Keynote Speaker: Dr. Katsushi Imai

Dr. Katsushi Imai is Reader in Economics at the Department of Economics at the University of Manchester. He has a PhD degree in Economics at the University of Oxford. Katsushi regularly works for the IFAD, the United Nations as a consultant to assist its policymaking. Katsushi serves as a co-editor of Review of Development Economics and an editorial board member for Development Studies Research and Asian Development Perspective. He publishes widely on inequality and poverty - including multidimensional poverty -, risk and vulnerability of households, child and adult nutrition and evaluations of public policies, such as the National Rural Employment Guarantee Scheme, microfinance programmes and conditional cash transfers in developing countries. Katsushi is also interested in the role of agriculture - broadly defined to include agricultural development, productivity improvement and institutions and how this contributes to achieving the UN's Sustainable Development Goals 1 and 2.

KS-2

The long-lasting impacts of exposure to herbicide bombing during the War?

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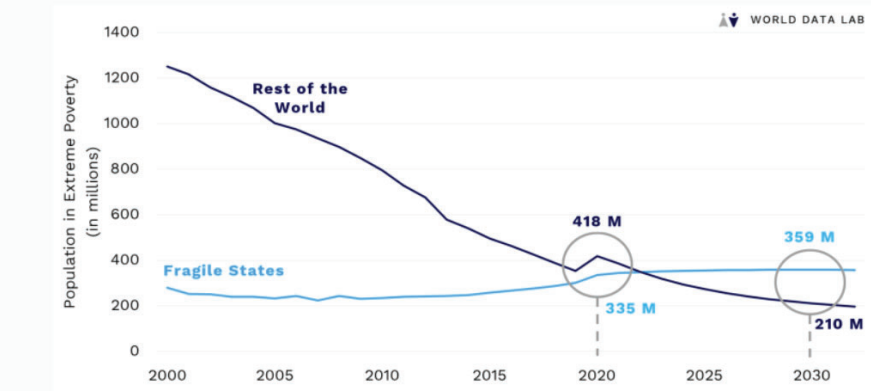
The 14th Biennial Conference of Asian Consumer and Family Economics Association (ACFEA)
Kitakyushu, Japan
9th July, 2023

Motivation



Source: World Data Lab projections.

Motivation

- The poorest and the most vulnerable households still live under the shadow of wars (Verwimp et al., 2019).
- Recent need for a development policy for stabilisation and development brought more attention to the study of violent conflict.
- Exposure to conflicts during early childhood has persistent effects on later life outcomes (i.e., health, education, earnings).
- A natural experiment
  - The US-Vietnam War was one of the most damaging conflicts with over 4.8 million people were exposed to the bombing and 400,000 deaths.
  - During the Operational Ranch Hand, 18 tons of herbicide gallons were dumped into Vietnam over 10 years between 1962 and 1971 (Hynes, 2015), which caused deaths due to cancers and other illnesses.

This paper

Questions	Are there heterogeneous impacts across different age groups as a result of early-life shocks? Are there persistent legacies across generations of herbicide bombing during the US-Vietnam War?
Approach	DID, Logit, IV Models
Data	Repeated cross-sectional LSMSs
Main results	(1) There are long-lasting effects of the herbicide bombings on human capital and (2) heterogeneous effects varied with the age of first exposure after birth exposure are stronger than *in utero*, (3) larger negative effects on females across all age groups, (4) spillover effects on parents exposed to bombing during early childhood, (5) only mothers' exposure to bombing has negative effects on the second generation.

Contributions to the literature

- Intergenerational impacts of the war (i.e., persistent legacies) on human capital (i.e., schooling outcomes).
- Interventions in conflict-affected areas are typically identified by the measure of geographical location or ethnic identity (Justino, 2009) $\rightarrow$ Heterogeneous levels of vulnerability to violence.
- Long-term impacts of the war experienced during childhood in developing countries.
  - Distinguish between different stages of early life shocks (e.g., foetal period and early childhood).
  - Conflicts in Colombia (Camacho, 2008); Nigerian civil war (Bhalotra and Akresh, 2012); Bifran war (Akresh, Nhalotra, Leone and Osili, 2017).
- Control for unobservable characteristics (e.g., parents' preferences towards health) using an instrumental variable strategy.

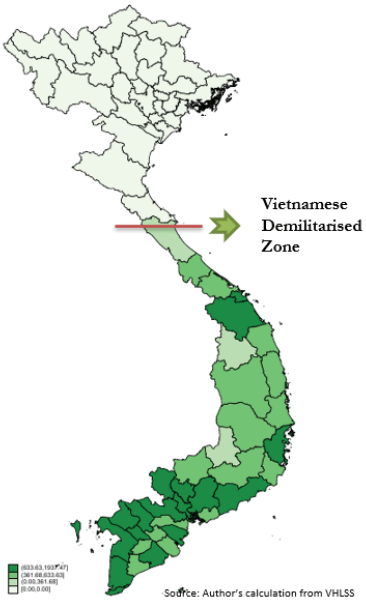
Household data

1. Vietnam Household Living Standards Measurement Survey - LSMS (VHLSS, 2014, 2016, 2018).
   - The sample is representative at national, regional, urban, rural and provincial levels and drawn from the 15% sample of the Vietnam Population and Housing Census 2009.
   - **Sampling:**
     - Three-stage stratified cluster design.
     - Each survey has a sample size of 9,399 households across 3,133 communes with detailed information on income and expenditure.
   - **Composition:**
     - Focus on the sub-sample of young adults (i.e., the second generation) aged between 22-65 years old.
     - Exclude those who are still at school.
     - Further restriction with the upper age limit of 45 years to exclude the second generation who were directly exposed to the bombings.

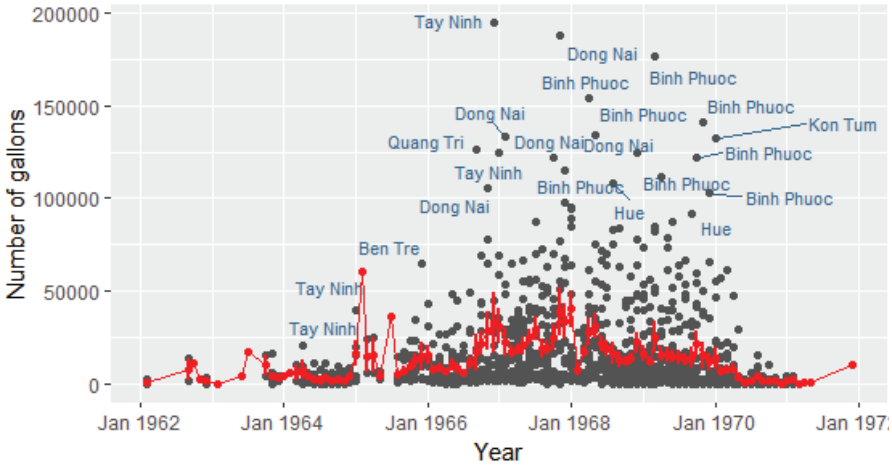
Conflict data

2. Herbicide Report System (HERBS) collected by the Foundation for Worker Veteran and Environmental Health, Inc., Columbia University.
   - A logbook of primary source spray data and provide estimates of the population influenced by their herbicide exposure.
   - Exploit the exact locations from GPS addresses (i.e., latitudes and longitudes) of the herbicide spray history.
   - The formatted address (i.e., detailed names of the province, district, commune, village, and road) is obtained using the Google Map Geocoding Application Programming Interface and relabeled using a unified coding system with the VHLSS.

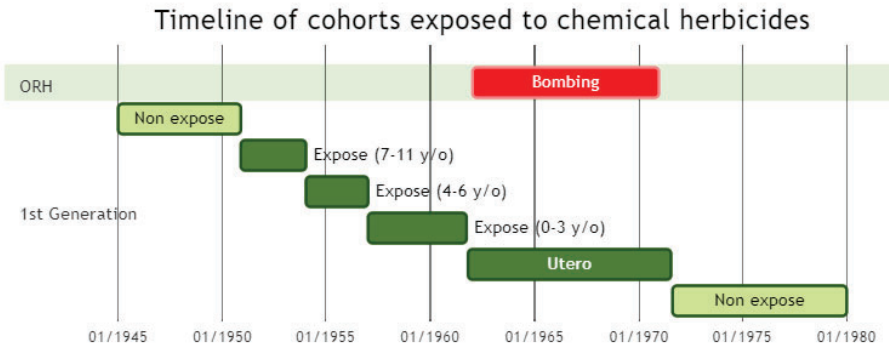
Intensity of herbicidal bombing across Vietnam



Intensity of the herbicide use over time



Exposure to the bombing at different life stages



Empirical strategy

Outcome variables: Years of education, formal educational qualifications Controls: Individual and household characteristics (e.g., age, ethnicity, household size, parents' education, grandparents' education), time and province fixed effects.
Controls: Individual and household characteristics (e.g., age, ethnicity, household size, parents' education, grandparents' education), time and province fixed effects

1. Direct impacts of exposure to bombing on the first generation - Difference-in-difference estimates: Average treatment effects (ATEs)
   - Geographical variation (province of birth **p**)
   - Cohort variation (timing of birth **t**)

$$y^p_{ihpt} = \delta_0 + \delta_1(Young_t * Exposed_p) + \delta_2 X_{ihpt} + \mu_p + \eta_t + u_{it} \quad (1)$$

$$y^p_{ihpt} = \delta_0 + \delta_1(Young_t * Intensity_p) + \delta_2 X_{ihpt} + \mu_p + \eta_t + u_{it} \quad (2)$$

$$y^p_{ihpt} = \delta_0 + \delta_1(total\ months\ exposure_t * Intensity_p) + \delta_2 X_{ihpt} + \mu_p + \eta_t + u_{it} \quad (3)$$

Empirical strategy (Cont.)

2. Indirect impacts of bombing on the second generation

$$y^c_{ihpt} = \gamma_0 + \gamma_1 ParentExposure_t * Intensity_p + \gamma_2 X_{ihpt} + \delta_p + \theta_t + v_{it} \quad (4)$$

3. Correct for endogeneity
   Instrumental variable: the distance from the provincial centroid to the 17^{th} parallel

$$y^c_{ihpt} = \beta_0 + \beta_1 \widehat{Bombing\ intensity}_{ihpt} + \beta_2 X_{ihpt} + \epsilon_{it}, \ t = 1, 2 \quad (5)$$

   The causal inference relies on the exogenous source of the variation in distance from each district to the DMZ.

Descriptive analysis

	Exposed	Non-exposed	Diff.
Years of education	9.7905	11.1143	1.3238***
Haven't completed primary school	0.1034	0.0603	-0.0431***
Completed primary school	0.2360	0.0971	-0.1389***
Completed secondary school	0.2304	0.2254	-0.0050
Completed high school	0.2407	0.3744	0.1337***
Completed higher education	0.1896	0.2428	0.0532***
Father's years of education	7.3416	8.6699	1.3283***
Mother's years of education	5.5758	7.7319	2.1562***
Age	30.4104	29.1736	-1.2368***
Squared Age	978.8251	896.4061	-82.4190***
Married	0.5085	0.6348	0.1263***
Father's age	59.3604	57.9567	-1.4038***
Mother's age	58.5245	56.6796	-1.8449***
Female headed household	0.3503	0.2838	-0.0665***
Ethnicity	0.9246	0.7491	-0.1755***
Log expenditure pc	9.8897	9.8510	-0.0387***
Grandparent's education	0.0716	0.2027	0.1311***
Second job	0.3203	0.4517	0.1314***
Household size	5.0304	5.0874	0.0571**
Traditional village	0.8835	0.8109	-0.0727***
Car road	0.9201	0.9663	0.0462***
Cultural house	0.6653	0.6649	-0.0004
Having primary schools	0.9923	0.9741	-0.0182***
Having secondary schools	0.9041	0.9298	0.0257***
Having high schools	0.1924	0.1512	-0.0412***

Direct impacts of bombing on schooling outcomes

Dependent variable: Years of education

	Dummy treatment			Continuous treatment		
	(1) All	(2) Female	(3) Male	(4) All	(5) Female	(6) Male
Panel A: Exposed at age 7-11						
Affected cohort*Affected province	-0.286***	-0.342***	-0.215**	-0.0904***	-0.112***	-0.0664***
	(0.0768)	(0.0921)	(0.0869)	(0.0133)	(0.0147)	(0.0183)
Observations	9748	5322	4426	9748	5322	4426
Adjusted R^2	0.313	0.371	0.257	0.315	0.375	0.258
Panel B: Exposed at age 4-6						
Affected cohort*Affected province	-0.158**	-0.258***	-0.0713	-0.0423***	-0.0778***	-0.0101
	(0.0609)	(0.0860)	(0.0653)	(0.0138)	(0.0175)	(0.0149)
Observations	9977	5450	4527	9977	5450	4527
Adjusted R^2	0.306	0.360	0.258	0.307	0.361	0.258
Panel C: Exposed at age 0-3						
Affected cohort*Affected province	-0.105**	-0.154***	-0.0524	-0.0329***	-0.0405***	-0.0251*
	(0.0505)	(0.0576)	(0.0636)	(0.0103)	(0.0117)	(0.0134)
Observations	11339	6105	5234	11339	6105	5234
Adjusted R^2	0.310	0.363	0.268	0.315	0.364	0.269
Panel D: Exposed in utero						
Affected cohort*Affected province	-0.0530*	-0.122***	-0.0223	-0.0200**	-0.0363***	-0.0145
	(0.0314)	(0.0384)	(0.0423)	(0.00781)	(0.00964)	(0.0105)
Observations	14763	7849	6914	14763	8675	7606
Adjusted R^2	0.306	0.380	0.280	0.309	0.357	0.261
Panel E: Exposed all						
Affected cohort*Affected province	-0.124***	-0.184***	-0.0655	-0.0358***	-0.0508***	-0.0208**
	(0.0345)	(0.0407)	(0.0408)	(0.00653)	(0.00684)	(0.00910)
Observations	19090	9993	9097	19090	9993	9097
Adjusted R^2	0.314	0.363	0.264	0.314	0.364	0.264
Treatment FE and Time FE	Y	Y	Y	Y	Y	Y
Control variables	Y	Y	Y	Y	Y	Y

Duration of bombing exposure and education

Dependent variable: Years of education						
	(1) **All**	(2) **Female**	(3) **Male**	(4) **All**	(5) **Female**	(6) **Male**
Bombing intensity	-0.000406***	-0.000523***	-0.000261***			
	(0.0000789)	(0.0000856)	(0.0000813)			
Total months exposed to bombing	-0.00190***	-0.00164**	-0.00230***			
	(0.000698)	(0.000735)	(0.000794)			
Bombing intensity in utero				-0.00200*	-0.00251**	-0.00154
				(0.00106)	(0.00106)	(0.00129)
Bombing intensity after birth				-0.000409***	-0.000522***	-0.000268***
				(0.0000791)	(0.0000856)	(0.0000826)
Months exposed to bombing in utero				-0.0137**	-0.00588	-0.0204**
				(0.00672)	(0.00999)	(0.00865)
Months exposed to bombing after birth				-0.00203***	-0.00172**	-0.00244***
				(0.000722)	(0.000757)	(0.000809)
Observations	21830	11445	10385	21830	11445	10385
Adjusted R^2	0.317	0.361	0.269	0.317	0.361	0.270
Procince FE	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes

Intergenerational transmission of bombing on human capital

Dependent variable: Years of education	**Whole sample**		**Daughter**		**Son**	
	2SLS	**First stage**	**2SLS**	**First stage**	**2SLS**	**First stage**
Panel A: Father's boming exposure						
Intensity × Months exposed to bombing in utero	-0.00141		-0.00119		-0.00143	
	(0.00281)		(0.00369)		(0.00331)	
Intensity × Months exposed to bombing after birth	-0.00108**		-0.00187**		-0.000685	
	(0.000487)		(0.000754)		(0.000484)	
Distance		-1.662***		-1.807***		-1.578***
		(0.400)		(0.432)		(0.385)
Observations	8252	8252	3254	3254	4998	4998
Adjusted R2	0.280		0.292		0.274	
Sanderson-Windmeijer F-stats	37.04		56.47		26.80	
Panel B: Mother's bombing expsure						
Intensity × Months exposed to bombing in utero	-0.00422*		-0.00402		-0.00485*	
	(0.00249)		(0.00357)		(0.00275)	
Intensity × Months exposed to bombing after birth	-0.00120**		-0.00149**		-0.00112*	
	(0.000595)		(0.000640)		(0.000679)	
Distance		-1.709***		-1.830***		-1.646***
		(0.420)		(0.477)		(0.392)
Observations	10210	10210	4056	4056	6154	6154
Adjusted R2	0.274		0.303		0.253	
Sanderson-Windmeijer F-stats	51.00	73.07		29.81		
Cohort FE	Y	Y	Y	Y	Y	Y
Control variables	Y	Y	Y	Y	Y	Y

Distance to the province centroid and bombing (first-stage)

Dependent variable: Log total gallons of herbicide bombing				
	(1)	(2)	(3)	(4)
Distance from 17^{th} parallel	-2.625***	-2.636***	-0.721***	-0.752***
	(0.0498)	(0.0509)	(0.120)	(0.130)
Observations	3624	3624	3295	3295
Adjusted R^2	0.347	0.356	0.781	0.785
Cohort FE	No	Yes	Yes	Yes
Pre-war province characteristics	No	No	Yes	Yes
Individual&household characteristics	No	No	No	Yes

Notes: Author's calculation from VHLSS 2014, VHLSS 2016 and VHLSS 2018. Robust standard errors in parentheses. Pre-war characteristics include the population density in 1960-1961, total paddy yield in 1960-1961, average precipitation (cm), average temperature (^0C), North latitude (^0N) and proportion of land areas at different high altitudes.

Mechanisms

Robustness checks

- No evidence that the negative impacts are driven through intergenerational persistence of education (with/without parents' education).
- Negative effects are robust to
  - Excluding households of provinces close to the DMZ
  - Displacement Migration
  - Parallel trend Parallel - IV validity
  - Strong first-stage
  - Reduced form Reduce

Conclusion

- We examine the impacts of herbicide bombing for both cohorts directly exposed to the bombing and cohorts indirectly affected through their parents.
- The herbicide bombing has significantly reduced years of schooling completed and the probability of obtaining formal qualifications due to disrupting education with stronger impacts on females.
- Allowing for heterogeneous impacts, results indicate that exposure to bombing after birth has more long-term negative impacts than those exposed *in utero*.
- The effect is larger for young cohorts at primary and secondary school levels.
- Results from 2SLS only show significant impacts on the second generation with parents exposed to the bombing after birth, with a larger impact on mother-daughter.

Implications

- The conflict further exacerbates the gender gap in education, which requires measures to mitigate its negative impacts.
- The targets of the previous program focus on individuals with tangible physical disabilities.
- Given the long-term impacts across generations, continuous support for families with children indirectly affected by the herbicide bombing is essential.

Thank you!

Selection bias

	(1) All	(2) Female	(3) Male	(4) All	(5) Female	(6) Male
Panel A: Sample of migrants						
Bombing intensity	-0.000572***	-0.000748***	-0.000372*			
	(0.000157)	(0.000173)	(0.000195)			
Total months exposed to bombing	-0.00423***	-0.00444***	-0.00380**			
	(0.00124)	(0.00154)	(0.00182)			
Bombing intensity in utero				-0.000285	0.000174	-0.000645
				(0.00157)	(0.00153)	(0.00268)
Bombing intensity after birth				-0.000580***	-0.000761***	-0.000380*
				(0.000158)	(0.000177)	(0.000195)
Months exposed to bombing in utero				-0.0122	-0.0121	-0.0174
				(0.0139)	(0.0233)	(0.0180)
Months exposed to bombing after birth				-0.00428***	-0.00452***	-0.00378**
				(0.00124)	(0.00156)	(0.00181)
Observations	3295	1719	1576	3295	1719	1576
Adjusted R^2	0.272	0.312	0.233	0.271	0.312	0.232
Panel B: Sample without migrants						
Bombing intensity	-0.000479***	-0.000625***	-0.000307***			
	(0.0000782)	(0.0000758)	(0.000100)			
Total months exposed to bombing	-0.000793	-0.000281	-0.00155*			
	(0.000626)	(0.000589)	(0.000878)			
Bombing intensity in utero				-0.00121	-0.00258**	0.0000526
				(0.000892)	(0.00101)	(0.00101)
Bombing intensity after birth				-0.000481***	-0.000620***	-0.000312***
				(0.0000800)	(0.0000778)	(0.000101)
Months exposed to bombing in utero				-0.00914	-0.00140	-0.0185*
				(0.00775)	(0.0127)	(0.00953)
Months exposed to bombing after birth				-0.000871	-0.000314	-0.00166*
				(0.000636)	(0.000585)	(0.000895)
Observations	16383	8589	7794	16383	8589	7794
Adjusted R^2	0.316	0.375	0.253	0.317	0.375	0.254

Back

DID strategy's assumptions

Dependent variable: Years of education

	Dummy treatment				Continuous treatment			
	Older (1945-1949)		Younger (1972-1981)		Older (1945-1949)		Younger (1972-1981)	
Panel A: All sample								
Placebo cohorts	-0.114	0.00570						
	(0.110)	(0.138)						
Placebo cohorts			0.0255	-0.0219				
			(0.0382)	(0.0451)				
Placebo cohorts					-0.0356	-0.0272		
					(0.0248)	(0.0266)		
Placebo cohorts							0.00990	-0.00411
							(0.00968)	(0.0120)
Observations	687	654	7009	6909	687	654	7009	6909
Adjusted R^2	0.222	0.365	0.167	0.324	0.224	0.366	0.167	0.324

Back

Reduced form

Dependent variable: Years of education												
	Father						Mother					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All	**Female**	**Male**	**All**	**Female**	**Male**	**All**	**Female**	**Male**	**All**	**Female**	**Male**
Bombing intensity	0.0000217	0.0000697	-0.00000210				-0.000153*	-0.000215*	-0.000113			
	(0.000109)	(0.000171)	(0.000126)				(0.0000815)	(0.000111)	(0.0000990)			
Total months exposed to bombing	0.000162	-0.000383	0.000417				-0.000673**	-0.000802**	-0.000654**			
	(0.000345)	(0.000571)	(0.000388)				(0.000269)	(0.000400)	(0.000298)			
Distance	0.168	0.185	0.139	0.169	0.187	0.140	-0.102	0.0673	-0.196	-0.0977	0.0675	-0.191
	(0.158)	(0.172)	(0.182)	(0.158)	(0.170)	(0.182)	(0.152)	(0.270)	(0.208)	(0.151)	(0.272)	(0.207)
Bombing intensity in utero				0.0000609	-0.000491	0.000371				0.00135	0.00166	0.00140
				(0.00158)	(0.00210)	(0.00176)				(0.00124)	(0.00200)	(0.00134)
Bombing intensity after birth				0.0000155	0.0000295	0.0000123				-0.0000722	-0.000124	-0.0000269
				(0.000131)	(0.000202)	(0.000151)				(0.000108)	(0.000143)	(0.000128)
Months exposed to bombing in utero				-0.00352	-0.00445	-0.00251				0.000892	-0.00113	0.00116
				(0.00440)	(0.00794)	(0.00426)				(0.00366)	(0.00636)	(0.00406)
Months exposed to bombing after birth				-0.0000669	-0.000668	0.000250				-0.000576*	-0.000768	-0.000567
				(0.000391)	(0.000627)	(0.000434)				(0.000340)	(0.000472)	(0.000382)
Observations	8252	3254	4998	8252	3254	4998	10210	4056	6154	10210	4056	6154
Adjusted R^2	0.184	0.236	0.153	0.184	0.236	0.152	0.192	0.238	0.163	0.192	0.238	0.163
Procince FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Author's calculation from VHLSS 2014, VHLSS 2016 and VHLSS 2018. Robust standard errors in parentheses are clustered at the provincial level. Provincial fixed effects, cohort fixed effects are included in all regressions. Bombir intensity is specified as an interaction between a number of gallons in logarithm and total months exposed to bombing.

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