

# Economy of Chest Running

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Chest running is one of the lottery type minigames in Guild Wars. With a modest investment you get a chance to win something valuable. The rewards or 'drops' from a chest differ depending on the level of the chest, as reflected by the price of opening it, and also by the associated mob of monsters<sup>1</sup>. Generally speaking, if you are hoping to find a req9 Leetsword of Muchomoney, your chances are infinitely better if you know which particular chest might drop it. However, the focus of this guide is not in rare high end weapons but in a more mundane bread and butter chest running for maxing various related titles. A maxed Treasure Hunter's title requires 10000 opened high end chests and thus convenient access is more important than monetary gain. But how expensive is the title, then? It depends on several variables that are poorly known or not known at all as far as wiki is concerned. This topic was researched to get some answers, especially concerning the relative difference between Normal and Hard Mode chest running.

## 1 Experiment

Although Normal mode chests can be opened with a key, only lockpicks are considered in this study because of their superior benefits. Also, although there is a variety of chests that provide Treasure Hunter points, only the low and high end options were considered. Other chest types fall somewhere in between and their profitability can be calculated with the same method once enough data have been collected. The experiment was conducted by using 40 lockpicks for Normal Mode 600 g chests (i.e., cheapest chest type that contributes to the Treasure Hunter title track) in an area where drops are

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<sup>1</sup>Every chest spawns with a mob which 'guards' it and drops the same kind of loot that the mob does. If you see a solitary chest the mob might be patrolling nearby or even lurking underground so beware!

inscribable<sup>2</sup>, and 80 lockpicks for Hard Mode chests of the same explorable. All drops were recorded. The character used for running had rank 5 in Treasure Hunting and rank 4 in Lucky. The retain probability of a lockpick is  $p_r = p_b + 0.03r_t + 0.02r_l$  where the base probability  $p_b$  is 0.4 for Normal Mode and 0.1 for Hard Mode, and  $r_t$  and  $r_l$  the treasure hunting and lucky ranks, respectively. The expected number of opened chests is thus  $N/(1-p_r)$  where  $N$  is the number of lockpicks. The results were as following:

40 lockpicks opened 105 Normal Mode chests (expected 108). Of these, 8 were grape armors, 58 grape weapons, 4 gold armors and 35 gold weapons.

80 lockpicks opened 116 Hard Mode chests (expected 119). Of these, 1 was a normal tome, 6 were grape armors, 24 grape weapons, 3 elite tomes, 5 gold armors and 77 gold weapons.

A comparison of grape and gold items from Normal and Hard Mode chests suggests that there are just one type of each. Grape items received in Normal Mode are drawn from the same pool as those from Hard Mode, and likewise a gold item has the same characteristics regardless of which mode it comes from. Hence the only important difference is the relative drop rate of each.

Furthermore, the number of weapons of different requirements between 9 and 13 was found to be 41, 32, 44, 38 and 39, respectively. The distribution was the same for grape and gold weapons alike and suggests that every requirement has a flat 20% chance to be applied. The requirement did not correlate with other characteristics of the weapons like the amount and quality of modifiers.

## 2 Analysis

The results suggest that the chances between grape and gold drop, and between different types (tome/armor/weapon) of drop are independent. In this analysis normal tomes are treated as grapes, and elite tomes as gold. The error of probability estimates can be calculated through the standard deviation of binomial distribution  $\sigma = \sqrt{Np(1-p)}$  where  $N$  is the number of cases and  $p$  is the probability of one outcome out of two. The probabilities for different outcomes are listed in Table 1<sup>3</sup>.

Since the color and type of an item are independent variables, the probability of a particular color and type is the product of the probabilities of

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<sup>2</sup>A noticeable percentage of potential value of a weapon is in its inscription and thus non-inscribable weapons are in average less profitable and only worth pursuing for a rare, i.e., expensive skin.

<sup>3</sup>The relative probabilities of armors and weapons may depend on location but tome probabilities are most likely universal

	NM	HM
$p_g$	$0.63 \pm 0.05$	$0.27 \pm 0.04$
$p_G$	$0.37 \pm 0.05$	$0.73 \pm 0.04$
$p_t$	0.0	$0.034 \pm 0.017$
$p_a$	$0.10 \pm 0.05$	$0.10 \pm 0.04$
$p_w$	$0.90 \pm 0.05$	$0.86 \pm 0.04$

Table 1: Drop probabilities for grape ( $p_g$ ) and gold ( $p_G$ ) items, and tomes ( $p_t$ ), armor ( $p_a$ ) and weapons ( $p_w$ ) for Normal and Hard Mode, respectively.

color and type. E.g., the probability to get a gold weapon in Hard Mode is  $p_{Gw}^H = p_G^H p_w^H = 0.73 * 0.86 \approx 0.63$ .

The worth  $w$  of an item is a quantity without a well defined value. First, there is the merchant value  $v$  that can be found by identifying the item. Then the item may have some additional value  $a$  which depends on the overall game economy and the specific selling strategy used by the player. First, there is the "no sell" strategy where the player doesn't sell anything to other players. Another strategy is "easy sell" where some high value, easy to sell items are sold to other players. Yet another strategy is "hard sell" where anything remotely valuable is salvaged and sold to other players to maximize profit at the expense of time used for finding a buyer. The consequences of the selling strategy must be considered separately for each item color and type. Starting from the easiest category, grape weapons don't have any additional value worth mentioning. On the other hand, gold weapons may have several values depending on which strategy is used to sell them. The "hard sell" values are

$$\begin{aligned}
 a &= a_1 - (1 - p_s)v && \text{if item has one valuable mod} \\
 a &= a_1 + p_s a_2 - (1 - p_s^2)v && \text{if item has two valuable mods} \\
 a &\approx 750 && \text{if req9 weapon} \\
 a &= 0 && \text{otherwise}
 \end{aligned}$$

where  $a_1$  and  $a_2$  are the market values of weapon modifications, and  $p_s = 0.5 + 0.03(r_t + r_w)$  is the salvage retain rate of the character,  $r_t$  and  $r_w$  being the current rank in Treasure Hunter and Wisdom titles, respectively. In the hard sell case mods are salvaged in the order of value if their expected market value is at least 1000 g. Perfect mods and req9 max equipment are sold separately and the remainder is sold to merchant. In the easy sell case mods are only salvaged if their expected market value is at least 1500 g, and req9 weapons are sold to merchant as well. The experiment yielded enough weapons for deriving the values from the sample to a satisfactory precision

	$v$ (g)	$w$ (g)
regular tome	0	500
grape armor	140	240
grape weapon	140	140
elite tome	0	6500
gold armor	280	1100
gold weapon	280	500...880

Table 2: Mean merchant value  $v$  and mean total worth  $w$  of items. Gold weapons have two different worths corresponding to "easy" and "hard" sell cases.

and fluctuations in market prices are larger than error in the sampled average.

The number of armors was too low for a statistically meaningful estimate of additional value. Instead, estimates were based on known high value insignias and runes and their trade values. The relevant insignias were Survivor, Radiant, Bloodstained, Sentinel's, Windwalker's and Centurion's. Runes of significant worth were Major and Superior Vigor, and Superior Fire, Death and all four superior monk runes. All armors from a chest contain a major or superior rune, but only about 75% contain an insignia as well. Also, universal insignias and runes have a somewhat higher probability than profession specific ones, here assumed to be a factor of two. Insignias and rune values are the same for all categories because there is a trader which accepts them. A hard sell player might gain some pieces of gold by selling them to other players instead of to the trader but the gain is most likely not worth the effort.

Tomes don't have any merchant value so a no sell player will use them herself. The mean market value of a regular tome is currently 500 g and that of an elite tome 6500 g. All tomes are considered to be easy to sell because they stack and there is a healthy market for them. The combined estimate of worth of various items is given in Table 2.

The expected yield of a lockpick can now be expressed as

$$y = n_t \sum_i \sum_j p_i p_j w_{ij} \quad (1)$$

where  $n_t = 1/(1 - p_r)$  is the expected number of treasure chests opened and points gained, and the sums are over color and type of items, respectively. In addition to treasure points, a lockpick also provides wisdom points  $n_w = (p_{Ga} + p_{Gw})n_t$ , lucky points  $n_l = 250p_r n_t$  and unlucky points  $n_u = 25$ . The yield and point gains are given in Table 3.

	$(r_t, r_l)$	$p_r$	$y$ (g)	$n_t$	$n_w$	$n_l$
NM	(0, 0)	0.40	503...713	1.67	0.62	167
	(3, 2)	0.53	643...911	2.13	0.79	282
	(6, 5)	0.68	943...1338	3.13	1.16	531
HM	(0, 0)	0.10	698...963	1.11	0.77	28
	(3, 2)	0.23	816...1126	1.30	0.91	75
	(6, 5)	0.38	1013...1398	1.61	1.07	153

Table 3: Retain rates  $p_r$ , yields  $y$  and treasure  $n_t$ , wisdom  $n_w$  and lucky  $n_l$  point gains for a single lockpick for some combinations of treasure  $r_t$  and lucky  $r_l$  rank.

### 3 Discussion

It would be tempting to declare one mode absolutely or even conditionally better than the other. However, the case is not that simple. Besides Treasure points, chest running provides Lucky and Wisdom points which in turn affect the economical gain depending on the current ranks of the character. E.g., even in a case where HM running would be generally better, it may be beneficial to do NM runs when getting close to a level gain in the Lucky rank. An additional complication is that Table 3 only tells how much gold in average a lockpick produces. The actual cost is the difference between that amount and the original cost of the lockpick, and thus the relevant quantity of cost per points gained depends on how the lockpick was obtained, directly from a discount merchant at 1200 g, through a reseller at 1250 g or at full price from a normal merchant at 1500 g. If we assume that it is relatively easy to acquire resold lockpicks at 1250 g the actual cost per treasure point can be calculated as shown in Fig. 1.

The most obvious feature of the treasure point cost profile is that the selling strategy is more important than whichever mode is used for running. The effect of selling strategy is much more pronounced for Hard Mode because the drops consist dominantly of gold weapons. In fact, when only treasure points are considered the order of the options is, from cheapest to most expensive, hard selling hard mode, hard selling normal mode, easy selling normal mode and easy selling hard mode. However, at highest ranks the question is largely moot because all options are either very cheap or even turn in a decent profit.

Taking all the above into account it is then possible to calculate that if a player starts from the beginning (no Treasure, Lucky or Wisdom points), maxing the Treasure Hunter title in Normal Mode will take in average 3760

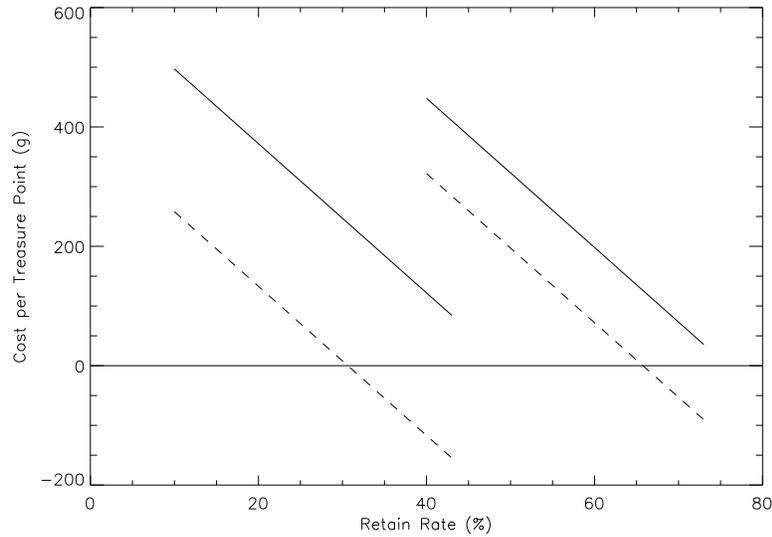


Figure 1: Cost of a treasure hunter point using 1250 g lockpicks in Hard and Normal Mode, as a function of retain rate. Easy sell strategy shown with a solid line and hard sell with a dashed line.

lockpicks and also gain 1560500 Lucky and 3701 Wisdom points. Depending on the selling strategy this will set the player back by 2419400 g for no sell, 1679200 g for easy sell or 418900 g for hard sell, respectively, provided that 1250 g lockpicks are used. For Hard Mode 6979 lockpicks are needed with a gain of 755400 Lucky and 7009 Wisdom points, and at the expense of 5773500 g, 2443200 g or 53000 g, respectively. Thus, roughly speaking, Normal Mode is better for those who are not interested in trading or want to go for maxed Lucky, and Hard Mode is better for keen traders and those who try to max Wisdom. The time needed for maxing the Treasure Hunter title doesn't depend on used mode, and only depends on the selling strategy to the extent which time is used to sell items. One chest opened every two minutes appears to be a very feasible rate, which turns into 333 hours or 14 days of continuous chest running, or twice as long as an Incurrible Ale-hound.