

**Table 1**

Classification of the studies on network data envelopment analysis.

Models	Basic Two-stage	General Two-stage	Series	Parallel	Mixed	Hierarchical	Dynamic
Independent	Chilingerian and Sherman (2004) Ho and Oh (2008)  Keh and Chu (2003) Keh et al. (2006)  Liu and Lu (2012) Liu et al. (2010) Lo (2010) Lo and Lu (2006) Lu (2009) Lu and Hung (2009) Luo (2003) Narasimhan et al. (2004) Seiford and Zhu (1999) Sexton and Lewis (2003) Tsai and Wang (2010) Tsolas (2011,2013) Wang et al. (1997) Yang (2006) Zhu (2000)	Abad et al. (2004)  Charnes et al. (1986) Simon et al. (2011)  Soteriou and Zenios (1999)			Adler et al. (2013)  Lewis and Sexton (2004) Lovell et al. (1994)		
System distance measure	Chen, Cook, et al. (2010) Lewis et al. (2013)  Sheth et al. (2007)  Yang et al. (2011)	Färe and Grosskopf (1996b) Färe and Whittaker (1995) Golany et al. (2006) Löthgren and Tambour (1999) Lozano et al. (2013) Yang et al. (2008)	Park and Park (2009)  Tone and Sahoo (2003)	Bi et al. (2012)  Färe et al. (1997)	Färe and Grosskopf (2000) Prieto and Zofio (2007) Zhao et al. (2011)		Chen (2009)  Chen and van Dalen (2010) Färe and Grosskopf (1996a) Jaenicke (2000)  Silva and Stefanou (2007)
Process distance measure	Chen and Zhu (2004)  Chiu and Huang (2011) Holod and Lewis (2011) Liu and Lu (2012) Rho and An (2007)  Saranga and Moser (2010)	Chiu et al. (2012)  Chiu, Huang, and Ma (2011) Chiu, Huang, and Ting (2011) Golany et al. (2006) Yang (2009)  Yu (2008a)  Yu and Chen (2011) Yu and Lee (2009) Xie et al. (2012)	Wei et al. (2011)	Chao et al. (2010)  Diez-Ticio and Mancebon (2002) Mar Molinero (1996)  Mar Molinero and Tsai (1997) Tsai and Mar Molinero (2002) Yu (2008b)  Yu and Fan (2006)	Wang et al. (2013)  Yu and Fan (2009) Yu and Lin (2008)	Färe and Primont (1984) Kao (1998)	Bogetoft et al. (2009)  Chen (2012)  Emrouznejad and Thanassoulis (2005) Jahanshahloo et al. (2006)
Factor distance measure	Chen et al. (2013)  Yu (2012)	Chen, Chang, et al. (2012)					Skevas et al. (2012)
Slacks-based measure	Akther et al. (2013) Fukuyama and Weber (2010)	Avkiran and McCrystal (2012)	Matthews (2013) Tsutsui and Goto (2009)		Amatatsu et al. (2012) Avkiran (2009)  Fukuyama and Mirdehghan (2012) Lin and Chiu (2013) Tone and Tsutsui (2009) Yu (2010)		Alperovych et al. (2013) Avkiran and Goto (2011) Lu et al. (2014)  Moreno et al. (2013)  Tone and Tsutsui (2010,2014) von Geymueller (2009)

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**Table 1** (continued)

Models	Basic Two-stage	General Two-stage	Series	Parallel	Mixed	Hierarchical	Dynamic
Ratio-form system efficiency	Cao and Yang (2011) Chen, Zhu, et al. (2012) Kao and Hwang (2008,2011,2013) Kao and Liu (2011) Liu (2011a,2011b)  Liu and Wang (2009) Yang and Liu (2012)	Guan and Chen (2010) Kao and Hwang (2010)	Kao (2014) Kao and Liu (in press)  Lee and Johnson (2012) Nouri et al. (2013)	Amirteimoori and Kordrostami (2005a) Amirteimoori and Nashtaei (2006) Bi et al. (2011) Da Cruz et al. (2013) Cook and Green (2004) Cook and Hababou (2001) Cook et al. (2000)  Jahanshahloo et al. (2004a,2004b) Kao (2009b,2012) Kao and Lin (2011,2012) Rogge and Jaeger (2012) Yang et al. (2000)	Chen and Yan (2011) Hsieh and Lin (2010) Kao (2009a,in press)	Castelli et al. (2004,2010) Cook et al. (1998) Cook and Green (2005)	Kao (2013)
Ratio-form process efficiency	Chen, Cook, et al. (2009) Chiou et al. (2010)  Cook, Liang, et al. (2010) Lim and Zhu (2013) Lu et al. (2012)  Wang and Chin (2010)	Amirteimoori (2013) Bichou (2011)  Chen, Liang, Yang, and Zhu (2006) Chen, Du, et al. (2010) Fang and Zhang (2008) Guan and Chen (2012) Liang et al. (2011) Liang et al. (2006) Premachandra et al. (2012) Wu and Birge (2012)	Amirteimoori and Kordrostami (2005b) Amirteimoori and Shafiei (2006) Kordrostami and Amirteimoori (2005)	Beasley (1995)	Castelli et al. (2001) Cook, Zhu, et al. (2010)		
Game theoretic	Du et al. (2011)  Liang et al. (2008) Zhou et al. (2013)	Chen, Liang, and Yang (2006) Li et al. (2012) Zha and Liang (2010)					
Value-based			Troutt et al. (2001) Wei and Chang (2011)	Vaz et al. (2010)			Amirteimoori (2006) De Mateo et al. (2006)  Färe et al. (2011) Nemoto and Goto (1999,2003) Ouellette and Yan (2008) Soleimani-damaneh (2009,2013a,2013b) Sueyoshi and Sekitani (2005)

although the year 2013 has not yet come to an end (the last review was conducted in August 2013), it already has the second most publications, after 2011.

Regarding applications, banks and financial institutions have the largest number of these, followed by farms (crop, dairy, and pig), public transportation (bus, railway, and airline), and power utilities. The focal topics are mainly on supply and value chains. Other units, such as universities, hi-tech companies, retail stores, waste handling, and manufacturing companies, also appear in the literature.

## 5. Conclusion

Network DEA models are able to incorporate the operations and interdependence of the component processes of a system in measuring efficiencies. The results are more representative than those obtained from the conventional black-box approaches. For this reason, models of various types have been developed and applied to measure the efficiencies of real world cases. This paper conducted a comprehensive review of studies related to network DEA with regard to both the models and structures examined.