$f(t,x) = x + tKx + $ matrix terms involving t^2 or $t\, x_i x_j$.
where K is a $n \times n$ matrix.

$\Rightarrow$ $$\frac{d\, f(t,x)}{dt} = B\, f(t,x) + [\partial] \quad \cdots \quad (*)$$

where B = transpose of $A = (a_{ij})$
$[\partial]$ is terms involving $x_i x_j$.

$\Rightarrow$ The solution of $(*)$ is
$$f(t,x) = e^{tB} \cdot x + \text{terms involving } t^2 \text{ or } x_i x_j.$$

by comparing $f(t,x) = x + tKx +$ matrix terms involving t^2 or $t\, x_i x_j$. $\Rightarrow B = K$. furthermore.

$\Rightarrow$ $$\left(\frac{\partial f_i}{\partial x_j}\right) = J_{f_t}(p) = e^{tB} + \text{terms involving } t^2.$$

Thus $$J_{f_t}(p) - I = t\left({}^tA + \frac{tA^2}{2} + \frac{t^2A^3}{6} + \cdots\right),$$

and for t positive and sufficiently small,

$$\iota_{f_t}(p) = \text{sgn} \det\left(J_{f_t}(p) - I\right) = \text{sgn} \det A = \iota_v(p).$$

Γ $$J_{f_t}(p) - I = t\left(B + \frac{tB^2}{2} + \frac{t^2B^3}{6} + \cdots\right) + t^2 \square$$

$\Rightarrow$ $\iota_{f_t}(p) = \text{sgn} \det\left(J_{f_t}(p) - I\right) =$
$\text{sgn}\left(\det B \det\left(I + \frac{tB}{2} + \cdots\right)\right)$ since $t^2 \square$ is so small, for sufficiently small t. $\Rightarrow$