## syn\_reg (Gradient Approach)

DATASET: **syn\_reg.csv (Synthetic with Negatives):**

* **Contains negative values** in both features and targets
* Feature range: **3.89 to +4.42** (spans negative and positive)
* Target range: **639.12 to +615.58** (spans negative and positive </aside>

| **Model** | **MSE (Y1)** | **MSE (Y2)** | **Avg MSE** | **MAPE (Y1)** | **MAPE (Y2)** | **Avg MAPE** |
| --- | --- | --- | --- | --- | --- | --- |
| **Linear Regressor** | 1.91e-06 | 9.81e-07 | 1.45e-06 | 0.046% | 0.029% | 0.037% |
| **GP Regressor** | 1.92e-06 | 1.01e-06 | 1.47e-06 | 0.045% | 0.029% | 0.037% |
| **MLP Regressor** | 0.0042 | 0.0072 | 0.0057 | 2.54% | 2.91% | 2.73% |
| **MultiOutput Regressor** | 0.5761 | 1.2027 | 0.8894 | 39.70% | 48.44% | 44.07% |
| **SGD Regressor** | 1.32e+14 | 5.11e+14 | 3.21e+14 | 522,798,474% | 1,022,255,542% | 772,527,008% |
| **Multi-GINN 1 Layer (4 PTA)** | 13.54 | 15.68 | 14.61 | 76.71 | 77.49 | 77.10 |
| **Multi-GINN 1 Layer (6 PTA)** | 2.06 | 1.82 | 1.94 | 50.23 | 42.14 | 46.18 |
| **Multi-GINN 2 Layer (4 PTA)** | 2.05 | 2.19 | 2.12 | 56.77 | 44.83 | 50.80 |
| **Multi-GINN 2 Layer (6 PTA)** | 13.54 | 16.21 | 14.87 | 76.72 | 77.27 | 77.00 |
| **Refitted Equations 1 Layer (4 PTA)** | 2.93 | 2.11 | 2.52 | 56.77 | 49.45 | 53.11 |
| **Refitted Equations 1 Layer (6 PTA)** | 2.93 | 2.11 | 2.52 | 56.77 | 49.45 | 53.11 |
| **Refitted Equations 2 Layer (4 PTA)** | 2.93 | 2.11 | 2.52 | 56.77 | 49.45 | 53.11 |
| **Refitted Equations 2 Layer (6 PTA)** | 2.93 | 2.11 | 2.52 | 56.77 | 49.45 | 53.11 |

**Refitted Equations:**

target 1

0.770384319898311\*X\_1 + 0.0646076947999754\*X\_10 + 0.272410386300816\*X\_2 + 0.188344081710922\*X\_3 + 0.0422547707458164\*X\_4 + 0.0745058537449321\*X\_5 + 0.590724857341408\*X\_6 + 0.329199957361266\*X\_7 + 0.73418249432773\*X\_8 + 0.119696078281247\*X\_9 - 9.99587361466385

target 2

0.504124372587723\*X\_1 + 0.178420637314049\*X\_10 + 0.444889717776257\*X\_2 + 0.452759187412413\*X\_3 + 0.220485558941471\*X\_4 + 0.279359460124295\*X\_5 + 0.442009883737925\*X\_6 + 0.256543941158553\*X\_7 + 0.283274879013817\*X\_8 + 0.497989935297461\*X\_9 - 11.5469985419395