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Effect of Pharmacist Involvement in COVID-19 Vaccination Campaign on Vaccine Coverage

Aniss Malik LOUCHEZ

aniss.louchez@yahoo.fr

Université de Lille

Research Article

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Posted Date: November 13th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11387516/v1

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Additional Declarations: No competing interests reported.

Effect of Pharmacist Involvement in COVID-19 Vaccination Campaign on Vaccine Coverage

Aniss LOUCHEZ[1]

Abstract

To address the COVID-19 pandemic, promoting vaccination emerged as a preferred strategy to mitigate the harmful consequences of non-pharmaceutical interventions. In Europe, a measure adopted by several states was to authorize pharmacists to administer vaccines. The objective of this chapter is to assess whether this involvement could improve vaccination coverage. To do this, the synthetic control group method is used, due to a European framework conducive to its establishment. The results show an improvement in coverage with the first dose in Italy, but a degradation with the second dose. In Ireland, the opposite situation is observed. In France, due to the early adoption of the measure, no significant results were obtained. These elements imply for the legislator that the pharmacist can have different effects on vaccination coverage and that this must be considered taking into account epidemiological and vaccine issues, the spatial distribution of healthcare provision, and potentially its regulation.

Keywords:

Communities' pharmacies; immunization; COVID-19; Vaccination; European country analysis; Synthetic control group; public health policy assessment

Declarations

Conflict of interest's statement and funding,

This study was supported by the French government through the Programme Investissement d'Avenir (I-SITE ULNE / ANR-16-IDEX-0004 ULNE) managed by the Agence Nationale de la Recherche.

The authors declare that they have no competing interests.

Ethics Declaration

Not Applicable

Data availability

All used data are publicly available and free access.

[1]Univ. Lille, UMR 9221 - LEM - Lille Économie Management, F-59000 Lille, France, aniss.louchez@yahoo.fr, https://orcid.org/0000-0002-2965-3852

1. Introduction

To mitigate the spread of COVID-19, governments initially relied on Non-Pharmaceutical Interventions (NPIs), such as social distancing and lockdowns. While effective in reducing mortality, these measures imposed significant secondary costs on economies, mental health, and access to essential healthcare services [1]–[3]. Consequently, the development of vaccination programs became a primary policy objective to provide a sustainable exit strategy from NPIs [4].

To ensure high vaccine uptake, public authorities implemented various demand-oriented interventions, including automatic appointment scheduling, priority lists, and legal incentives such as "health passes" [5], [6]. However, the effectiveness of these measures depends heavily on the efficiency of the supply side, specifically, the ease of access to the vaccine. Literature suggests that vaccination coverage is sensitive to the place of injection, proximity, and waiting times [5]. In this context, community pharmacies emerged as a strategic asset. Due to their dense geographic distribution, extended operating hours, and high patient accessibility, pharmacies can reduce the "distance effect" and temporal barriers to vaccination[7], [8].

Capitalizing on this potential, several European countries authorized community pharmacies to administer COVID-19 vaccines, including France (26/03/2021), Italy (24/05/2021), Ireland (14/06/2021), Croatia (21/08/2021), Germany (01/01/2022), and Belgium (18/07/2022). Despite this widespread adoption, there remains a lack of empirical evidence regarding the efficacy of pharmacy involvement. It remains unclear whether pharmacies generated an additional effect by increasing total coverage, or merely a substitution effect, where patients shifted from general practitioners to pharmacists without changing their overall vaccination status. Furthermore, it is unknown if these effects vary by dose (first vs. second), population priority (elderly vs. general), or underlying healthcare system organization.

This study addresses this gap by employing a Synthetic Control Method (SCM) to construct a counterfactual scenario: simulating what vaccine coverage would have been in the absence of pharmacy-led administration. This approach investigates whether pharmacy involvement significantly improved vaccination rates and explore the drivers behind these effects across different temporal and spatial dimensions.

2. The European Institutional Framework: A Basis for Comparability

To ensure the validity of the synthetic control method, it is crucial to establish that the analyzed European countries operated under a highly harmonized institutional framework. This convergence minimizes potential confounding factors and facilitates international comparisons across several dimensions: vaccine supply, financial accessibility, and immunization strategies.

2.1. Harmonized Vaccine Supply and Distribution

The European regulatory and procurement framework significantly reduced disparities in vaccine availability. First, the centralized authorization procedure managed by the European Medicines Agency (EMA) ensured that once a vaccine was approved, it became available to all Member States simultaneously. Second, to mitigate the risks of high demand[9], [10] and production shortages[11], [12], the European Commission implemented Advance Purchase Agreements (APAs). Under this centralized negotiation and procurement strategy [13], vaccines were distributed across Member States in proportion to their population. Consequently, the volume of available doses was largely independent of a country's individual wealth or bargaining power, ensuring a level playing field regarding supply.

2.2. Uniformity in Financial Access and Delivery

The framework effectively eliminated socio-economic barriers related to the cost of vaccination. All studied countries provided vaccines free of charge[14], thereby mitigating disparities linked to personal income or healthcare spending. Furthermore, while operational logistics varied, the underlying immunization schemes remained highly consistent across the continent:

- Prioritization**:** By March 2021, all countries had implemented age-based priority lists, focusing on the elderly [15], with only minor variations in specific age thresholds.
- Dosing Regimens: The intervals between the first and second doses were largely standardized, with the notable exception of Finland (Figure A2). Similarly, the authorization of heterologous combinations (using different manufacturers for the two doses) was widely adopted by late 2021[16].
- Resource Optimization: To address acute shortages, most countries implemented protocols to extract additional doses from multi-dose vials[17].

2.3. Convergence of Non-Pharmaceutical Interventions

Finally, the emergence of new variants did not trigger significant structural shifts in vaccination policy; adjustments were minimal in only a few Member States by late 2021[17], [18]. While many countries introduced "health passes" by September 2021 to regulate movement under specific conditions (e.g., negative test or recovery), the transition to a strict "vaccine pass", where vaccination became the sole requirement for relaxation of restrictions, was not universally adopted, providing a controlled environment to study the impact of pharmacy-led administration without extreme policy divergence.

3. Data

3.1. Sources and Variables

Two primary databases are employed. The first, Our World in Data (OWID)[19], provides contextual variables related to the COVID-19 pandemic that may influence vaccination rates. This includes epidemiological dynamics (number of tests, hospitalizations, and cases) and a stringency index to account for the intensity of Non-Pharmaceutical Interventions (NPIs). To control for national disparities, macroeconomic and structural variables are included: age vulnerability (life expectancy at birth), economic wealth (GDP per capita) affecting healthcare infrastructure quality, the Human Development Index (HDI), population density (capturing potential epidemic propagation), and healthcare orientation (hospital beds per capita).

The second database is the European Centre for Disease Control (ECDC) vaccination tracker, which provides the variable of interest: vaccine coverage. This allows for a granular analysis to identify potential trade-offs in vaccine allocation. Given production constraints, improvements in one subcategory may divert access from others. The total population ($p = 1$) and the elderly population ($p = 2$) are compared to account for prioritized access groups. Furthermore, distinguishing between the first dose ($d = 1$) and the second dose ($d = 2$) allows us to identify whether the intervention exerts an intensive effect (reinforcing protection for the already vaccinated) or an extensive effect (increasing coverage among the unvaccinated).

All variables are reported per capita to ensure comparability across different population sizes. However, vaccine coverage is expressed relative to the last observation of December 2021. By assuming that all individuals ready to be vaccinated had received their dose by this date, it adjusts for disparities in vaccine hesitancy, thereby assessing the intervention's ability to accelerate the attainment of maximum coverage.

3.2. Spatio-temporal Dimension

The analysis is restricted to EU Member States. This choice is twofold: first, Advanced Purchase Agreements (APAs) ensured a similar vaccine supply per capita across these states, enhancing comparability; second, several countries (France, Italy, Ireland) adopted the intervention prior to the widespread implementation of "health passes," allowing us to evaluate the policy without major interference from secondary interventions.

To ensure the quality of the counterfactual, countries with missing data regarding tests or hospitalizations were excluded. The final sample comprises 17 countries: 3 treatment groups (FRA, ITA, IRL) and 14 control groups (AUT, BEL, CYP, CZE, DNK, ESP, EST, FIN, LUX, NLD, PRT, SVK, SVN, SWE). Notably, due to data limitations, the effect of specific vaccine manufacturers cannot be distinguished.

The analysis period spans from the arrival of vaccines (December 25, 2020) to July 2021, avoiding the confounding effects of subsequent sanitary pass mandates. All data are aggregated at the weekly level following ISO standards to maintain consistency with ECDC reporting.

3.3. Descriptive Statistics

Vaccine coverage across all countries follows a sigmoid trajectory (Figure A1): a slow initial phase reaching 10% by the 10th week, followed by an acceleration until week 28, and finally a plateau. The second dose (Figure A2) exhibits a similar pattern but with a 2-4 week delay, with the exception of Finland, which adopted a significantly longer interval (3 months).

The over-60 population experienced a faster and earlier progression in coverage (Figure A3, Figure A4). However, in Italy and Ireland, coverage for this group was already nearing its peak at the time of the intervention, potentially limiting the observable benefits for this specific demographic.

4. Empirical Analysis

4.1. Synthetic Control Group Methodology

The Synthetic Control Group (SCG) method [20] is particularly suited for studies where randomized controlled trials are unfeasible due to a limited number of treated units. Unlike traditional difference-in-differences approaches, SCG relaxes the "parallel trends assumption," which posits that unobserved trends are identical across groups. This assumption is often violated in epidemic contexts, where disease dynamics and population behaviors vary significantly over time and across borders[21], [22]. Consequently, SCG has become a standard tool for evaluating COVID-19 interventions[23], [24].

The methodology constructs a counterfactual (Y^N_{jdpt}) representing what would have occurred if the intervention had not been adopted, considering a specific dose (d), population (p), and state (j). The difference with intervention curve (Y^I_{jdpt}) is noted α_{jdpt}, in presence of the intervention ($D_{jdpt} = 1$). The conterfactual is achieved by assigning weights (w_{jdp}) to control countries based on their similarity in contextual variables (z_{jdp}) during the pre-intervention period. The estimation can be formalized as:

$$\begin{aligned} Y^I_{jdpt} &= Y^N_{jdpt} + \alpha_{jdpt} \cdot D_{jdpt} \\ Y^N_{jdpt} &= \sum_{j=2}^{J+1} w_{jdp} \cdot Y^N_{jdpt} \\ w_{jdp} &= \delta_{dpt} + \lambda_{dpt}\mu_{jdp} + \theta_{dpt}Z_{jdp} + \epsilon_{jdpt} \end{aligned} \quad (1)$$

where i denotes the treated country, D_{jpdt} indicates the presence of the intervention, and the model incorporates time effects (δ_{dpt}), country fixed effects (μ_{idp}), and a time-dependent vector (λ_{dpt}) to relax the parallel trends requirement. The quality of the counterfactual is assessed by minimizing the Mean Square Predictive Error (MSPE) and ensuring that the gaps between the observed and weighted contextual variables are minimized.

4.2. Analytical Strategy

A separate counterfactual is constructed for each treated country (France, Italy, and Ireland), stratified by vaccine dose (first and second) and population type (elderly vs. general population).

To prevent confounding effects from subsequent sanitary pass mandates, the primary analysis period is restricted to the period ending in July 2021. To test for potential interference, an extended analysis through December 2021 is provided as a complementary result. This extension also serves to confirm that the choice of the post-intervention window does not bias the results, as weights are established solely during the pre-treatment period.

4.3. Statistical Inference and Robustness Checks

Given the small number of treated units, placebo experiments are employed [20] to assess the uncertainty of our estimates. This involves applying the SCG method to each country in the control group as if they had implemented the intervention. The MSPE ratio (post-intervention vs. pre-intervention) of the treated unit against that of the placebo units are compared; a significant effect is identified only if the treated unit's ratio exceeds those of the control group.

To ensure the stability and validity of our findings, two robustness tests are conducted:

- Backdating Test: the intervention is advanced by one month to detect potential anticipated effects. This is particularly relevant for France, where a short pre-intervention period requires careful verification.
- Leave-one-out Test: each country is removed from the control group to ensure that the estimated effect is not driven by a single influential unit in the donor pool.

5. Results

5.1. Synthetic Control Quality

A counterfactual is implemented for each population category (general population or those over 60), for each dose (first or second dose), and for each treated state (France, Ireland, and Italy). Contextual variables are compared considering averages and counterfactual values (Table 1). Overall, weighted controls are closer to observed treated state. Few variables presenting larger differences (e.g. hospitalizations) do not influence the counterfactual establishment (low weight).

Table 1 : Quality of Counterfactual

Variable	Treated State Observed	-Treated State Counterfactual	-Control Group	Weight
		France - General Population - Dose 1		
Cases	306.345	379.150	361.345	0.024
Tests	4.788	6.158	12.566	0.166
Hospitalizations	382.070	276.605	263.641	0.060
Stringency index	64.266	65.212	68.341	0.381
Beds	5.980	5.371	4.303	0.154
Population density	122.578	261.127	151.340	0.000
GDP per capita	38,605.671	41,951.456	41,666.488	0.014
HDI	0.901	0.913	0.911	0.092
Life expectancy	82.660	81.205	81.206	0.062
		France - General Population - Dose 2		
Cases	306.345	432.753	361.345	0.061
Tests	4.788	12.155	12.566	0.008
Hospitalizations	382.070	337.109	263.641	0.372
Stringency index	64.266	65.705	68.341	0.292
Beds	5.980	5.549	4.303	0.164
Population density	122.578	232.315	151.340	0.006
GDP per capita	38,605.671	54,668.922	41,666.488	0.000
HDI	0.901	0.912	0.911	0.022
Stringency index	64.266	70.880	68.341	0.000
Beds	5.980	5.979	4.303	0.319
Population density	122.578	122.611	151.340	0.206
GDP per capita	38,605.671	36,640.599	41,666.488	0.000
HDI	0.901	0.894	0.911	0.001
Life expectancy	82.660	79.551	81.206	0.000
		France - Over 60 - Dose 1		
Cases	306.345	379.150	361.345	0.024
Tests	4.788	6.158	12.566	0.166
Hospitalizations	382.070	276.605	263.641	0.060
Stringency index	64.266	65.212	68.341	0.381
Beds	5.980	5.371	4.303	0.154

Population density	122.578	261.127	151.340	0.000
GDP per capita	38,605.671	41,951.456	41,666.488	0.014
HDI	0.901	0.913	0.911	0.092
Life expectancy	82.660	81.205	81.206	0.062
		France - Over 60 - Dose 2		
Cases	306.345	403.170	361.345	0.001
Tests	4.788	23.894	12.566	0.000
Hospitalizations	382.070	381.531	263.641	0.422
Stringency index	64.266	64.306	68.341	0.479
Beds	5.980	5.803	4.303	0.028
Population density	122.578	121.897	151.340	0.069
GDP per capita	38,605.671	35,013.010	41,666.488	0.000
HDI	0.901	0.893	0.911	0.000
Life expectancy	82.660	79.332	81.206	0.000
		Italy - General Population - Dose 1		
Cases	238.734	353.759	303.970	0.042
Tests	4.497	5.963	14.007	0.066
Hospitalizations	395.523	282.202	221.673	0.155
Stringency index	76.101	72.012	65.986	0.287
Beds	3.180	4.054	4.303	0.078
Population density	205.859	151.705	151.340	0.090
GDP per capita	35,220.084	33,084.205	41,666.488	0.038
HDI	0.892	0.893	0.911	0.195
Life expectancy	83.510	81.880	81.206	0.049
		Italy - General Population - Dose 2		
Cases	238.734	295.145	303.970	0.000
Tests	4.497	4.247	14.007	0.017
Hospitalizations	395.523	237.317	221.673	0.113
Stringency index	76.101	70.604	65.986	0.075
Beds	3.180	3.448	4.303	0.092
Population density	205.859	154.998	151.340	0.229
GDP per capita	35,220.084	35,495.219	41,666.488	0.075
HDI	0.892	0.906	0.911	0.112
Life expectancy	83.510	82.816	81.206	0.279
		Italy - Over 60 - Dose 1		
Cases	238.734	285.376	303.970	0.119
Tests	4.497	3.907	14.007	0.012

Hospitalizations	395.523	203.734	221.673	0.049
Stringency index	76.101	73.376	65.986	0.311
Beds	3.180	3.385	4.303	0.197
Population density	205.859	141.525	151.340	0.016
GDP per capita	35,220.084	29,450.232	41,666.488	0.001
HDI	0.892	0.870	0.911	0.000
Life expectancy	83.510	82.067	81.206	0.000
	Italy - Over 60 - Dose 2			
Cases	238.734	340.398	303.970	0.001
Tests	4.497	5.374	14.007	0.000
Hospitalizations	395.523	254.315	221.673	0.087
Stringency index	76.101	72.062	65.986	0.175
Beds	3.180	3.880	4.303	0.030
Population density	205.859	187.082	151.340	0.327
GDP per capita	35,220.084	35,027.173	41,666.488	0.077
HDI	0.892	0.900	0.911	0.088
Life expectancy	83.510	82.082	81.206	0.098
	Ireland - General Population - Dose 1			
Hospitalizations	395.523	254.315	221.673	0.087
Cases	207.042	235.903	273.263	0.131
Tests	3.491	16.885	13.814	0.048
Hospitalizations	111.817	128.172	199.008	0.046
Stringency index	76.958	74.059	64.305	0.568
Beds	2.960	5.300	4.303	0.011
Population density	69.874	273.386	151.340	0.027
GDP per capita	67,335.293	44,949.637	41,666.488	0.006
HDI	0.955	0.925	0.911	0.026
Life expectancy	82.300	81.897	81.206	0.045
	Ireland - General Population - Dose 2			
Cases	207.042	214.535	273.263	0.174
Tests	3.491	19.811	13.814	0.000
Hospitalizations	111.817	113.020	199.008	0.666
Stringency index	76.958	67.144	64.305	0.020
Beds	2.960	3.752	4.303	0.012
Population density	69.874	93.529	151.340	0.110
GDP per capita	67,335.293	46,423.190	41,666.488	0.017
HDI	0.955	0.937	0.911	0.000

Life expectancy	82.300	81.667	81.206	0.000
	Ireland - Over 60 - Dose 1			
Cases	207.042	230.482	273.263	0.182
Tests	3.491	4.683	13.814	0.260
Hospitalizations	111.817	65.547	199.008	0.036
Stringency index	76.958	67.152	64.305	0.019
Beds	2.960	3.108	4.303	0.381
Population density	69.874	305.503	151.340	0.000
GDP per capita	67,335.293	46,320.759	41,666.488	0.000
HDI	0.955	0.942	0.911	0.070
Life expectancy	82.300	82.143	81.206	0.031
	Ireland - Over 60 - Dose 2			
Cases	207.042	207.477	273.263	0.823
Tests	3.491	15.511	13.814	0.010
Hospitalizations	111.817	188.173	199.008	0.000
Stringency index	76.958	70.534	64.305	0.027
Beds	2.960	4.912	4.303	0.000
Population density	69.874	99.688	151.340	0.028
GDP per capita	67,335.293	38,974.919	41,666.488	0.000
HDI	0.955	0.911	0.911	0.000
Life expectancy	82.300	82.627	81.206	0.001

The table compares the contextual variables of the treated states (France, Ireland, Italy), their counterfactuals and the average of the control group, distinguishing doses (1st and 2nd dose) and populations (general and over 60). Variables are: the number of tests, cases and beds per thousand inhabitants. The number of hospitalizations and cases are per million inhabitants. GDP per capita is in current dollars, in 2021. The stringency index and the Human Development Index (HDI) are unitless. Life expectancy at birth is in years. Population density is indicated as the number of inhabitants per square kilometer.

5.2. Main Effects

Before the intervention (indicated by vertical lines), effects are close to x-axis, indicating a good counterfactual quality in the absence of intervention. This point is confirmed by a MSPE lower than 2% (Table A2), excepted for the first dose for over 60 in Italy (8.7%) and Ireland (1st dose: 5,3%; 2nd dose: 4,7 %).

For general population (Figure 1), in all countries, we observe a substitution between the 1st dose and the 2nd dose coverage. In Italy, from 21st week to 27th the intervention accelerated the diffusion of the first dose, but negative on the second. In Ireland, the phenomenon is reversed from the 24th to the 28th week. For France, while negative, results are not statistically significant. An explanation is related to the short pre-intervention period while countries are similar in terms of vaccine coverage preventing to establish a relevant counterfactual.

For over 60 (Figure 2), Italy and Ireland do not show significant effect on the first dose. This result is expected considering the late adoption of the intervention, that decreases the potential improvement

of vaccine coverage for prioritized population such as elderly people. The effect for the second dose shows an improvement for Ireland (+ 5%), a loss in Italy (-10%), and an increase (+2,4%) followed by a decrease (-7,6 %) in France.

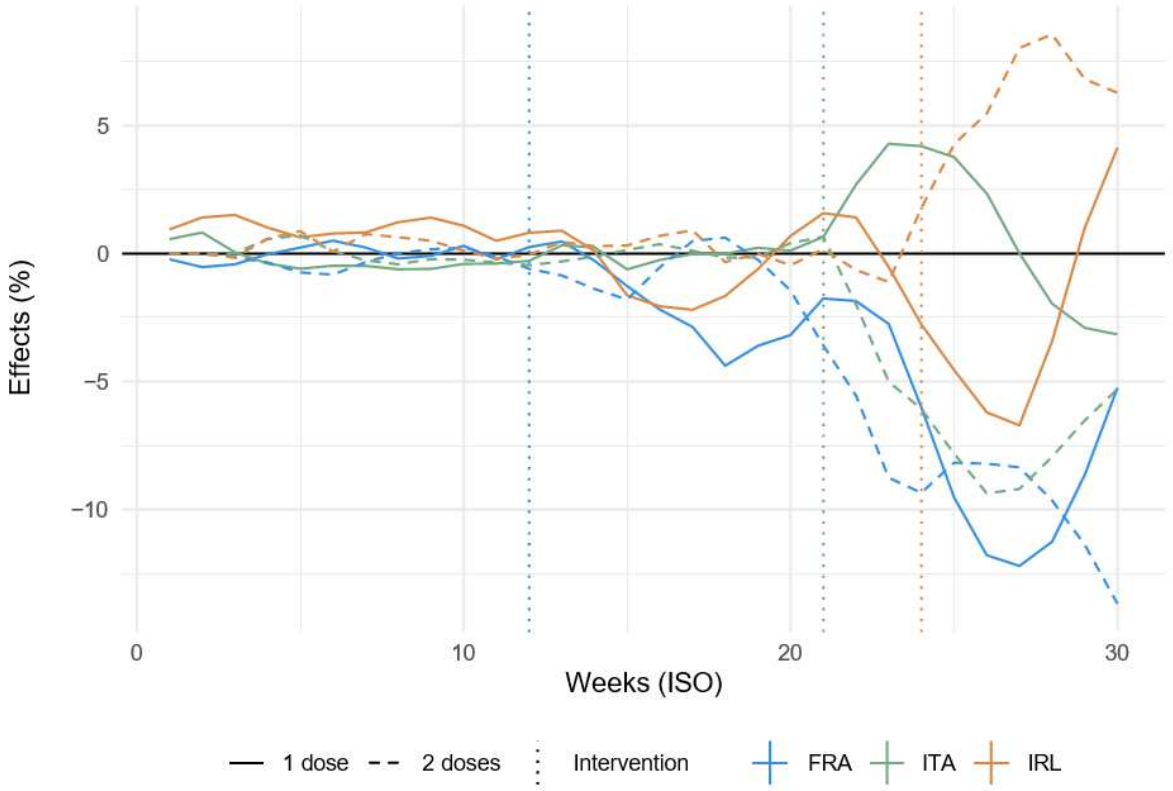


Figure 1: Effects on the entire population

This figure presents the measured effects, i.e., the difference between the synthetic control (x-axis) and the observed values for the entire population, in France (in blue), Italy (in green), and Ireland (in orange). Intervention adoptions are indicated by vertical dotted lines. The first dose is indicated by a solid line and the second by dashes. The analysis period extends from January 1, 2021, to August 1, 2021.

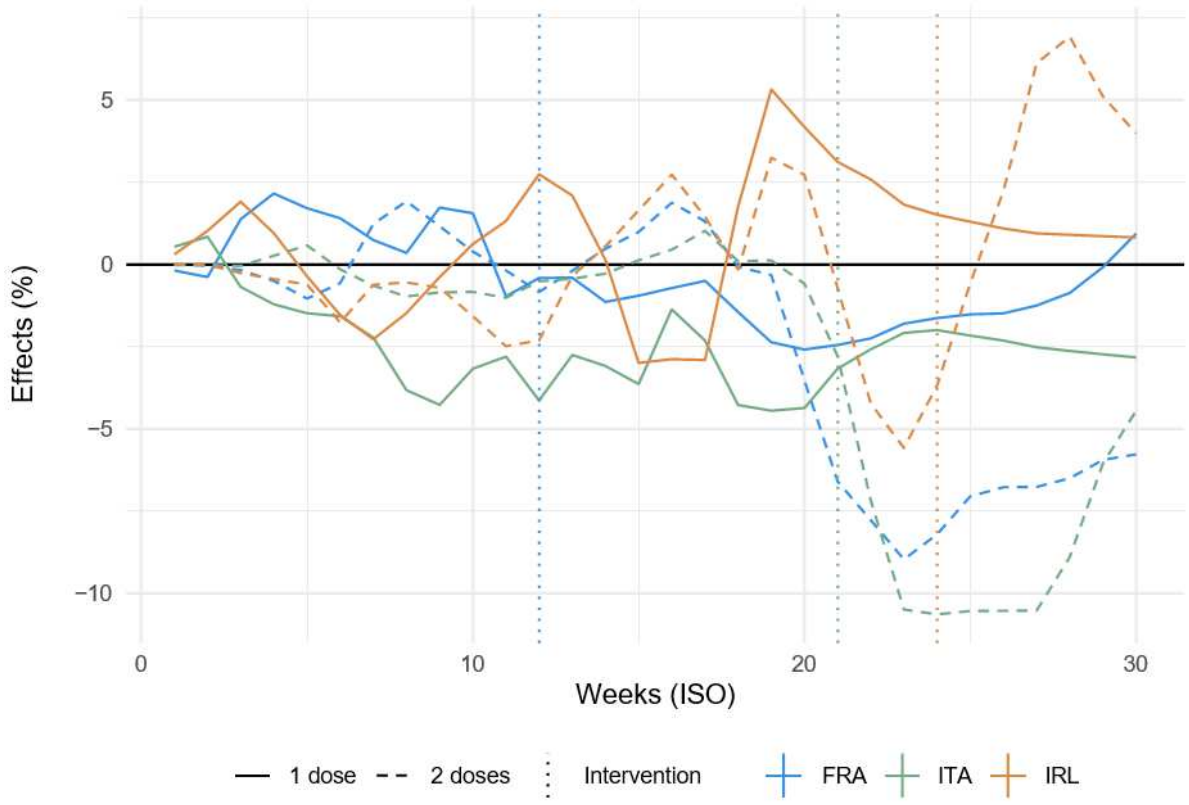


Figure 2 :Effects on those over 60 years old

This figure presents the measured effects, i.e., the difference between the synthetic control (x-axis) and the observed values for the over 60, in France (in blue), Italy (in green), and Ireland (in orange). Intervention adoptions are indicated by vertical dotted lines. The first dose is indicated by a solid line and the second by dashes. The analysis period extends from January 1, 2021, to August 1, 2021.

5.3. Observation Window Extension – Interaction with Health Pass

By extending the analysis period until the 52nd 2021 week, all gaps between counterfactuals and observed data converge to zero. This is expected considering that all vaccine coverage is reported to the 52th week ($Y_{jdp,52} = 100\ \%$). After the sanitary pass adoption (30th 2021 week), some profile changes occur for the general population (Figure 3), suggesting potential interactions. In Ireland, a decrease is observed of the 2nd dose coverage (-2,7 %) and an increase for the 1st dose (+9,3 %). Italy exhibits transitory effects with an improvement of the second dose coverage (+4,8%) and a decrease for the first dose (-2,5%). France shows reversal effects with a decrease of the second dose (-9,6%) and an improvement of the first dose (+13,5 %). These results support potential interactions while preventing any consensual sign or magnitude.

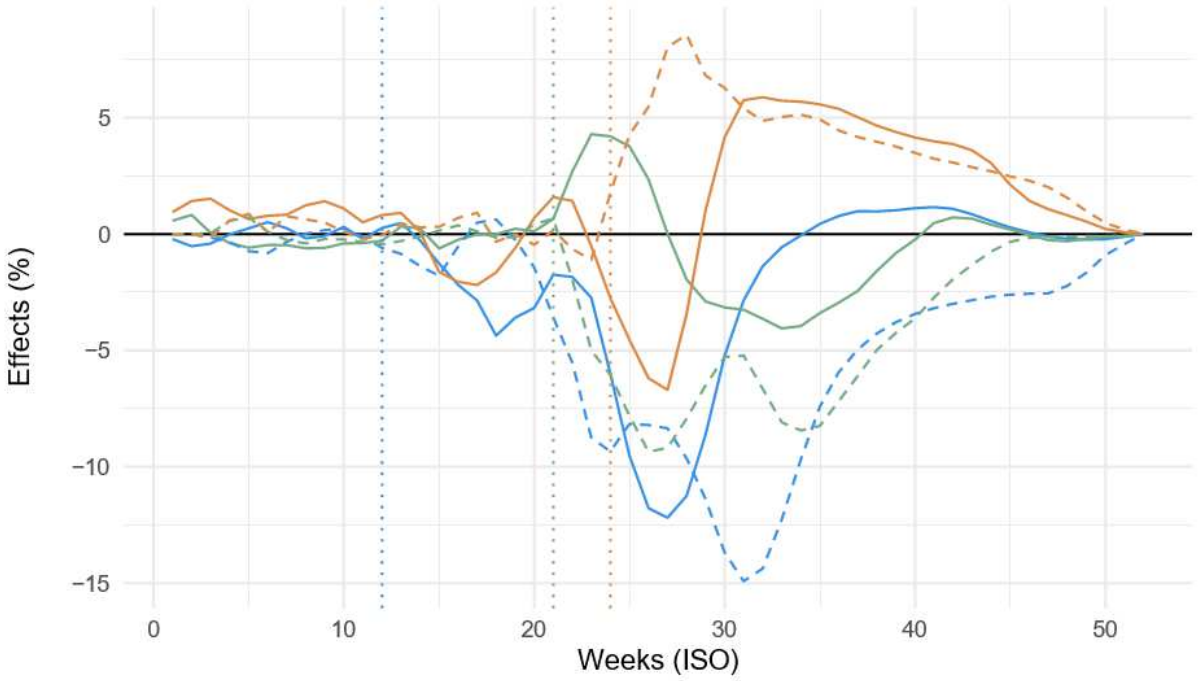


Figure 3: Effects on the entire population - period extended to December 31, 2021

This figure presents the measured effects, i.e., the difference between the synthetic control (the abscissa) and the observed values for the general population, for each treated state: France (in blue), Italy (in green), and Ireland (in orange). The dates of adoption of the intervention are indicated by a vertical dotted line. The first dose is indicated by a solid line and the second by dashes. The analysis period extends from January 1, 2021, to December 31, 2021.

5.4. Robustness Results

The backdating tests show for the three treated states (Table A3), an absence of anticipation effect for the general population and the elderly. This result is expected considering that the regulatory nature of the reform where pharmacists could not administer vaccine before being authorized.

The leave-one out test exhibits that France (Figure A5) is sensitive to Belgium exclusion (1st dose), Luxembourg and Spain exclusions (2nd dose). Italy (Figure A6) is sensitive to Spain (2nd dose) and Portugal (1st dose for the general population) exclusions. Ireland (Figure A7) is sensitive to the exclusion of Sweden, Denmark, Austria and Slovenia. These differences remain minor, in the sense that they do not call into question the observations made in the results section.

6. Discussion

6.1. Principal Findings

This study provides one of the few evaluations of pharmacist-administered vaccination during the COVID-19 pandemic [25], [26]. The results reveal a pattern of substitution between first-dose and second-dose coverage across the three countries examined. In Italy, first-dose coverage improved by approximately 4% while second-dose coverage declined by 5%. In Ireland, the opposite pattern emerged: first-dose coverage decreased by 6% while second-dose coverage increased by 4%. In France, no statistically significant effect was identified, likely reflecting the early timing of adoption relative to the pre-intervention estimation period.

Two interpretive elements follow from these observations. First, the direction of the effect differs across contexts, indicating that pharmacist involvement does not produce a uniform gain in coverage but rather redistributes vaccination activity across dose types. Second, the magnitude and direction of this effect are conditioned by the spatial distribution of pharmacies, the timing of adoption relative to epidemic dynamics, and the specific regulatory environment of each country.

6.2. Contextual Interpretation

In Italy, the modest positive effect on first-dose coverage is consistent with the role of pharmacy accessibility. Pharmacies in Italy are distributed more equitably across the territory than other healthcare facilities [27], [28], and the literature identifies reduced distance as a key determinant of preventive care utilization [29], [30]. This finding aligns with prior results [8] demonstrating a positive link between the number of access points and vaccine uptake.

In Ireland, the absence of a regulatory framework governing pharmacy location [31] means that pharmacies tend to follow existing medical supply patterns [32], which do not always correspond to population needs [33]. Expanding vaccination points in already well-supplied areas therefore does not necessarily reach additional populations. The later and more gradual opening of vaccination to the general population (July-September, compared with early June in France and Italy) further constrains the interpretation of the Irish results.

These findings confirm that pharmacist involvement improves vaccination coverage outside the pandemic context[34]. Several distinctions are relevant. The studies included in that meta-analysis concerned pneumococcal or influenza vaccines, for which established supply chains and annual renewal cycles reduce the urgency and scarcity dimensions characteristic of a pandemic. The decision to vaccinate during the COVID-19 campaign was additionally shaped by the prospect of lifting freedom restrictions[6], a motivational factor absent in routine vaccination. Furthermore, differences in outcome metrics (relative risk versus cumulative coverage), the level of analysis (individual versus national), and the presence of concurrent interventions (lockdowns, health passes) limit direct comparability across studies [35], [36].

6.3. Methodological Considerations

The synthetic control group method was selected over difference-in-differences because vaccination coverage follows a sigmoid trajectory rather than a linear trend, and the method is less sensitive to the parallel trends assumption and to the arbitrary selection of the post-intervention window. Results for France and Italy were confirmed under both specifications, supporting robustness.

Several contextual factors constrain the precision of the estimates. The short pre-intervention period, particularly for France, limits the quality of the counterfactual [20]. Vaccine availability was restricted

during this period [37], and the duration of this constraint could not be precisely determined. Heterogeneity in second-dose strategies across countries (interval extension, recognition of recovery certificates, single-dose vaccines) further complicates cross-country interpretation[15]–[17]. Anticipation effects associated with the health pass from mid-July 2021[6] may also confound the estimated effects, particularly for the second dose.

6.4. Limitations

Several limits exist. The short pre-intervention period and the concurrent supply constraints limit the precision of the counterfactual, particularly for France. The specific conditions of the pandemic—extreme demand, supply scarcity, evolving regulatory measures, and public uncertainty regarding vaccine safety [38], [39], reduce the transferability of findings to routine vaccination contexts. Outside the European Union, economic disparities in vaccine access further limit generalizability[40]. Finally, this study is an effectiveness analysis; it does not incorporate the financial costs of pharmacist-administered vaccination nor their long-term budgetary consequences, an essential dimension for a full health economic evaluation[26].

6.5. Policy Implications

The central policy finding is that pharmacist involvement in vaccination does not produce a uniform increase in coverage but rather shifts activity between dose types. This trade-off has direct implications for vaccination strategy design.

Strategic prioritization. Policymakers face a choice between broad first-dose coverage and efficient second-dose completion. The decision should be informed by the epidemiological context (transmission rate, severity, variant characteristics), the relative effectiveness of each dose, and the receptivity of priority populations. If priority groups have already achieved high coverage before the intervention, the marginal benefit of pharmacist involvement for those groups is likely limited.

Spatial planning. The distribution of pharmacies relative to other vaccination infrastructure is a critical determinant of the effect. In contexts where pharmacies provide equitable territorial coverage (as in Italy), their inclusion is most likely to reach additional populations. Where pharmacy location follows existing medical supply rather than population need (as in Ireland), the incremental coverage benefit is constrained. Regulatory frameworks governing pharmacy location may therefore warrant reconsideration in preparation for future pandemics.

Timing and sequencing. The timing of adoption relative to epidemic dynamics and to concurrent policy measures (health passes, lockdowns) substantially affects the observable effect. Early adoption, as in France, may yield no detectable marginal effect if the population has already been reached through other channels. Late adoption, as in Ireland, may capture a different phase of the epidemic with different population dynamics.

Evaluation requirements. Given the limited number of policy-relevant evaluations in this domain, future studies should integrate cost data to enable budget impact analyses, and should account for concurrent interventions to isolate the specific contribution of pharmacist-administered vaccination. The European framework, with its homogenized supply conditions through APAs, provides a particularly suitable setting for such comparative evaluations.

7. Conclusion

This study aims to assess the effect of pharmacist involvement in vaccination facing COVID-19 pandemic, through a synthetic control group in an European framework improving state comparability. While results exhibit an effect pharmacists may provide an intensive effect, promotion of the second dose (2nd dose), or an extensive effect, expanding the number of vaccinated persons (1st dose). Such effects appear to depend of pharmacy prior settlement rules. This study provide insight for lawmakers on the opportunity with respect to their public health goal, vaccination efficacy and healthcare organization.

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