with a medium education but high training level.
- Next, we disaggregate each of the job-zone characteristics and analyze how they influence the polluting-green transition match. To do so, we regress the level of training, experience and education for each polluting occupation o , on its job-match similarity with every other green occupation s . We repeat the same exercise for job-matches between polluting and other non-green occupations. For ease of interpretation, we report standardized effects in the text figure (right panel) from the regression specification below:

$$\sum_{s \in \text{Green, Other}} \text{JobMatch}_{o,s} = \beta \text{Training}_o + \gamma \text{Exp}_o + \theta \text{Edu}_o + \varepsilon_o$$

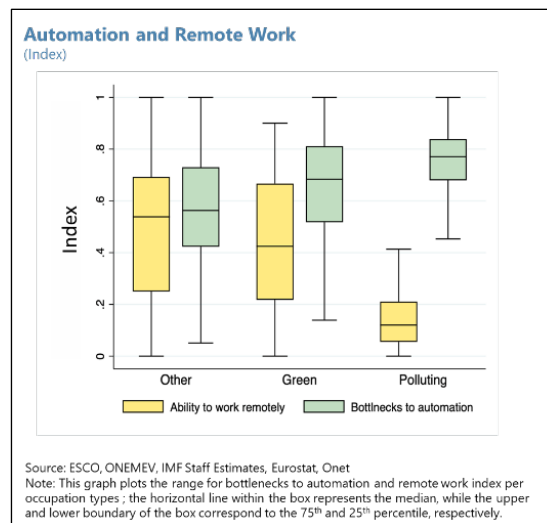
Similar to the descriptive analysis of job-zones above, the results show that polluting occupations with higher training and work experience are associated with a larger number of

green job-matches. A one standard deviation increase in a polluting occupation’s training or work-experience level, is significantly associated with an increased green job match by about 0.2 standard deviations. On the other hand, the level of education is less strongly associated with possible green transitions.



14. Job-transition possibilities could however be dampened by structural transformations related to the pandemic.

The pandemic has accelerated the need for automation and the associated ability to perform work duties remotely. Using the occupation-specific automation index (Kanders et al., 2020) and remote-working index (del Rio-Chanona et al. 2020), it can be seen (text figure) that polluting occupations are less likely to be automated and have less capabilities of remote-working. On the other hand, green occupations can be more easily automated with higher ability of remote-working. This suggests that while polluting occupations are less at risk from automation, they face more obstacles in shifting to new ways of working, which could lower future job mobility if workers are not appropriately trained.



E. Additional Insights on Desirable Transitions from Job Multipliers

15. Carbon emission shifts in specific sectors could also affect employment in other sectors through input-output linkages. The analysis in section B revealed that only a small share of jobs in polluting sectors are directly a risk. However, relatively small shocks to key emission sectors could also lead to indirect job losses in other sectors of the economy through economy-wide supply and demand linkages. Therefore, in addition to assessing the direct impact of the climate

transition on jobs within carbon-intensive sectors, there is a need to also focus on sectoral linkages to gain insight on possible general equilibrium effects. As sectors are closely linked in an economy through complex input–output linkages, policies adopted in any sector can materially affect other sectors. For instance, carbon-intensive sectors may occupy integral positions in the supply chain, such that any output shocks to these sectors will ripple through the production chain and impact the development of related sectors. Employment impacts of the climate transitions should thus not only focus on the individual sectors but also the intersectoral linkages. In addition, households affect the output of production sectors through consumption and second-round labor compensation effects, further impacting sectoral employment losses from carbon emission shifts. To analyze all these factors, the analysis in this section uses a semi-closed input–output model with partially endogenized consumption to quantify the full extent of employment impacts of carbon emissions reduction. Three types of employment multipliers – the impact on employment throughout the economy arising from a change in the final demand for each sector – are derived:

- *Direct job multiplier*: increase in the number of direct jobs in a sector from a unit increase in its output,
- *Indirect job multiplier* (Leontief backward linkages¹⁷): increase in number of jobs in other sectors from a unit increase in a sector’s output,
- *Induced job multipliers* (forward linkages): increase in number of jobs from increased household demand (through labor compensation) feeding into all sectors from a unit increase in a sector’s output.

These job multipliers can be augmented by the sector’s carbon intensity (output per unit of carbon emissions) so as to quantify the impacts of reduced carbon emissions on employment (Bai et. al., 2021).

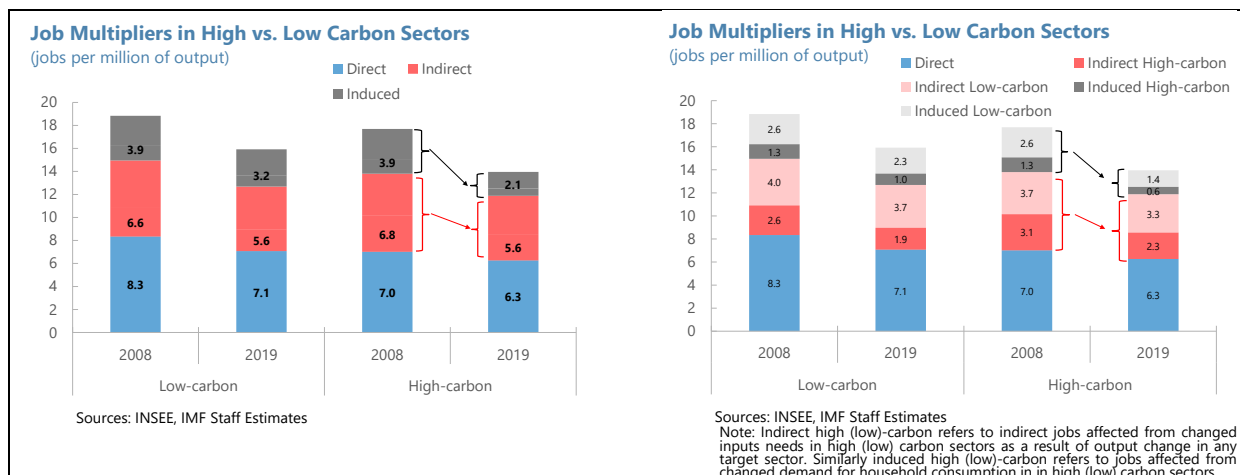
16. While direct job multipliers decreased secularly across all sectors, indirect and induced effects decreased relatively more in carbon-intensive sectors. For the majority of sectors, the combination of indirect and induced effects was also greater than direct effects. Between 2008 and 2019 direct job multipliers – i.e., employment per output - fell in all sectors, partly reflecting the declining labor share in the production process¹⁸. However, indirect and induced multipliers decreased to a greater extent in carbon-intensive sectors¹⁹ compared to low-carbon sectors,

¹⁷ The economy-wide input output matrix comprises the value of each sector’s intermediate inputs to every other sector of the economy for their production needs. Direct employment effects are measured by the labor inputs used per unit of output. Indirect effects are derived using the inverse of the input per output coefficient matrix – the so-called Leontief inverse. Induced effects are derived based on the household demand augmented version of the input per output coefficient matrix. For further details on the methodology see Miller and Blair (2009).

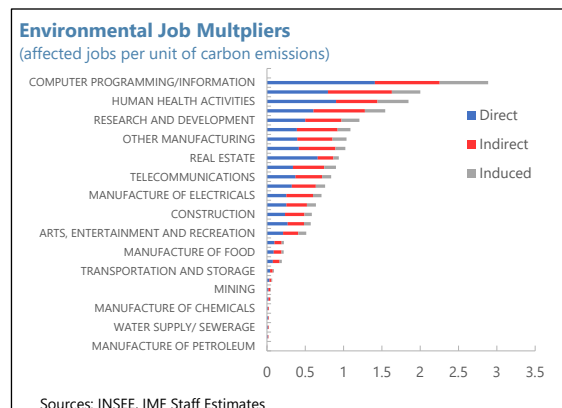
¹⁸ A large literature analyzes the declining share of labor, attributing it mainly to increased automation, globalization and market concentration (see Kehrig and Vincent, 2021, for a recent review). It is worth noting however that jobs in carbon-intensive sectors are less prone to automation (T14) which suggests other factors at play for these sectors.

¹⁹ The definition of carbon-intensive sectors largely corresponds to that defined in T14 i.e., based on sectors with high carbon emissions per output. However, the analysis in this section uses more disaggregate sectoral identities.

suggesting a shift away from the demand for goods produced in these sectors, both from households as well as other sectors. These effects can be further decomposed into those emanating from high vs low carbon sectors' demand for the target sector's output as well as the second-round household demand for high vs low carbon sectors' output. The analysis shows that the falling employment multiplier for high-carbon sectors are mostly driven by a fall in induced household demand for products from other high-carbon sectors.



17. Augmenting job multipliers with environmental factors can help in the sectoral targeting of employment policies. Each sector's job multipliers can be adjusted by its carbon emission intensity, so as to identify environmentally friendly sectors with high job growth potential. This is done by multiplying direct, indirect and induced employment multipliers by the output per unit of carbon emissions. The text figure shows the results for 2019. Tertiary and service-oriented sectors such as IT, R&D, health services, telecommunications, have high carbon adjusted employment multipliers –suggesting a “multi-win” situation in terms of carbon emissions reductions, and employment stability. Policies could thus be focused on boosting jobs and production in these sectors. Other sectors, such as mining, transportation, chemicals manufacturing have low environmental employment multipliers suggesting that a per unit of carbon emissions reduction would also generally lead to few job losses – both in terms of direct and indirect/induced impacts – and limiting their output could cause less negative effects. However, for key sectors such as manufacturing of electronics and machinery, with strong economy-wide integration, there are relatively high employment effects per unit of carbon emissions change and policies could focus more on the green-enhanced industrial upgrading of these sectors.



F. Conclusion and Policy Considerations

18. Achieving urgently needed environmental sustainability through policy action can create the double dividends of economic and jobs growth if the transition is properly managed. Skills mismatches between occupations in polluting sectors and growing green occupations are large, but the paper’s analysis shows that training and work experience (but not necessarily education) could be associated with improved job matches. Improved dissemination of work experience, through for instance employer ratings or evaluations, has been found to substantially improve workers’ subsequent employment outcomes in entry-level labor markets (Pallais, 2013). This could be achieved for instance, by subsidizing firms for hiring young workers, as already pursued under the French recovery plan. The government could also work with the private sector to regulate skills-based measures of worker performance, through employment tests or simulated work experience, to avoid stigmatization of previous (high-carbon) job contexts. A data-driven strategy – making use of the granular skills matches between occupations, as done in the paper - to map career pathways for workers affected by the climate transition, can be utilized by public-sector agencies to aid job seekers.²⁰ Investing in sectors that have the potential to create sustainable green jobs, such as those identified in Section E, or supporting the evolution of skills in affected sectors, should also be a key complementary pillar of a well-managed transition.

19. France has set up important institutional frameworks and support mechanisms to analyze and meet future skills needs related to the green transition. The skills investment plan adopted by the government in the context of the NECP is a step in the right direction, including the formation of Onemev to monitor green jobs growth. The plan strikes a collaboration between the government and the social partners to develop skills, including within the electricity sector, and provide training for job seekers affected by the energy transition. Accrediting ministries are also tasked with improving certifications and upgrading the necessary diplomas to prepare the future workforce for the transition. Linking these new training programs and pedagogy to digital tools should be prioritized given the shift to new ways of working induced by the pandemic and given the low level of remote-work readiness in carbon-intensive industries. Emphasis should be placed on developing inter-sectoral qualifications, as many occupations in carbon-intensive industries are likely to be locked-in from too many non-transferable sector-specific skills (ILO, 2018). Efforts should also be made, along with the private sector to raise the attractiveness of green jobs to increase labor supply for the unmet and increasing demand for such jobs. Further initiatives to strengthen the institutional set-up, through for instance providing a legal framework for green skills and training (e.g., Philippines Green Jobs Act) or establishing a multi-year green growth plan (e.g., Korea green growth committee, India skill council for green jobs) can provide more effective and sustainable support to the green transition (ILO, 2019). Finally, there may be a need to bolster long-term support programs for displaced workers who are unable to transition easily.

²⁰ See for instance an interactive [recommendation](#) algorithm to support jobs at risk of automation in the United Kingdom.

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