| Parameter | Mean - LIC | Distribution - LIC | Mean - MIC | Distribution - MIC | Mean - HIC | Distribution - HIC | Assumptions, calculations & transformations | Source(s) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Population | 100m | Not included in PSA | 100m | Not included in PSA | 100m | Not included in PSA | Assumed for comparability | / |
| Population growth | 0.02120725 | Not included in PSA | 0.006578764 | Not included in PSA | 0.003443516 | Not included in PSA | Used total population of whole income group, forecast using auto.ARIMA for 20 years in the future, and converted the 20 year change into a constant annual growth rate | WB data |
| Timeframe (years) | 20 | Not included in PSA | 20 | Not included in PSA | 20 | Not included in PSA | Assumed for comparability | / |
| Productivity growth | 0.02359892 | Not included in PSA | 0.04131553 | Not included in PSA | 0.01379446 | Not included in PSA | Found the average growth rate from 2010-2019 for each country, and then took the population-weighted mean of these values for each income category | WB data |
| Discount rate | 0.04303848 | Not included in PSA | 0.06784175 | Not included in PSA | 0.02931224 | Not included in PSA | From Haacker, Hallett and Atun we get a discount rate of r(c) = 0.01 + 1.4\*g, where g is the growth in per-person consumption. Using the same per-person GDP growth rates that we used for the productivity growth rates, and this formula, we get a discount rate | Haacker, Allett and Atun, 2021 |
| WTP per QALY | 160.180 | Not included in PSA | 2206.707 | Not included in PSA | 26449.670 | Not included in PSA | Took the mean of the upper and lower (nominal USD) values for WTP from Woods *et al*. for each country, and then took the population-weighted mean of this for each income category  We then multiplied each of these values by GDPPC growth in each income category between 2015-2019  LIC 688.279/713.817 = 0.964223323  MIC 5480.251/4755.36 = 1.15243662  HIC 45406.634/40444.068 = 1.12270195 | Woods *et al*., 2016; World Bank, 2021 |
| Number of pigs | 3037648 | Lognormal (14.6972337, 0.02475434) | 11229177 | Lognormal (15.699209, 0.01485079) | 28456813 | Lognormal (16.9900869, 0.01866447) | We took the meat production (tonnes) and divided it to get the tonnes per 100k population.  The world made 342422466 tonnes of meat and had population of 7752840547, giving 4416.7356 tonnes per 100,000 population  There were 25.69bn chickens and 0.9783bn pigs worldwide, or 3.348 and 0.1275 per person, or (in a typical country of 100m people) 334,800,000 chickens and 12,750,000 pigs  For each country, we multiplied the tonnes / 100k population (relative to the world) by these numbers of pigs and chickens per 100m people  We then took the (population-weighted) mean of this for each income group | [Our World in Data](https://ourworldindata.org/meat-production) and World Bank |
| Number of chickens | 79765056 | Lognormal (17.9652357, 0.02475434) | 294864982 | Lognormal (18.967211, 0.01485079) | 747242435 | Lognormal (20.2580889, 0.01866447) |
| Portion of animals in industrial farms | 0.1 | Beta (1, 9) | 0.25 or 0.75 | Beta (10,10) | 0.8 | Beta (40,10) | Due to inexact definitions and lack of country-specific data, we chose these four values / distributions to be a rough reflection of different agricultural production systems | / |
| Size of industrial pig farm | 2000 | Lognormal (7.476, 0.5) | 2000 | Lognormal (7.476, 0.5) | 2000 | Lognormal (7.476, 0.5) | [This](https://www.theguardian.com/environment/2020/apr/07/industrial-sized-pig-and-chicken-farming-continuing-to-rise-in-uk#:~:text=One%20million%2Dchicken%20farms,with%201%2C534%20industrial%2Dsized%20farms.) article says that industrial farms in the UK hold around 40,000 chickens or 2,000 pigs, and contain 70% of the UK’s farm animals. [This](https://bmcvetres.biomedcentral.com/articles/10.1186/s12917-016-0849-7) source from Thailand lists ‘large’ pig farms as being those with at least 5,000 pigs. This gives a range of 2,000-5,000, so we have allowed values to fall 1,000 pigs on either side of this  The Thailand source lists backyard pig farms as having fewer than 5 pigs, and smallholder farms as having fewer than 50. We have therefore used 5-50 as the range  [This](https://zootecnicainternational.com/focus-on/netherlands-leading-country-european-egg-poultry-meat-exports/) source claims that, in the Netherlands, the average broiler farm had 81,632 chickens but that the country had been experiencing a concentration of production in fewer larger farms  [This](https://www.nationalhogfarmer.com/farm-life/farm-progress-america-august-4-2021) source suggests that the average pig farm in the USA had a stock of 1,900 *female* pigs, so presumably ~4,000 pigs in total  As the USA and Netherlands are quite intensive, we will assume for HICs that there are only industrial farms (2,000 pigs or 40,000 chickens) but that they can only be visited one at a time]  [Burgos *et al*](https://www.researchgate.net/publication/26558148_Characterization_of_Poultry_Production_Systems_in_Vietnam). describes backyard farms in VN as being <=50 birds (average 32), semi-intensive as being 51-2000 and intensive as being > 2000. Intensive farms are described as having as many as 100,000 birds. | Sources linked in calculations |
| Size of smallholder pig farm | 10 | Lognormal (2.0213, 0.75) | 10 | Lognormal (2.0213, 0.75) | 10 | Lognormal (2.0213, 0.75) |
| Size of industrial chicken farm | 40,000 | Lognormal (10.31, 0.75) | 40,000 | Lognormal (10.31, 0.75) | 40,000 | Lognormal (10.31, 0.75) |
| Size of smallholder chicken farm | 1000 | Lognormal (6.63, 0.75) | 1000 | Lognormal (6.63, 0.75) | 1000 | Lognormal (6.63, 0.75) |
| Price of a pig ($) | 64.64618 \*1.015892 | 64.64618 \* lognormal (-0.0351000,0.06007284) | 64.64618 \*1.802562 | 64.64618 \* lognormal (0.5590797,0.00807645) | 64.64618 \*1.699701 | 64.64618 \* lognormal (0.4408899,0.013521752) | Population-weighted average weight of a pig across countries (64.64618kg) multiplied by the (population-weighted) price per kg of meat in countries of each income group | [FAO](https://www.fao.org/faostat/en/#data/PP) (1) for animal prices per kg, [Knoema](https://knoema.com/FAOPRDSLS2020/production-statistics-live-animals-live-stocks-primary-live-stocks-processed) for pig weight, and [FAO](http://www.fao.org/faostat/en/#data/QCL) (2) for chicken weight |
| Price of a chicken ($) | 1.484145 \*2.935612 | 1.484145 \* lognormal (1.0685631,0.01998350) | 1.484145 \*1.667056 | 1.484145 \* lognormal (0.4494172,0.010793934) | 1.484145 \*1.382834 | 1.484145 \* lognormal (0.2776198,0.013028735) | Population-weighted average weight of a chicken across countries (1.484145kg) multiplied by the (population-weighted) price per kg of meat in countries of each income group |
| Pig production cycles per year - smallholder | 2.5 | Not included in PSA | 2.5 | Not included in PSA | 2.5 | Not included in PSA | / | ILRI data |
| Chicken production cycles per year - smallholder | 3 | Not included in PSA | 3 | Not included in PSA | 3 | Not included in PSA | / | Phu *et al*., 2021 |
| Pig production cycles per year - industrial | 2 | Not included in PSA | 2 | Not included in PSA | 2 | Not included in PSA | Australian source suggests 3-4 weeks before weaning, then 5-6 months before slaughter  UK source suggests that slaughter weight is reached after 24 weeks  China source suggests that porkers live for 180-230 days | [This](https://aussiepigfarmers.com.au/pigs/our-animals/reproduction/) source for Australia  [This](https://www.ciwf.org.uk/media/5235118/The-life-of-Pigs.pdf) source for UK  [This](http://www.savewater-china.com/info/pig-production-cycle_i0026.html) source for China |
| Chicken production cycles per year - industrial | 9.125 | Not included in PSA | 9.125 | Not included in PSA | 9.125 | Not included in PSA | Production cycle of 35-45 days → 365/40 = 9.125 | [This](https://www.theguardian.com/environment/2020/apr/07/industrial-sized-pig-and-chicken-farming-continuing-to-rise-in-uk#:~:text=One%20million%2Dchicken%20farms,with%201%2C534%20industrial%2Dsized%20farms.) article |
| Chicken mortality - industrial | 0.05 | Beta (1.6, 30) | 0.05 | Beta (1.6, 30) | 0.05 | Beta (1.6, 30) | Weeks *et al*. found that mortality for laying hens in the UK during laying period was 5.39% in cages, 8.55% in parn, 9.52% for free-range and 8.68% for organic  van Horne *et al*. found that, in Mexico, broiler mortality was 8-10% due to disease problems. They found that it was around 4% in the USA and 3-3.5% in the EU  Since we are taking chicken farms to be smallholder only in the LIC scenario, and since we are looking only at broilers, we use the results of van Horne *et al*., taking the mortality rate to be 3.5% in HICs and 9% in MICs | [Weeks *et al*., 2021](https://pubmed.ncbi.nlm.nih.gov/22678619/); [van Horne et al., 2018](https://edepot.wur.nl/443735); |
| Chicken mortality - smallholder | 0.25 | Beta (50, 150) | 0.25 | Beta (50, 150) | 0.26 | Beta (50, 150) | Phu *et al*. found mortality of 25% (Viet Nam)  The [original parameter spreadsheet](https://lshtm-my.sharepoint.com/:w:/r/personal/eidegkni_lshtm_ac_uk/_layouts/15/Doc.aspx?sourcedoc=%7B1AA3AE79-C2AE-445A-81D9-EC9951C0CDCC%7D&file=Rough%20Model%20inputs%20and%20outputs.docx&action=default&mobileredirect=true) used 32.9%  Delabouglise *et al*. found 19.9% (Viet Nam) but this was for extremely small farms (avg. 16 birds)  Carrique-Mas *et al*., 2019 found 37.76%, but this was during an ongoing disease outbreak  Otiang *et al*. (Kenya) found mean offtake of 5.35 per quarter, of which 59.41% (3.178435) was from mortality. Average farm size was 10, suggesting 31.8% mortality. However, as we are looking at larger smallholder farms (~ 2,500) this may be less relevant, and this is given per quarter rather than per production cycle  Therefore go with the estimates of Phu *et al*. | Phu *et al*., 2021; original parameter spreadsheet from Nichola; Delabouglise *et al*., 2019; Carrique-Mas *et al*., 2019; Otiang *et al*., 2020 |
| Pig mortality - industrial | 0.18355 | Beta (11.2, 50) | 0.18355 | Beta (11.2, 50) | 0.18355 | Beta (11.2, 50) | Mehling *et al*., 2019 suggests that in ‘commercial’ pig farms, the density of pigs affects post-weaning mortality, ranging from 8.36% to 28.35% mortality  Mainau *et al*., 2015 suggest that pre-weaning mortality ranges from 5% to 35% and is the result of several innate and structural factors - however it might not make sense to include this as the number of pigs that we use is based on the number in farms, which will naturally not include those which died at birth  Bergman *et al*., 2019 found that, in Finland, large intensive pig farms had mortality of 10% where smaller and less intensive ones had mortality of ~8%, but culling was much higher than mortality for both  Gebhart *et al*., 2020 (systematic review) note that some studies find stocking density to have contributed positively to mortality  We will use the average of the range from Mehling *et al*. → 0.5(0.0836 + 0.2835) = 0.18355 | Mehling *et al*., 2019; Mainau *et al*., 2015; Bergman *et al*., 2019; Gebhart *et al*., 2020 |
| Pig mortality - smallholder | 0.1565 | Beta (18.55, 100) | 0.1565 | Beta (18.55, 100) | 0.1565 | Beta (18.55, 100) | Kambashi *et al*. found mortality of 9.5% to 21.8% (0.1565) | Kambashi *et al*., 2014 |
| Chance of developing sepsis | 0.013182211 | Beta (8.483491, 635.831784) | 0.006753598 | Beta (2.342106, 344.344761) | 0.002029572 | Beta (13.09855, 6455.69134) | The population-weighted average incidence for countries in each income group | Rudd *et al*., 2020 |
| Sepsis fatality (sus) | 0.3544173 | Beta (8.483491, 635.831784) | 0.2514949 | Beta (16.16834, 48.09834) | 0.1548441 | Beta (35.20625, 192.16882) | For each country, we divided the incidence (per 100,000) by the mortality (per 100,000) to get the mortality rate. Then, we took the population-weighted average for countries in each income group as the mortality for susceptible infections. We multiplied this by 1.62 following Serra-Burriel *et al*.’s findings that multidrug-resistance increases the mortality odds ratio of HAI’s by 1.62 | Rudd *et al*., 2020; Serra-Burriel *et al*., 2020 |
| Sepsis fatality (res) | 0.574156026 | 1.62 \* Beta (8.483491, 635.831784) | 0.407421738 | 1.62 \* Beta (16.16834, 48.09834) | 0.250847442 | 1.62 \* Beta (35.20625, 192.16882) |
| Portion of Sepsis from resistant bacteria | 0.106864 | Beta (58.82916, 491.64083) | 0.106864 | Beta (58.82916, 491.64083) | 0.045100 | Beta (3.059945, 64.807960) | The portion of infections by resistant bacteria based on a meta-analysis (Serra-Burriel *et al*., 2020) of 19 studies from HICs and 1 from an MIC (China) was 0.0451. We assumed this to be representative of HICs.  For the relative incidence of AMR by income status, we looked to the overall drug resistance index (DRI) from CDDEP. The index was only available for MICs and HICs. We took the population-weighted average DRI by income category, and assumed that the DRI is the same in MICs as in LICs.  We multiplied the DRI relative to HICs by the portion of infections by resistant bacteria in HICs to get the estimated portion of infections by resistant bacteria in each income category     | Income level | DRI | DRI relative to HIC | Estimated portion of BSIs from AMR Pathogens | | --- | --- | --- | --- | | LIC | 66.24125 | 2.369491 | 0.106864 | | MIC | 66.24125 | 2.369491 | 0.106864 | | HIC | 27.95590 | 1 | 0.0451 | | Serra-Burriel *et al*., 2020; [CDDEP](https://resistancemap.cddep.org/DRI.php); World Bank Open Data; [World Bank](https://www.worldbank.org/en/topic/agriculture/publication/pulling-together-to-beat-superbugs-knowledge-and-implementation-gaps-in-addressing-antimicrobial-resistance) |
| AMR growth | 1.02844688 | 1 + 0.01 \* Gamma(6853.33, 0.015) | 1.02844688 | 1 + 0.01 \* Gamma(6853.33, 0.015) | 1.02844688 | 1 + 0.01 \* Gamma(6853.33, 0.015) | For the mean growth rate, we took the estimated global resistance prevalence in 2015 and 2030, and assumed a constant growth rate  For upper and lower bounds, we used the same method as we did to find the default growth rate, but used the extremes of the 95% CI for the projected values for 2030 (still using the middle values for 2015)  third-gen cephalosporin-resistant E coli: lower bound 64.5% to 55% [0.9894], upper bound 64.5% to 99.1% [1.029]  carbapenem-resistant E coli: lower bound 5.8% to 3.7% [0.9705], upper bound 5.8% to 19.9% [1.0857]  third-gen cephalosporin-resistant K pneumoniae: lower bound 66.9% to 50.2% [0.981], upper bound 66.9% to 66.1% [0.9992]  carbapenem resistant K pneumoniae: lower bound 23.4% to 16.3% [0.9762], upper bound 23.4% to 89.3% [1.0934]  Average of lower bounds: 0.979275  Average of upper bounds 1.051825 | Alvarez-Uria *et al*., 2018 |
| Chance of developing sequelae following sepsis with susceptible bacteria | 0.361634098 | Not included in PSA (lack of country-specific data) | 0.23432137 | Not included in PSA (lack of country-specific data) | 0.152 | Not included in PSA (lack of country-specific data) | Kyriazopoulou *et al*. trialled a specific form of antimicrobial withdrawal for patients with sepsis in an HIC (Greece), and found that the baseline prevalence of sequelae after 180 days was 15.2% - we use this for HICs. For other countries, we assume that the relative probability of sequelae is the same as the relative probability of fatality (from Rudd *et al*.), by looking at the ratio of population-weighted average fatality from sepsis by income category i.e.:  0.152(0.2387058/0.1548441) = 0.23432137  0.152(0.3684007/0.1548441) = 0.361634098  We then assumed that the odds ratio for sequelae from resistant bacteria was the same as the odds ratio for mortality from resistant bacteria from Serra-Burriel *et al* (1.62), i.e.  0.152 \* 1.62 = 0.24624  0.23432137\* 1.62 = 0.379600619  0.361634098 \* 1.62 = 0.585847239 | Kyriazopoulou *et al*., 2021; Rudd *et al*., 2020; Serra-Burriel *et al*., 2020 |
| Chance of developing sequelae following sepsis with resistant bacteria | 0.585847239 | Not included in PSA (lack of country-specific data) | 0.379600619 | Not included in PSA (lack of country-specific data) | 0.24624 | Not included in PSA (lack of country-specific data) |
| QoL from infection | 0.66035 | Beta (195, 100) | 0.66035 | Beta (195, 100) | 0.66035 | Beta (195, 100) | They give a disability weight of 0.125 for uncomplicated BSIs, which occur with probability 0.595; and a disability weight of 0.655 for complicated BSIs, which occur with a probability 0.405  Therefore expected QoL is 0.595(1-0.125) + 0.405(1-0.655) = 0.66035  QoL for sequelae is just mean QoL of different kinds of sequelae named in paper, adjusted by their relative probabilities  For the extreme values, we used the min and max QoL for each state in the paper, and then selected an unbiased distribution with little probability mass outside of those limits  Minimum and maximum possible QoL from Cassini *et al*.  Complicated infection: probability 0.34-0.47, DW 0.579-0.727  Uncomplicated infection: 0.53-0.66, DW 0.104-0.152  Maximum DW and maximum likelihood of complication gives:  0.47(0.727) + 0.53(0.152) = 0.42225, so QoL = 0.57775  Minimum DW nd minimum likelihood of complication gives:  0.34(0.579) + 0.66(0.104) = 0.2655, so QoL = 0.7345  Min DW from sequelae:  0.584(0.012) + 0.0064(0.071) + 0.0026(0.117) + 0.0005(0.194) + 0.0013(0.154) + 0.236(0.058) + 0.0483(0.136) + 0.118(0.090) = 0.0389406, so QoL = 0.9610594  Max DW from sequelae:  t0.584(0.052) + 0.0064(0.489) + 0.0026(0.516) + 0.0005(0.560) + 0.0013(0.534) + 0.236(0.107) + 0.0483(0.194) + 0.118(0.146) = 0.0876636, so QoL = 0.9123364 | Cassini *et al*., 2015 |
| QoL from sequelae | 0.9355 | Beta (1090, 75) | 0.9355 | Beta (1090, 75) | 0.9355 | Beta (1090, 75) |
| Hospital LoS from sus infection (years) | 0.0238466804 | (1/365.25) \* Lognormal (2.16, 0.11) | 0.0238466804 | (1/365.25) \* Lognormal (2.16, 0.11) | 0.0238466804 | (1/365.25) \* Lognormal (2.16, 0.11) | Baseline attributable LoS from BSI is 5.87-11.54 days (mean 8.71). We assigned an unbiased distribution with little probability mass outside of this range. We converted this into years (as one period in our model is one year)  We multiply this figure by 1.27 for resistant infections, adjusting for the effect of resistance on LoS from Serra-Burriel *et al*. | Cassini *et al*., 2015 from Stewardson, 2016; Serra-Burriel *et al*., 2020 |
| Hospital LoS from res infection (years) | 0.0302852841 | (1.27/365.25) \* Lognormal (2.16, 0.11) | 0.0302852841 | (1.27/365.25) \* Lognormal (2.16, 0.11) | 0.0302852841 | (1.27/365.25) \* Lognormal (2.16, 0.11) |
| Portion of population working | 0.3931943 | Not included in PSA | 0.4284953 | Not included in PSA | 0.4827129 | Not included in PSA | Portion of population of working age multiplied by labour force participation rate. We then take the population-weighted mean of this value for each income category | WB data |
| Annual productivity per worker ($USD) | 2530.0268 | Not included in PSA | 22875.54 | Not included in PSA | 91200.02 | Not included in PSA | To get the productivity per worker, we multiply the average annual hours worked per worker by the productivity per hour worked. For MICs and HICs, we take the population-weighted average of this by income group.  There was no productivity data for LICs from these sources, so we took the MIC with the lowest estimated annual productivity per worker (Cambodia, $5554.053), and adjusted the value by the ratio of Cambodia’s GDPPC ($1512.728) to the LIC average ($689.09)  Thus, val = 5554.053 \* (689.09/1512.728) = 2530.0268 | Penn World Tables |
| Adjustment for unpaid productivity (multiply productivity per person, inclusive of LFPR, by this factor) | 1.4849951 | Not included in PSA | 1.46548185 | Not included in PSA | 1.2935917 | Not included in PSA | Bridgman *et al*., 2018 estimate the ratio of total productivity per person to market productivity per person. We regress this against GDPPC and then take the expected values for the average PC income level of each income group, giving ratios of  LIC: 1.4849951  MIC: 1.46548185  HIC: 1.2935917 | [Here](https://www.sciencedirect.com/science/article/pii/S0304387817301281?casa_token=IKHMW9riN3oAAAAA:NZEcvANc5XOaTYV18JY6IZNVCxUD115RUzByLvhm5NrGK-J9VIpKbpD7Su5VP6WHnE4QPRKwMwc) and [here](https://www.imf.org/en/Publications/WP/Issues/2019/10/15/Reducing-and-Redistributing-Unpaid-Work-Stronger-Policies-to-Support-Gender-Equality-48688) |
| Cost of a hospital bed day ($USD) | 6.232739 | Lognormal (1.257771, 0.925305) | 39.732420 | Lognormal (3.2110302, 0.9573006) | 627.543312 | Lognormal (6.3243080, 0.5410926) | Population-weighted average for countries in each income group, in $2019 | WHO-Choice |
| Remaining life years | 45 | Not included in PSA | 41 | Not included in PSA | 39 | Not included in PSA | For each country, we took the median age and life expectancy. The difference was taken to be the remaining life years. For remaining work years, we took the difference between 65 (assumed age of retirement) and median age. We took the population-weighted average of these two values for countries in each income group | World Bank (life expectancy) and CIA World Factbook (median age) |
| Remaining working years | 45 | Not included in PSA | 34 | Not included in PSA | 23 | Not included in PSA |
| Effect on human AMR | {-0.025, -0.05, -0.1, -0.16} | -1 \* beta (1.1, 20.9) | {-0.025, -0.05, -0.1, -0.16} | -1 \* beta (1.1, 20.9) | {-0.025, -0.05, -0.1, -0.16} | -1 \* beta (1.1, 20.9) | Drawn from the literature (see paper) | See paper |
| Pig income effect | {-0.02, -0.01, 0, 0.01, 0.02} | 90% chance of beta (1, 39), 10% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 90% chance of beta (1, 39), 10% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 90% chance of beta (1, 39), 10% chance of - beta (1, 39) | / | / |
| Chichen income effect | {-0.02, -0.01, 0, 0.01, 0.02} | 90% chance of beta (1, 39), 10% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 90% chance of beta (1, 39), 10% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 90% chance of beta (1, 39), 10% chance of - beta (1, 39) | / | / |
| Pig mortality effect | {-0.02, -0.01, 0, 0.01, 0.02} | 10% chance of beta (1, 39), 90% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 10% chance of beta (1, 39), 90% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 10% chance of beta (1, 39), 90% chance of - beta (1, 39) | / | / |
| Chichen mortality effect | {-0.02, -0.01, 0, 0.01, 0.02} | 10% chance of beta (1, 39), 90% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 10% chance of beta (1, 39), 90% chance of - beta (1, 39) | {-0.02, -0.01, 0, 0.01, 0.02} | 10% chance of beta (1, 39), 90% chance of - beta (1, 39) | / | / |