

	(LITERAL)
	(FORMALVAR)
	(GLOBALVAR)
$\frac{x \in \text{dom } \rho \quad \langle e, \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho' \rangle}{\langle \text{SET}(x, e), \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho' \{x \mapsto v\} \rangle}$	(FORMALASSIGN)
$\frac{x \notin \text{dom } \rho \quad x \in \text{dom } \xi \quad \langle e, \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho' \rangle}{\langle \text{SET}(x, e), \xi, \phi, \rho \rangle \Downarrow \langle v, \xi' \{x \mapsto v\}, \phi, \rho' \rangle}$	(GLOBALASSIGN)
$\frac{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle \quad v_1 \neq 0 \quad \langle e_2, \xi', \phi, \rho' \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle}{\langle \text{IF}(e_1, e_2, e_3), \xi, \phi, \rho \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle}$	(IFTRUE)
$\frac{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle \quad v_1 = 0 \quad \langle e_3, \xi', \phi, \rho' \rangle \Downarrow \langle v_3, \xi'', \phi, \rho'' \rangle}{\langle \text{IF}(e_1, e_2, e_3), \xi, \phi, \rho \rangle \Downarrow \langle v_3, \xi'', \phi, \rho'' \rangle}$	(IFFALSE)
$\frac{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle \quad v_1 \neq 0 \quad \langle e_2, \xi', \phi, \rho' \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle \quad \langle \text{WHILE}(e_1, e_2), \xi'', \phi, \rho'' \rangle \Downarrow \langle v_3, \xi''', \phi, \rho''' \rangle}{\langle \text{WHILE}(e_1, e_2), \xi, \phi, \rho \rangle \Downarrow \langle v_3, \xi''', \phi, \rho''' \rangle}$	(WHILEITERATE)
$\frac{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle \quad v_1 = 0}{\langle \text{WHILE}(e_1, e_2), \xi, \phi, \rho \rangle \Downarrow \langle 0, \xi', \phi, \rho' \rangle}$	(WHILEEND)
$\overline{\langle \text{BEGIN}(), \xi, \phi, \rho \rangle \Downarrow \langle 0, \xi, \phi, \rho \rangle}$	(EMPTYBEGIN)
$\begin{array}{c} \langle e_1, \xi_0, \phi, \rho_0 \rangle \Downarrow \langle v_1, \xi_1, \phi, \rho_1 \rangle \\ \langle e_2, \xi_1, \phi, \rho_1 \rangle \Downarrow \langle v_2, \xi_2, \phi, \rho_2 \rangle \\ \vdots \\ \langle e_n, \xi_{n-1}, \phi, \rho_{n-1} \rangle \Downarrow \langle v_n, \xi_n, \phi, \rho_n \rangle \end{array}$	(BEGIN)
$\frac{\langle e_n, \xi_{n-1}, \phi, \rho_{n-1} \rangle \Downarrow \langle v_n, \xi_n, \phi, \rho_n \rangle}{\langle \text{BEGIN}(e_1, e_2, \dots, e_n), \xi_0, \phi, \rho_0 \rangle \Downarrow \langle v_n, \xi_n, \phi, \rho_n \rangle}$	(BEGIN)
$\begin{array}{c} \phi(f) = \text{USER}(\langle x_1, \dots, x_n \rangle, e) \\ x_1, \dots, x_n \text{ all distinct} \\ \langle e_1, \xi_0, \phi, \rho_0 \rangle \Downarrow \langle v_1, \xi_1, \phi, \rho_1 \rangle \\ \vdots \\ \langle e_n, \xi_{n-1}, \phi, \rho_{n-1} \rangle \Downarrow \langle v_n, \xi_n, \phi, \rho_n \rangle \end{array}$	(APPLYUSER)
$\frac{\langle e, \xi_n, \phi, \{x_1 \mapsto v_1, \dots, x_n \mapsto v_n\} \rangle \Downarrow \langle v, \xi', \phi, \rho' \rangle}{\langle \text{APPLY}(f, e_1, \dots, e_n), \xi_0, \phi, \rho_0 \rangle \Downarrow \langle v, \xi', \phi, \rho_n \rangle}$	(APPLYUSER)

Figure 1.5: Summary of operational semantics (expressions)