using expected 0/1 error for four tech buildings.

There are two qualitatively different shapes in the baseline error curves (Figure 4). For the Robotics Facility and the Observatory, baseline error peaked and then decreased, while for the Citadel of Adun (“Citadel”) and Robotics Support Bay (“Support Bay”), it continued to increase for the entire opening. Our model with no observations tracks the baseline error closely, until the baseline error begins to drop.

We again seem to outperform the baseline from the onset of scouting, though the baseline sometimes makes a comeback at the end of the opening. As with the Gateway results in Section 3.4, the drop in error for the Robotics Facility at the end of the opening is explained by typical strategy. The great majority of openings involve building a single Robotics Facility before epoch 13. In constrast to the Gateway results, our model was able to capture this temporal structure for the Robotics Facility, perhaps because a Robotics Facility is built only once, whereas multiple Gateways are built over a period of time. On the other hand, a Support Bay will only be built in some openings, and will be skipped entirely in others. We would expect error to stabilize after the time period during which the Support Bay would be constructed passes, and we do see some evidence of this for our model with observations. It is also worth noting that the probability of scouting a Robotics Facility given that it exists is 0.37, while the probability of scouting a Support Bay is only 0.18.

3.6 INFERRING ABSENCE OF UNITS

Because we model the probability of observation success as a function of effort put into observing, we can make maximum use of negative observations to infer that units are not present. In Figure 5, we show our model’s error for predictions of the final epoch, given evidence up to varying horizons, in games where the target unit was not present. For example, at horizon 6, the model is making predictions for $t = 13$ given evidence through $t = 6$. The true count is equal to 0, so all of the error comes from over-predicting. We see that as more negative observations arrive, the model revises its predictions downwards. The observation model uses the negative observations to infer that there are currently no units, and the rates of production given by the state model limit the number of units that could be built in the remaining time. The effect is strongest for units that are normally easy to scout. For example, Dragoons are present in all but 11 games, and they are easy to observe because they will be trying to attack the scout. Similarly, Robotics Facilities are both more common and more frequently scouted than Observatories. The baseline (not shown) would have a large, flat error on this task.

3.7 CASE STUDY

To demonstrate how our model would be applied in a game-playing agent, we examined a single game in detail. In this game, the Protoss player follows the Reaver drop strategy, which involves using a transport aircraft to carry a powerful unit called a Reaver behind enemy lines to attack the workers. This attack is potentially devastating, but easy to stop unless we are caught by surprise. We must note that one of the reasons that we chose this particular game is that the Terran player’s scouting was particularly effective, giving our model a chance to make interesting inferences.

The key units in this strategy are the Robotics Support Bay, which is the tech building required for the Reaver; the Shuttle, which is the aircraft that transports the Reaver; and of course the Reaver itself. We can also contrast the Reaver drop opening to the “standard” opening, which involves building an Observatory.

This game features two distinct periods of scouting,