Projected Disease Transmission, Health System Requirements, and Macro-economic Impacts of the Coronavirus Disease 2019 (COVID-19) in the Philippines

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Philippine Institute for Development Studies
Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas

Objectives and Outline

- Projected magnitude of COVID-19 outbreak
- Projected health system resource requirements
- Projected economy-wide impacts
- Recommendations

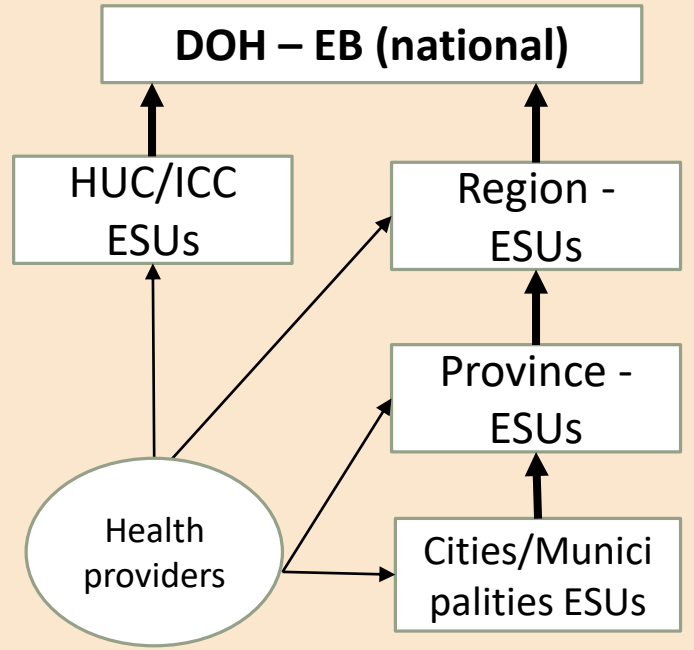
Projected Magnitude of the COVID-19 Outbreak in the Philippines

OBJECTIVE 1

Data Sources for Disease Transmission Model

- DOH Epidemiology Bureau (EB)
  - confirmed cases and deaths
  - time-to-event data
    - symptom onset ➔seeking care/testing
    - care/testing ➔ test confirmation
    - test confirmation ➔ recovery/death
- Literature review for parameters where DOH-EB data is too biased/incomplete
  - e.g. Case severity, incubation period

Devolved Disease Surveillance and Health Information system
(DOH AO 2020-0013)



ESU = Epidemiology and surveillance units
HUC = Highly urbanized cities
ICC = Independent component cities

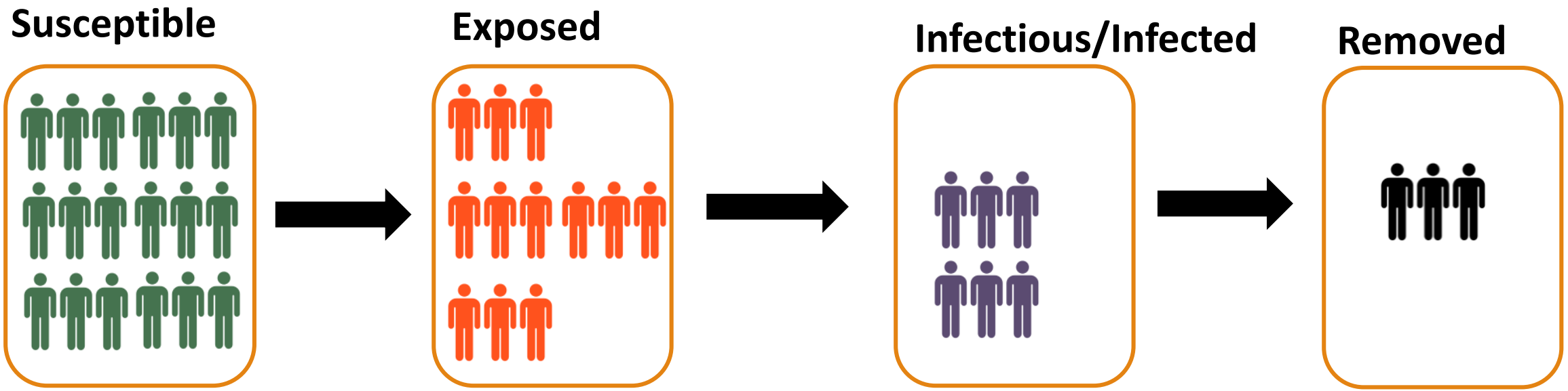
Data on Confirmed COVID-19 Cases

DOH-EB data as of April 7, 2020

Characteristic	All cases (*n* = 3,781)	All deaths (*n* =177)
Median (IQR) age, years	53 (37 - 65)	65 (58 - 74)
Age group, *n* (%)		
< 15 years old	39 (1.03%)	1 (0.56%)
15 - 44 years old	1,284 (34.0%)	11 (6.2%)
45 - 64 years old	1,476 (39.0%)	68 (38.4%)
≥ 65 years old	981 (25.9%)	97 (54.8%)
Missing	1 (0.03%)	0 (0%)
Sex, *n* (%)		
Males	2195 (58.0%)	126 (69.5%)
Females	1,585 (41.9%)	54 (30.5%)
Missing	1 (0.03%)	0 (0%)
Residence, *n* (%)		
National Capital Region (NCR)	2,114 (55.9%)	109 (61.6%)
Outside of NCR	798 (21.1%)	60 (33.9%)
Missing	869 (23.0%)	8 (4.5%)
Known travel history within 14 days before reported onset of symptoms, *n* (%)		
Foreign country with local transmission	140 (3.7%)	10 (5.7%)
No foreign travel	1,186 (31.4%)	104 (58.8%)
Unknown travel history	2,455 (64.9%)	63 (35.6%)

"Imported" cases ➔

Overview of "SEIR" Compartmental Models



S(t)

- At risk
- Healthy
- Not immune

E(t)

- "Latent" or "incubating"
- Exposed
- No symptoms yet

I(t)

- Ill/symptoms
- Spreading the disease

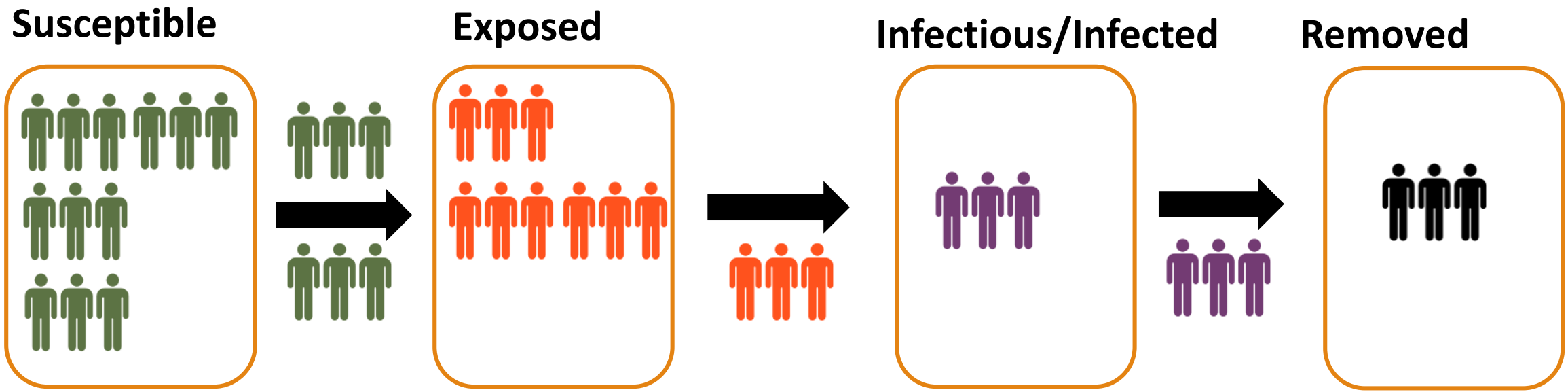
R(t)

- Recovered
- Died
- Absorbing state

Model projection: for each time (t), how many people are in each compartment/health state?

$*N = S + E + I + R$

Transition among "SEIR" Compartments



Difference Equations

$$\beta \frac{I(t)}{N} * S(t) \qquad E(t) * \frac{1}{latent\ period} \qquad I(t) * \frac{1}{time\ to\ recover/die}$$

Probability of transmission

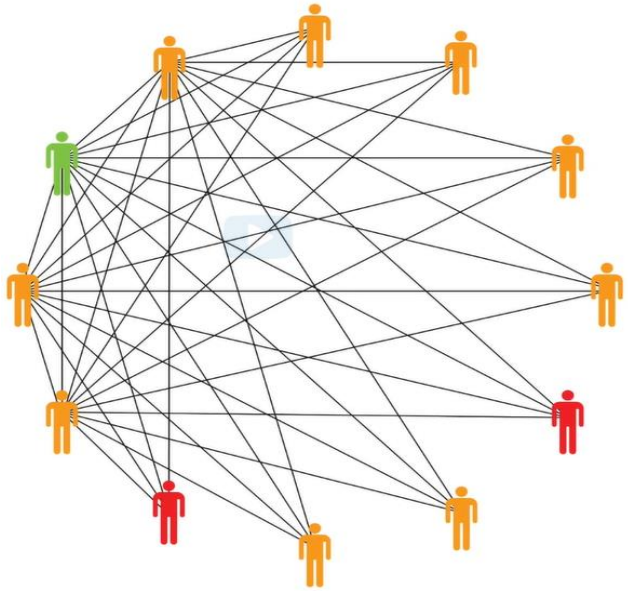
- What % of susceptible people who contact infectious people will become infected?
- Incorporates info on the basic reproduction number (R0) where β = R0 / (duration of infectiousness)

Model projection: for each time (t), how many people are in each compartment/health state?

Implicit Assumption of "SEIR" Model

Assortative Mixing $\beta \frac{I(t)}{N} * S(t)$

- Everyone in the population will make contact with each other with equal probability
- Same frequency, intensity, duration

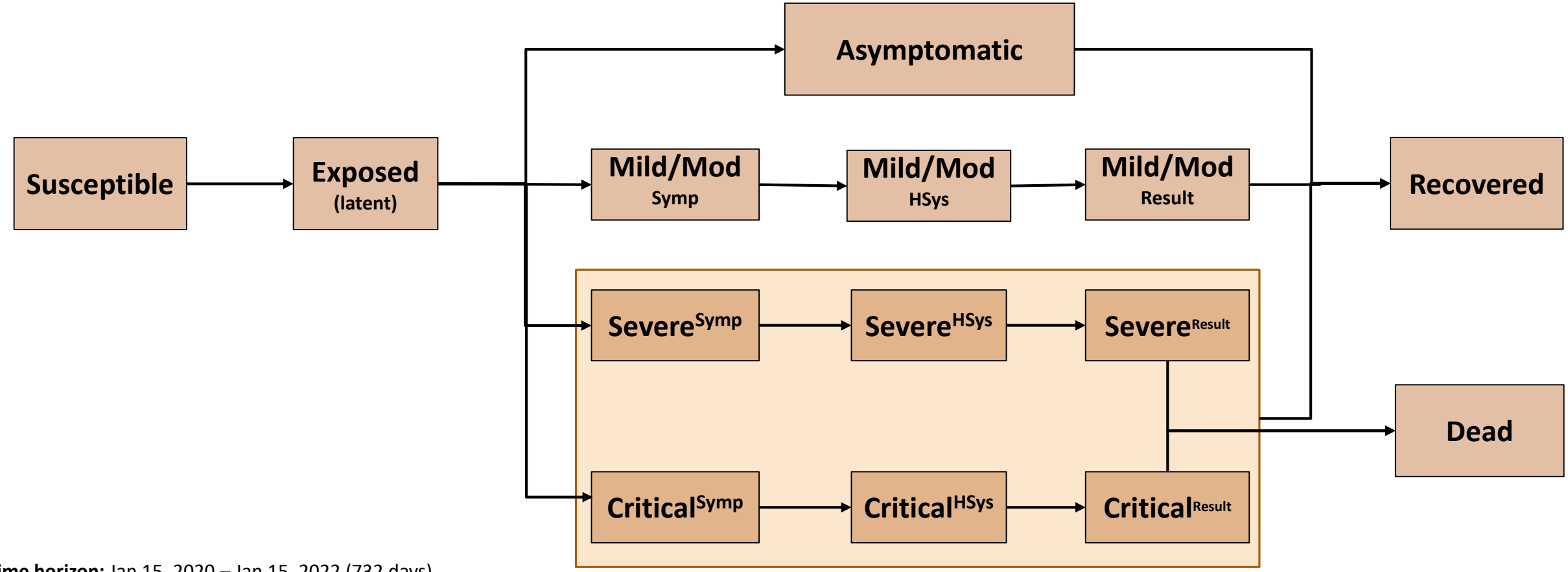


Rate of Transition between Compartments

- Transition between compartments occurs at a constant rate
- That means, if we assume that it takes 5 days for infected people to show symptoms, then we apply this assumption to everyone in the population and for all days in the simulation.

COVID-19 SEIR compartmental model

*All values are calculated at the **provincial level,** then aggregated up.*

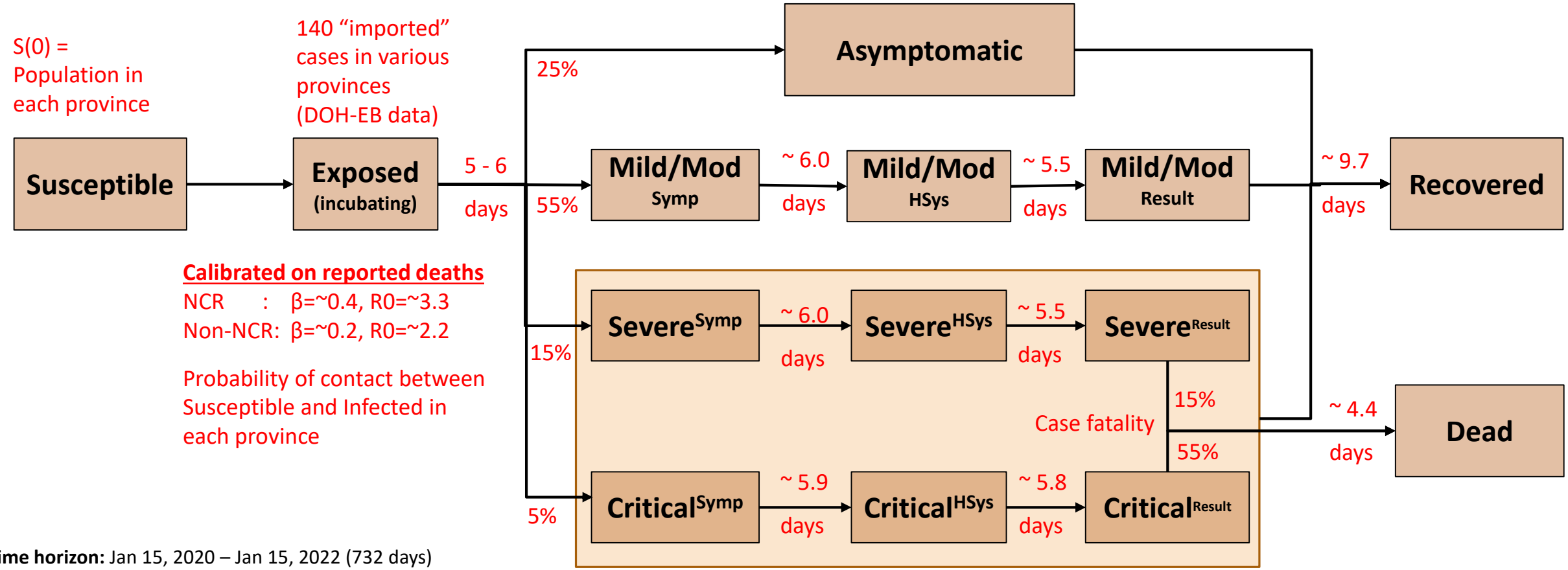


Time horizon: Jan 15, 2020 – Jan 15, 2022 (732 days)
"Imported" – travel to country with known transmission 14 days prior to symptoms
Age-standardized case fatality from DOH-EB data is 5%

Symp: Symptom onset
HSys: Health system contact (consultation, hospitalization)
Result: Laboratory result

COVID-19 SEIR model parameters

*All values are calculated at the **provincial level,** then aggregated up.*



Time horizon: Jan 15, 2020 – Jan 15, 2022 (732 days)
"Imported" – travel to country with known transmission 14 days prior to symptoms
Pre-symptomatic transmission: people are infectious 2 days prior to symptoms onset
Age-standardized case fatality from DOH-EB data is 5%

Symp: Symptom onset
HSys: Health system contact (consultation, hospitalization)
Result: Laboratory result

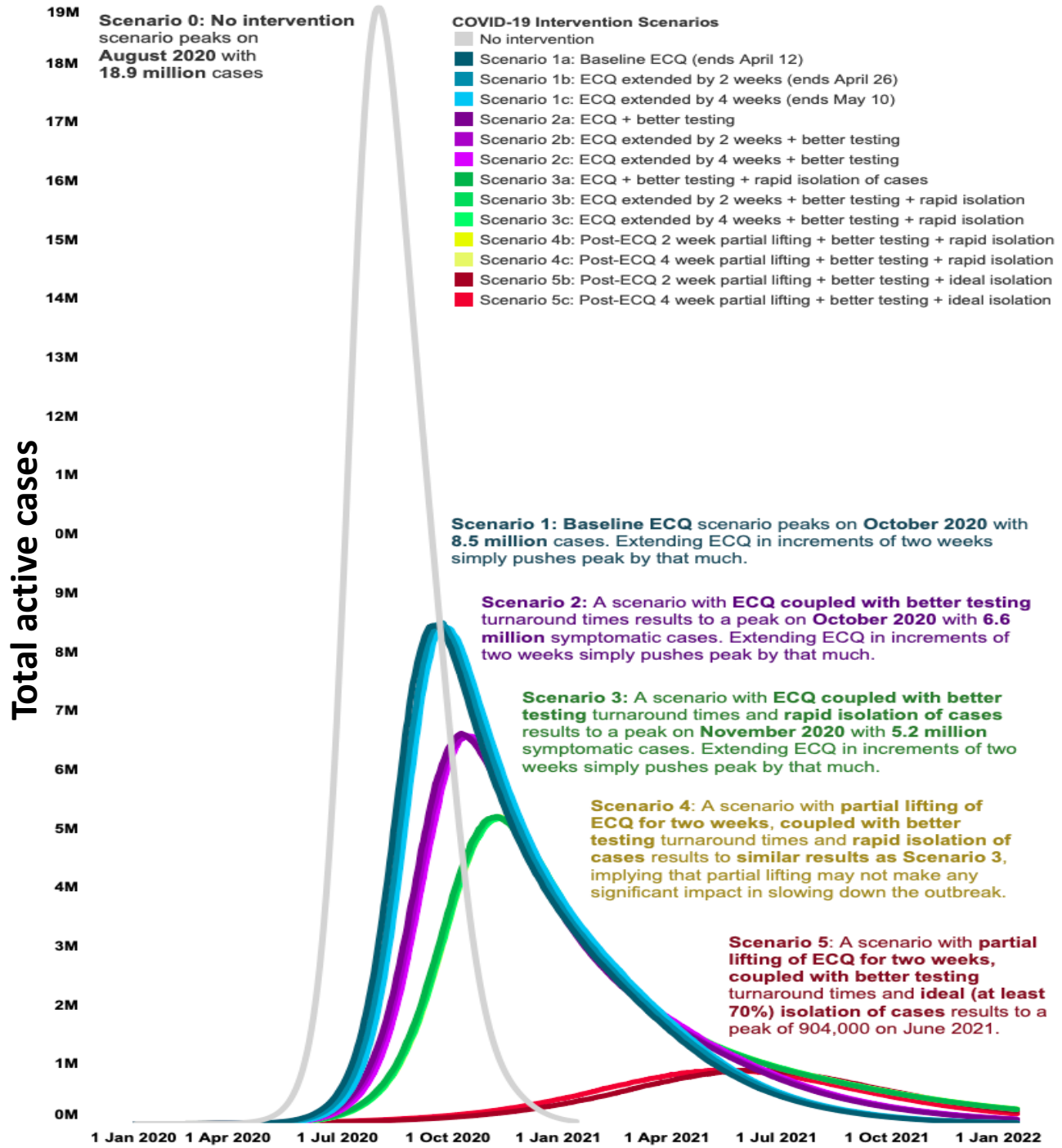
COVID-19 scenarios

- Five scenario sets
- Letter suffixes refer to length of ECQ
- Number of scenarios refer to additional interventions

SCENARIOS			LUZON-WIDE ECQ		Health System contact for Testing and Individual Isolation	Early Isolation at Symptom Onset
			Duration	Compliance		
S0	No intervention		None	n/a	None	n/a
S1	ECQ	a	Mar 17 - Ap 12	95%	*Time to Test/Care from Symptoms* = ~6 days* *% Following Isolation* During ECQ - 80% Post-ECQ - 50%	n/a
		b	+2 weeks			
		c	+4 weeks			
S2	ECQ + better testing	a	Mar 17 - Ap 12	95%	*Time to Test/Care from Symptom Onset* ECQ to April 12= ~6 days Extended ECQ = 4days Post-ECQ = 2 days *% Following Isolation* During ECQ - 80% Post-ECQ - 50%	n/a
		b	+2 weeks			
		c	+4 weeks			
S3	ECQ + better testing + isolate at symptom onset	a	Mar 17 - Ap 12	95%		50%
		b	+2 weeks			
		c	+4 weeks			
S4	Extended ECQ with partial lifting + better testing + isolate at symptom onset	b	+2 weeks	50% during extension		
		c	+4 weeks			
S5		b	+2 weeks			70%
		c	+4 weeks			

* Author's calculations from DOH-EB data as of April 7, 2020.

Results


Total active cases
19M
18M
17M
16M
15M
14M
13M
12M
1M
0M
9M
8M
7M
6M
5M
4M
3M
2M
1M
0M
1 Jan 2020
1 Apr 2020
1 Jul 2020
1 Oct 2020
1 Jan 2021
1 Apr 2021
1 Jul 2021
1 Oct 2021
1 Jan 2022
Scenario 0: No intervention scenario peaks on August 2020 with 18.9 million cases
COVID-19 Intervention Scenarios
No intervention
Scenario 1a: Baseline ECQ (ends April 12)
Scenario 1b: ECQ extended by 2 weeks (ends April 26)
Scenario 1c: ECQ extended by 4 weeks (ends May 10)
Scenario 2a: ECQ + better testing
Scenario 2b: ECQ extended by 2 weeks + better testing
Scenario 2c: ECQ extended by 4 weeks + better testing
Scenario 3a: ECQ + better testing + rapid isolation of cases
Scenario 3b: ECQ extended by 2 weeks + better testing + rapid isolation
Scenario 3c: ECQ extended by 4 weeks + better testing + rapid isolation
Scenario 4b: Post-ECQ 2 week partial lifting + better testing + rapid isolation
Scenario 4c: Post-ECQ 4 week partial lifting + better testing + rapid isolation
Scenario 5b: Post-ECQ 2 week partial lifting + better testing + ideal isolation
Scenario 5c: Post-ECQ 4 week partial lifting + better testing + ideal isolation
Scenario 1: Baseline ECQ scenario peaks on October 2020 with 8.5 million cases. Extending ECQ in increments of two weeks simply pushes peak by that much.
Scenario 2: A scenario with ECQ coupled with better testing turnaround times results to a peak on October 2020 with 6.6 million symptomatic cases. Extending ECQ in increments of two weeks simply pushes peak by that much.
Scenario 3: A scenario with ECQ coupled with better testing turnaround times and rapid isolation of cases results to a peak on November 2020 with 5.2 million symptomatic cases. Extending ECQ in increments of two weeks simply pushes peak by that much.
Scenario 4: A scenario with partial lifting of ECQ for two weeks, coupled with better testing turnaround times and rapid isolation of cases results to similar results as Scenario 3, implying that partial lifting may not make any significant impact in slowing down the outbreak.
Scenario 5: A scenario with partial lifting of ECQ for two weeks, coupled with better testing turnaround times and ideal (at least 70%) isolation of cases results to a peak of 904,000 on June 2021.

Projection for May 11 (Monday)

	Current Active Infections (including asymptomatic and undetected)	Deaths (Cumulative) **
Scenario S1C	11,864 (11,111 – 12,617)	850 (808 – 886)
Scenario S3C	11,896 (11,184 – 12,677)	856 (823 – 886)
Reported (DOH)	8,361 (11,086 total cases less 1,999 recovered and 726 dead)	726

** Lag in reporting of deaths not taken into account in calibration

Key Message #1

- **Aggressive efforts in the post-ECQ period to isolate at least 70% of infectious cases** through better contact tracing, social distancing, individual or household isolation, and reduced delays in time to seek care for symptomatic cases are necessary to suppress the outbreak.

- Extending the ECQ without other mitigation measures merely delays the progression of the outbreak and still results in a large number of cases.

Projected Health System Resource Requirements

OBJECTIVE 2

Assumptions

- Linked SEIR projections with resource requirement per case that require ***medical intervention*** at health care facilities.

- Assumed chronology of health care contact:
  - Outpatient care (primarily ER) to be triaged.
  - In-patient care for severe and critical cases.
  - Discharged for mild/moderate cases.

Assumptions

Table 5. Human resources and PPE needs per setting for a 24-hour period

Setting	Ratio of staff to patients (Liwanag & Ayaay, 2020)	PPE sets per Patient Type per day
Outpatient Triage Team	At maximum, 120 patients can be seen in the emergency room: • Physicians - 4:120 (2 Residents, 1 Consultant, 1 Fellow) • Nurses - 3:120 • Auxiliary staff - 4:120 • Cleaner - 1:120 • Guard - 1:120	0.217 per symptomatic case (Calculated from Ratio of staff to patients in outpatient triage team)
Inpatient wards	• Doctor - 1:6 • Nurse - 1:3	15 per severe case per day (DOH estimates in consultation with UP-PGH)
Intensive Care Unit	• Doctor - 1:1 • Nurse - 1:1 • Intensivist - 1:5 • Pulmonologist - 1:5 • Infectious disease specialist - 1:5 • Respiratory therapist - 1:5	30 per severe case per day (DOH estimates in consultation with UP-PGH)

Beds, Ventilators, PPE sets, Human resources

Scenario	Peak Month	Hospital Bed	ICU beds	Ventilators	PPE sets	Doctors	Nurses	Specialists
0	August 2020	3.39 mil	1.03 mil	557,000	82.0 mil	1.64 mil	2.19 mil	206,113
1a	September 2020	1.51 mil	456,000	246,000	36.5 mil	727,000	975,000	91,300
1b	September 2020	1.52 mil	458,000	247,000	36.7 mil	730,000	979,000	91,600
1c	September 2020	1.51 mil	454,000	245,000	36.4 mil	725,000	971,000	91,800
2a	October 2020	1.33 mil	410,000	222,000	32.3 mil	646,000	864,000	82,000
2b	October 2020	1.32 mil	408,000	220,000	32.1 mil	642,000	859,000	82,500
2c	October 2020	1.32 mil	408,000	220,000	32.2 mil	643,000	860,000	81,600
3a	November 2020	1.05 mil	322,000	174,000	25.5 mil	508,000	680,000	64,500
3b	November 2020	1.05 mil	322,000	174,000	25.5 mil	508,000	680,000	64,400
3c	November 2020	1.04 mil	321,000	174,000	25.4 mil	507,000	678,000	64,300
4b	November 2020	1.04 mil	321,000	174,000	25.4 mil	507,000	678,000	64,300
4c	November 2020	1.04 mil	323,000	174,000	25.5 mil	509,000	681,000	64,600
5b	June 2021	182,000	55,500	30,000	4.41 mil	88,000	118,000	11,100
5c	May 2021	182,000	55,600	30,000	4.41 mil	88,000	118,000	11,100

Source: Authors' calculations; mil = million; rounded off to three significant figures

PhilHealth Reimbursement

Table 8. Projected total PhilHealth reimbursements for COVID-19 cases

Scenario	Reimbursements in PHP (Billions)
0	9,520
1a	6,430
1b	6,340
1c	6,250
2a	4,970
2b	4,920
2c	4,860
3a	3,800
3b	3,760
3c	3,740
4b	3,760
4c	3,740
5b	206
5c	268

Source: Authors' calculation

PhilHealth Case rates for hospitalized cases

- Severe – P 333,519
- Critical – P 786,384

For reference: In 2019, PhilHealth only had a corporate budget of PHP 175 billion (PhilHealth, 2019).

** Assume that the case rates will not be revised (e.g. to a lower amount) for April 14, 2020 onwards and that all COVID-19 cases will avail of PhilHealth benefits.

Key Message #2

- For **all scenarios that do not successfully isolate at least 70%** of infectious individuals, **demand** for health care resources generated by COVID-19 **at the peak** of the outbreak **will far exceed available supply** in the health sector.
- **Only S5 scenarios present a manageable timeline to scale up health system capacity within a year to a reasonable level that the health system can sustain and benefit from** even after the COVID-19 outbreak.
  - For example, should the gaps in hospital beds be addressed, the Philippine health system would have with 1.7 L2 and L3 beds per 1,000 population compared to the current supply of 0.57 L2 and L3 beds per 1,000.

Projected Economy-Wide Impacts

OBJECTIVE 3

Where are the Filipinos?

Retail & recreation

-79%

compared to baseline

Mobility trends for places like restaurants, cafes, shopping centers, theme parks, museums, libraries, and movie theaters.

Grocery & pharmacy

-56%

compared to baseline

Mobility trends for places like grocery markets, food warehouses, farmers markets, specialty food shops, drug stores, and pharmacies.

https://www.gstatic.com/covid19/mobility/2020-04-17_PH_Mobility_Report_en.pdf

Where are the Filipinos?

Workplaces

-71%

compared to baseline

Mobility trends for places of work.

Residential

+39%

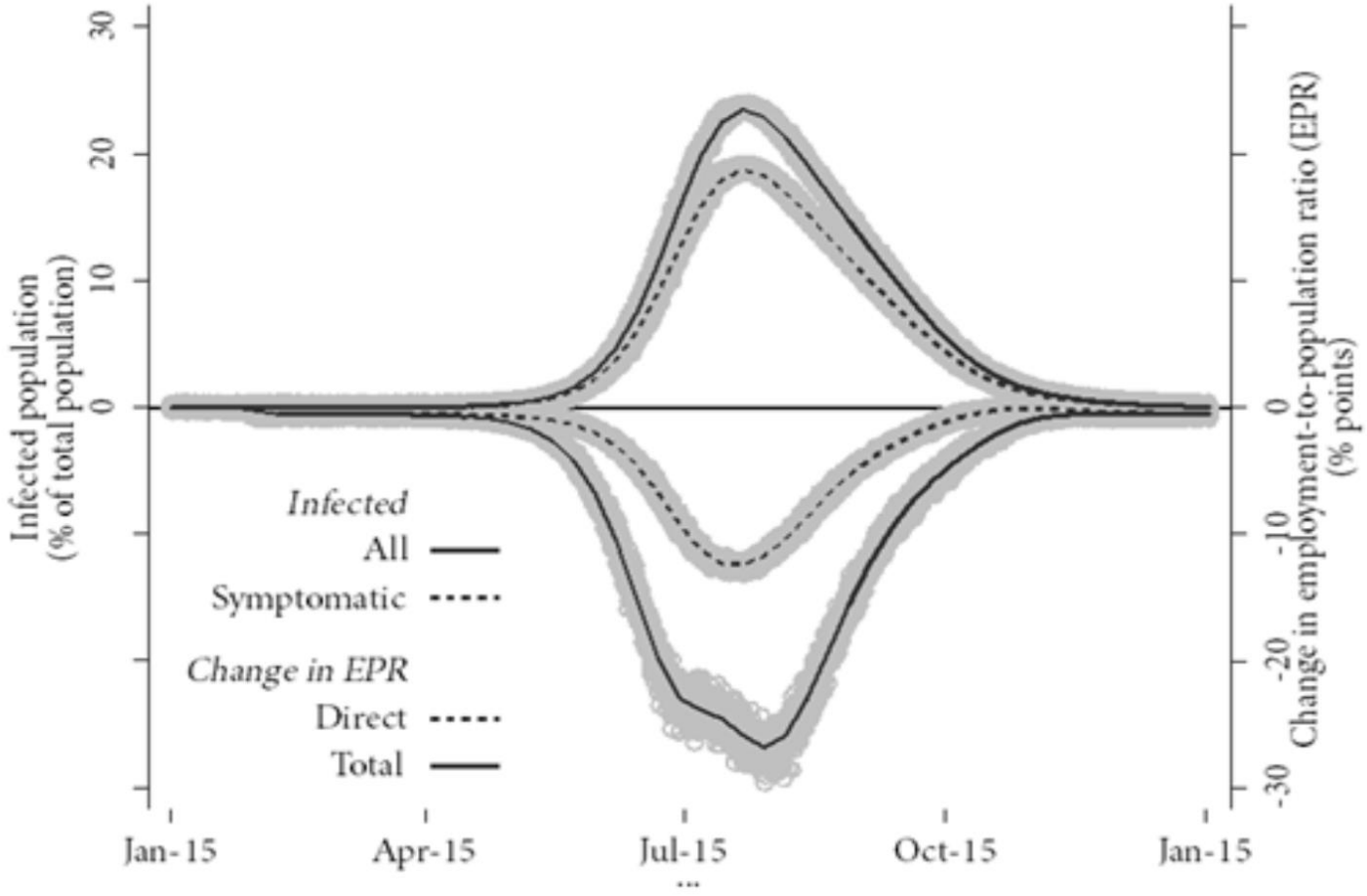
compared to baseline

Mobility trends for places of residence.

https://www.gstatic.com/covid19/mobility/2020-04-17_PH_Mobility_Report_en.pdf

COVID-19 and labor supply

Figure 3. Projected Infected cases and EPR change for a No intervention scenario (S0)



Impact on labor supply likely to have important spillovers

- Household income
- Production
- Government revenues

Potential limits of interventions

- Three in every five Filipinos have limited capacity to subsist without additional support if community quarantines are extended beyond one month.
- Alternative (non-wage) sources of income are not equally available among different households.
- Remittances from international migrant workers' jobs may also be at risk with the spread of COVID-19 in host countries.

Potential limits of interventions

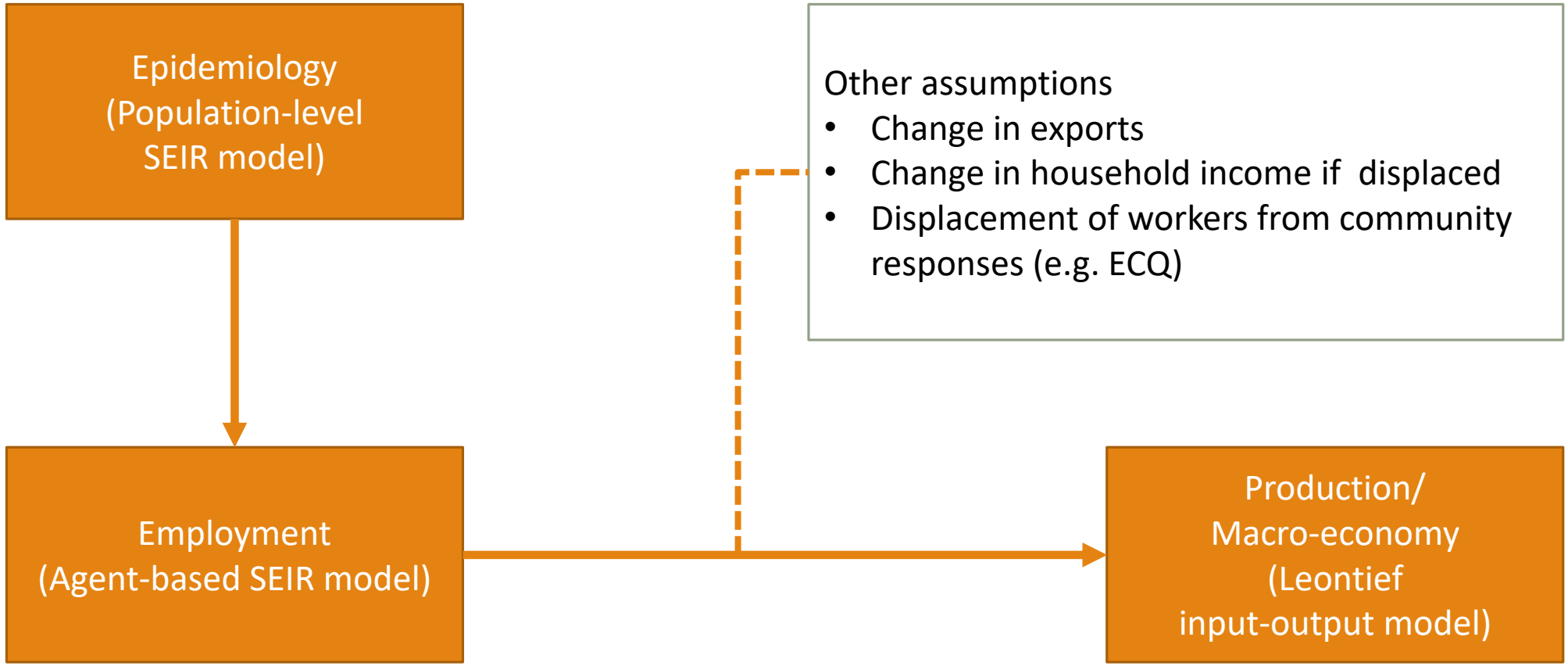
- Telecommuting arrangements may be possible for some but not all occupations/classes.

- Limiting travel, while important, may have strong negative impacts on the ability of consumers to access and producers to delivery essential resources.

Macroeconomic projection

- Based on Leontief input-output model.
- Estimated gross value added response to change in final demand (consumption, exports).
- Change in exports assumed to be half of 2009 global financial crisis levels in worse case.
- Change in household demand linked with epidemic curve projections

Modelling strategy



Projection scenarios

Table 11. Macroeconomic projection scenarios

Scenarios	Consumption/Employment[1]	Exports
Worse case Scenario S1B; The pandemic is not contained around the world, and the global economy slows down into a recession.	5.3% reduction in household consumption as a result of 19.7% drop in annual average labor supply, and 20% net reduction in average incomes among displaced workers.	Philippine exports of goods decline by 80 percent of 2009 Global Financial Crisis rates for agriculture, forestry and fishing (5%), mining and quarrying (20%), and manufacturing (24%). Consumption from transportation, storage and communication, and other services export decline by 20%.
Moderate case Scenario S3B; The pandemic is effectively contained around the world by end of 2020Q3.	3.7% reduction in household consumption as a result of 14.4% drop in annual average labor supply, and 20% net reduction in average incomes among displaced workers.	50% of worse-case scenario.

Projection scenarios

Best case Scenario S5B; The pandemic is effectively contained around the world by end of 2020Q2.	0.7% reduction in household consumption as a result of 7.4% drop in annual average labor supply, and 20% net reduction in average incomes among displaced workers.	10% of worse-case scenario.

Note: Authors' assumptions.

1 Commodity-specific income elasticities of demand are calculated based on aggregate data from PSA. See Appendix 3 for the calculation of the change in employment by scenario.

Important caveats

- Estimates are only indicative.
- Excluded expected increase in health care demand in response to COVID-19.
- Intentionally based on conservative assumptions to provide a lower limit to the potential economic losses.

Projected GVA decline

Economy-wide losses as much as PHP2.5 trillion

Worse-hit by value are manufacturing, trade, and other services

Also mining and quarrying if by share

Table 12. Projected decline in sectoral gross value added

	Level (PHP Billions)			Share of 2019 Gross Value Added (%)		
	Best	Moderate	Worse	Best	Moderate	Worse
Agriculture, forestry and fishing	9.4	50.5	110.3	0.5	2.9	6.4
Mining and quarrying	1.7	8.6	26.9	1.1	5.3	16.7
Manufacturing	82.1	421.8	855.2	2.3	11.7	23.8
Construction	1.7	9.0	19.3	0.1	0.5	1.2
Electricity, gas and water	5.7	30.5	44.3	0.9	5.0	7.3
Transportation, storage and communication	11.7	61.6	124.3	1.1	5.6	11.3
Wholesale and retail trade	93.2	497.7	724.8	2.6	13.9	20.3
Financial intermediation	18.5	98.9	141.3	1.1	6.0	8.6
Real estate, renting and business activities	10.7	56.8	79.7	0.4	2.4	3.3
Other services	41.5	221.0	356.9	1.5	7.8	12.6
All sectors	276.3	1,456.3	2,482.9	1.4	7.6	12.9

Source: Authors' calculations.

Impact of ECQ extension

Table 13. Projected macro-economic impact of NMI

	Mitigation measures			ECQ Extension		
	ECQ	Better testing	Isolation at onset	No extension	+2 weeks	+ 4 weeks
A. Level (PhP Billion)						
S1	Yes; 95%	No	No	1,417.9	1,475.7	1,573.3
S2	Yes; 95%	Yes	No	1,230.4	1,323.7	1,415.7
S3	Yes; 95%	Yes	Yes; 50%	1,043.6	1,141.5	1,241.2
S4	Yes; 50%	Yes	Yes; 50%	…	980.7	1,029.8
S5	Yes; 50%	Yes	Yes; 70%	…	213.4	283.7
B. Share of 2019 GVA (%)						
S1	Yes; 95%	No	No	7.4	7.7	8.2
S2	Yes; 95%	Yes	No	6.4	6.9	7.4
S3	Yes; 95%	Yes	Yes; 50%	5.4	5.9	6.4
S4	Yes; 50%	Yes	Yes; 50%	…	5.1	5.3
S5	Yes; 50%	Yes	Yes; 70%	…	1.1	1.5

*No intervention: PhP1,980B; 10.2% of 2019 GVA

Key Message #3

- The Philippine economy may lose between 276.3 billion (best case) and PHP 2.5 trillion (worse case) due to COVID-19.
  - Manufacturing (PHP 82.1- to 855.2-billion)
  - Wholesale and retail trade (PHP 93.2- to 724.8-billion)
  - Other services (PHP 41.5- to 356.9-billion)

- Given the same set of mitigation measures, extending the ECQ by one month may potentially cost the Philippine economy at least PHP150 billion due to possible decline in household consumption as workers remain unemployed for longer periods.

Recommendations

Recommendations

- Maximize the implementation of the ECQ (effective, but temporary and devastating to the economy and health).

- Plan a gradual and calibrated transition: ECQ to risk-based strategy. Identify when is the best time to transition; set the criteria.

Criteria on lifting the ECQ

- There is a clear evidence that transmission is controlled.
- There is sufficient health system capacity.
- There is ability to protect vulnerable population, specifically health workers.
- Workplaces are prepared.
- Local governments are prepared.
- People are prepared of the new normal.

Criteria on lifting the ECQ

- **There is a clear evidence that transmission is controlled.**
  - Significant and consistent decline in doubling time.
  - Significant and consistent decline in R0.
  - Decline in positive test.

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Criteria on lifting the ECQ

- **There is sufficient health system capacity.**

Capacity to do massive testing

Capacity to trace

Capacity to isolate

Capacity to treat

Capacity to track and monitor

Criteria on lifting the ECQ

Capacity to do massive testing

- **There is sufficient health system capacity (TESTING).**
  - The government has the capacity to conduct 10,000 to 15,000 test per day.
  - The government has a clear strategy to democratize testing by incentivizing local governments and private sector to expand testing infra.
  - Strategy: Use PhilHealth strategic purchasing power.

Criteria on lifting the ECQ

Capacity to trace

- **There is sufficient health system capacity (TRACING).**
  - The local governments with the support of the national government have already hired and trained an army of contact tracers to do the detective work.

Criteria on lifting the ECQ

Capacity to isolate

- **There is sufficient health system capacity (ISOLATING).**
  - Strategy of WHO: Test and isolate.
  - Ideal strategy: Isolate and test.
  - Shift in policy from home to quarantine facility.
  - The local governments should have established quarantine facilities.
  - Strategy: allow the private sector to build isolation facilities. PhilHealth include isolation as part of their benefit package.

Criteria on lifting the ECQ

Capacity to treat

- **There is sufficient health system capacity (TREATING).**
  - The government has established COVID referral hospitals all over the country to promote efficiency.
  - The government has augmented supply-side requirements to accommodate possible second wave. The government has increased the number of isolation rooms, ventilators, and other critical equipment.
  - The government has set standard treatment protocol to reduce treatment variation.

Criteria on lifting the ECQ

Capacity to monitor

- **There is sufficient health system capacity (MONITORING).**
  - The government have established a robust IT system to monitor the trajectory of new cases real-time.
  - A potential surge in cases might occur as early as two weeks after relaxing the ECQ, and the system should be detect the potential surge. This allows decision makers to re-calibrate directions/actions if necessary.

Criteria on lifting the ECQ

- **There is ability to protect vulnerable population, specifically health workers.**
  - The country has enough supply/buffer of personal protective equipment (PPE).
  - The government has strategic plan to avoid depletion of PPE (e.g., local production, importation, innovation)
  - The government has increased the number of health workers – to ensure optimal rotation to avoid burn out, which is one of the major drivers of higher infection rate in HCW.
  - Hospitals have robust infection control.

Criteria on lifting the ECQ

- **Workplaces are prepared.**
  - Ability to implement physical distancing and other public health interventions (e.g. handwashing, temperature gathering).
  - Ability to implement nudges to ensure employees abide with public health interventions.
  - Workplaces have established outbreak strategic/infection control strategic plan (e.g. random testing protocols).
  - Demand vs. supply modalities?

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