Abstract. We show that, for a coanalytic subspace $X$ of $2^\omega$, the countable dense homogeneity of $X^\omega$ is equivalent to $X$ being Polish. This strengthens a result of Hrušák and Zamora Avilés. Then, inspired by results of Hernández-Gutiérrez, Hrušák and van Mill, using a technique of Medvedev, we construct a non-Polish subspace $X$ of $2^\omega$ such that $X^\omega$ is countable dense homogeneous. This gives the first ZFC answer to a question of Hrušák and Zamora Avilés. Furthermore, since our example is consistently analytic, the equivalence result mentioned above is sharp. Our results also answer a question of Medini and Milovich. Finally, we show that if every countable subset of a zero-dimensional separable metrizable space $X$ is included in a Polish subspace of $X$ then $X^\omega$ is countable dense homogeneous.