### Arrival rate

Figure 5‑7 to Figure 5‑12 show the relationship between various performance metrics and the arrival rate . Both simulation results and analytical results are shown for comparison.

Figure 5‑7 illustrates the impact of the arrival rate on the average waiting time in the customer queue (). As increases, increases steadily. This is because higher arrival rate leads to more customers entering the system, causing increased congestion and longer queuing delays before customers can be batched into blocks. Lastly, the analytical results are in good agreement with the simulation results.

Figure 5‑8 illustrates the impact of the arrival rate on the average waiting time in the block queue (). As increases, remains nearly constant. This indicates that the time each block spends in the consensus queue is determined by the consensus rate and system transition rate, and is independent of the arrival rate. Lastly, the analytical results are in good agreement with the simulation results.

Figure 5‑9 illustrates the impact of the arrival rate on the average waiting time in the system (). As increases, increases steadily. This is because higher arrival rate leads to more customers entering the system, causing increased congestion and longer queuing delays before customers departure from the system. Lastly, the analytical results are in good agreement with the simulation results.

Figure 5‑10 illustrates the impact of the arrival rate on the average number of customers in the block queue (). As increases, increases steadily. This is because a higher arrival rate leads to more frequent block formation and more customers being accumulated in the block queue, increasing the average number of customers waiting for consensus. Lastly, the analytical results are in good agreement with the simulation results.

Figure 5‑11 illustrates the impact of the arrival rate on the blocking probability (). As increases, rises sharply, specially beyond . This is because a higher arrival rate leads to more frequent saturation, increasing the chance that incoming customers are blocked due to limited queue capacity. Lastly, the analytical results are in good agreement with the simulation results.

Figure 5‑12 illustrates the impact of the arrival rate on the system throughput (). As increases, rises rapidly at first and then gradually saturates. This is because higher arrival rates supply more customers into the system, but throughput eventually becomes limited by the system service capacity, which is decided by the maximum block size, the block generation rate, the consensus rate, and system transition rate. Lastly, the analytical results are in good agreement with the simulation results.

Figure 5‑7: Effect of arrival rate on average waiting time in the customer queue

Figure 5‑8: Effect of arrival rate on average waiting time in the block queue

Figure 5‑9: Effect of arrival rate on average waiting time in the system

Figure 5‑10: Effect of arrival rate on average number of customers in block queue

Figure 5‑11: Effect of arrival rate on blocking probability

Figure 5‑12: Effect of arrival rate on throughput