# APPENDIX A

All of the matrix's eigenvalues have negative real parts, i.e

Evaluating along the first column gives the characteristic equation

(2)

Equation (2) has two negative roots by Descartes's rule of signs if

(3)

is a positive matrix because in the invariant set. Hence, it follows that

whenhe matrix's eigenvalues are negative. Given that , the linearized differential inequality (4) is stable. Consequently,

as . Evaluating system (4) at providing, and for . Therefore, the HIV-HCV diseases free equilibrium of the system (4) is asymptotically stable globally when . It instantly follows if that the HIV-HCV disease-free equilibrium of the system (4) is shown to be unstable.

# APPENDIX B

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