Smart Contract Audit Report for Petcoin

Testers

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Management Summary

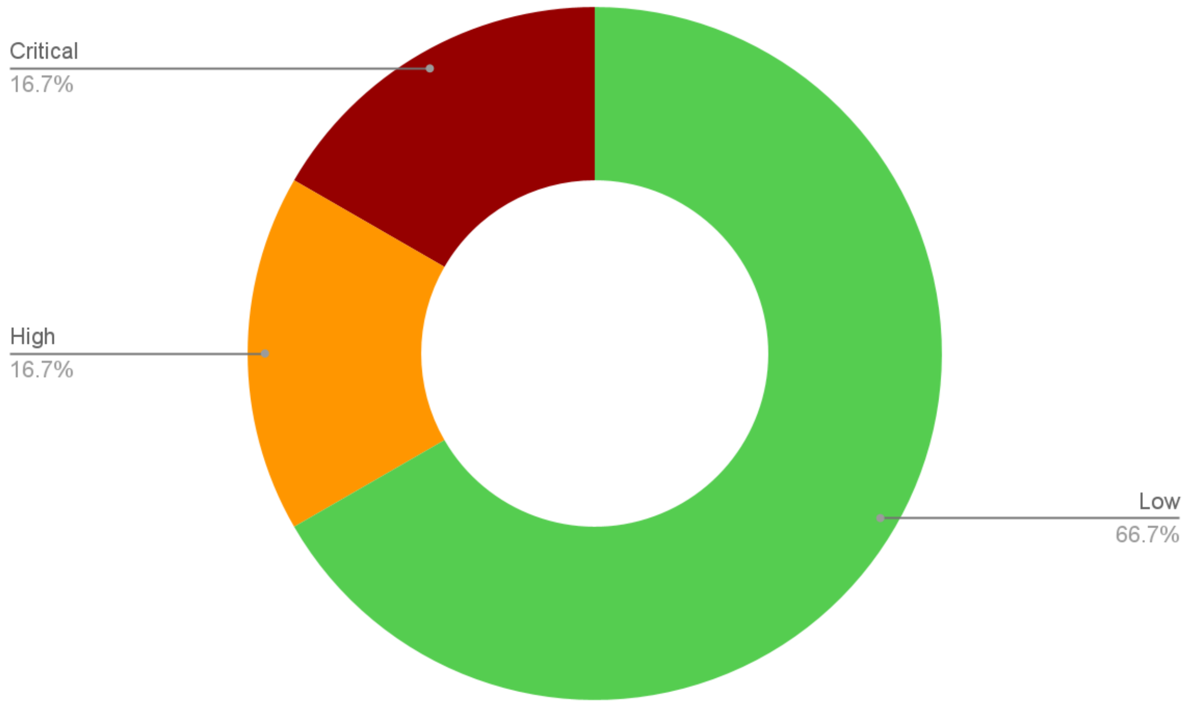
Petcoin contacted Sayfer to perform a security audit on their smart contract.

This report documents the research carried out by Sayfer targeting the selected resources defined under the research scope. Particularly, this report displays the security posture review for the Petcoin smart contract.

Over the research period of 40 research hours, we discovered 6 vulnerabilities in the contract. One of them is marked as critical as deploying the contract as is, which can cause an unusable contract.

The Percoin team was quick to react and fixed all the findings within 24h.

Vulnerabilities by Risk



Risk	Low	Medium	High	Critical	Informational
# of issues	4	0	1	1	0

- **Critical** - Immediate or ongoing part of the business being exploited with direct key business losses.
- **High** – Direct threat to key business processes.
- **Medium** – Indirect threat to key business processes or partial threat to business processes.
- **Low** – No direct threat exists. The vulnerability may be exploited using other vulnerabilities.
- **Informational** – This finding does not indicate vulnerability, but states a comment that notifies about design flaws and improper implementation that might cause a problem in the long run.

Approach

Introduction

Petcoin contacted Sayfer to perform a security audit on their smart contracts.

This report documents the research carried out by Sayfer targeting the selected resources defined under the research scope. Particularly, this report displays the security posture review for the aforementioned contracts.

Scope Overview

Together with the client team we defined the following contract as the scope of the project:

Petcoin.sol	6755146f013b4e649a5e5213a9af44ce17c57b6ef7a02449df74477eb6f680e8

Scope Validation

We began by ensuring that the scope defined to us by the client was technically logical. Deciding what scope is right for a given system is part of the initial discussion.

Threat Model

We defined that the largest current threat to the system is the ability of malicious users to steal funds from the contract.

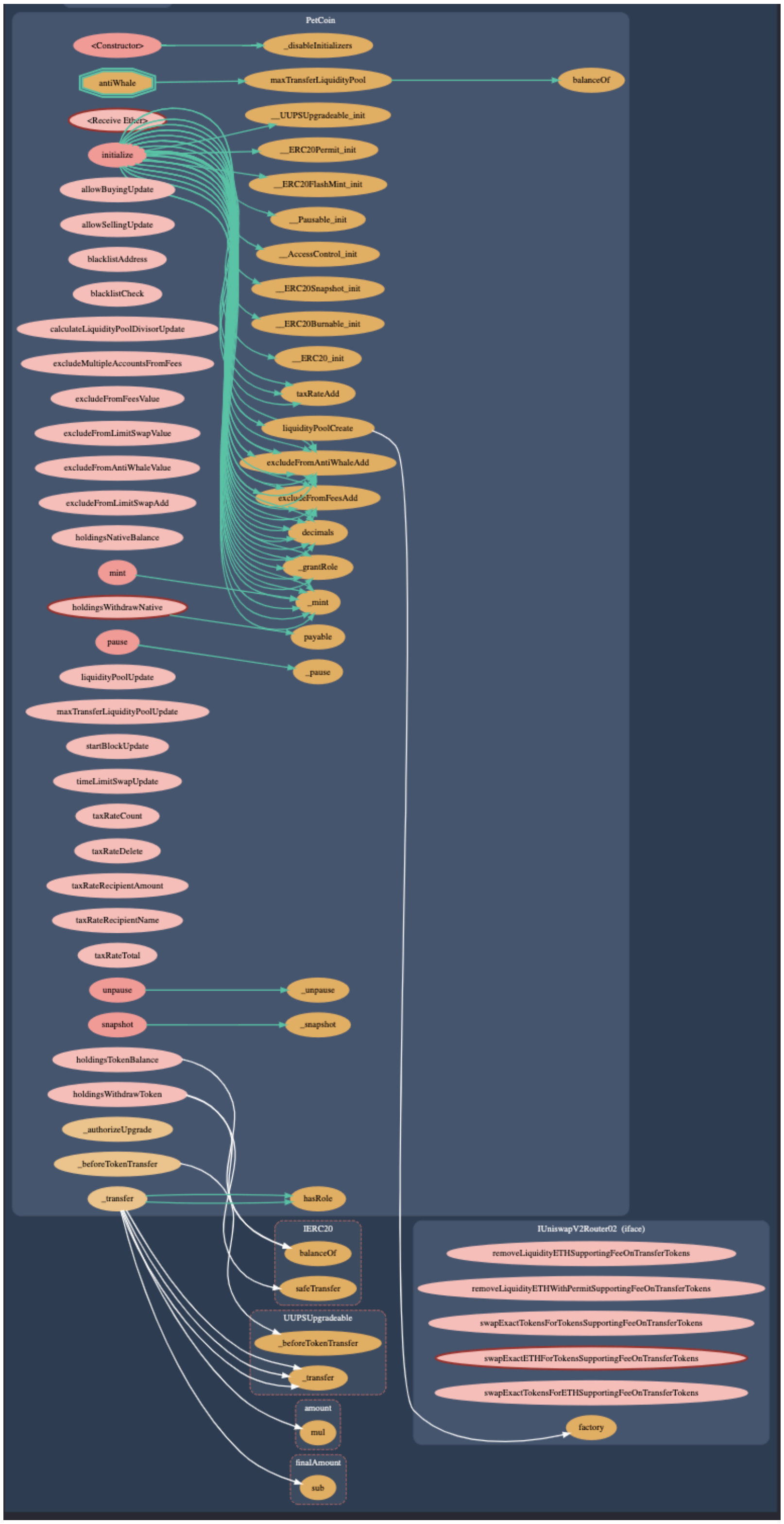
Protocol Overview

Protocol Introduction

PetCoin is a digital currency with a cause. A portion of each transaction is automatically donated to shelters and rescues in desperate need of assistance.

With low fees, high transparency, and blockchain-powered technology, PetCoin is ready to make a significant impact on our furry friends in need.

Protocol Graph



Security Evaluation

The following test cases were the guideline while auditing the system. This checklist is a modified version of the SCSVS v1.2, with improved grammar, clarity, conciseness and additional criteria. Where there is a gap in the numbering, an original criterion was removed. Criteria that are marked with an asterisk were added by us.

Architecture, Design and Threat Modeling	Test Name
G1.2	Every introduced design change is preceded by threat modeling.
G1.3	The documentation clearly and precisely defines all trust boundaries in the contract (trusted relations with other contracts and significant data flows).
G1.4	The SCSVS, security requirements or policy is available to all developers and testers.
G1.5	The events for the (state changing/crucial for business) operations are defined.
G1.6	The project includes a mechanism that can temporarily stop sensitive functionalities in case of an attack. This mechanism should not block users’ access to their assets (e.g. tokens).
G1.7	The amount of unused cryptocurrencies kept on the contract is controlled and at the minimum acceptable level so as not to become a potential target of an attack.
G1.8	If the fallback function can be called by anyone, it is included in the threat model.
G1.9	Business logic is consistent. Important changes in the logic should be applied in all contracts.
G1.10	Automatic code analysis tools are employed to detect vulnerabilities.
G1.11	The latest major release of Solidity is used.
G1.12	When using an external implementation of a contract, the most recent version is used.
G1.13	When functions are overridden to extend functionality, the super keyword is used to maintain previous functionality.
G1.14	The order of inheritance is carefully specified.
G1.15	There is a component that monitors contract activity using events.
G1.16	The threat model includes whale transactions.
G1.17	The leakage of one private key does not compromise the security of the entire project.

Policies and Procedures	Test Name
G2.2	The system's security is under constant monitoring (e.g. the expected level of funds).
G2.3	There is a policy to track new security vulnerabilities and to update libraries to the latest secure version.
G2.4	The security department can be publicly contacted and that the procedure for handling reported bugs (e.g., thorough bug bounty) is well-defined.
G2.5	The process of adding new components to the system is well defined.
G2.6	The process of major system changes involves threat modeling by an external company.
G2.7	The process of adding and updating components to the system includes a security audit by an external company.
G2.8	In the event of a hack, there's a clear and well known mitigation procedure in place.
G2.9	The procedure in the event of a hack clearly defines which persons are to execute the required actions.
G2.10	The procedure includes alarming other projects about the hack through trusted channels.
G2.11	A private key leak mitigation procedure is defined.

Upgradability	Test Name
G2.2	Before upgrading, an emulation is made in a fork of the main network and everything works as expected on the local copy.
G2.3	The upgrade process is executed by a multisig contract where more than one person must approve the operation.
G2.4	Timelocks are used for important operations so that the users have time to observe upcoming changes (please note that removing potential vulnerabilities in this case may be more difficult).
G2.5	*initialize()* can only be called once.
G2.6	*initialize()* can only be called by an authorized role through appropriate modifiers (e.g. *initializer*, *onlyOwner*).
G2.7	The update process is done in a single transaction so that no one can front-run it.
G2.8	Upgradeable contracts have reserved gap on slots to prevent overwriting.
G2.9	The number of reserved (as a gap) slots has been reduced appropriately if new variables have been added.
G2.10	There are no changes in the order in which the contract state variables are declared, nor their types.
G2.11	New values returned by the functions are the same as in previous versions of the contract (e.g. *owner()*, *balanceOf(address)*).

G2.12	The implementation is initialized.
G2.13	The implementation can't be destroyed.

Business Logic	**Test Name**
G4.2	The contract logic and protocol parameters implementation corresponds to the documentation.
G4.3	The business logic proceeds in a sequential step order and it is not possible to skip steps or to do it in a different order than designed.
G4.4	The contract has correctly enforced business limits.
G4.5	The business logic does not rely on the values retrieved from untrusted contracts (especially when there are multiple calls to the same contract in a single flow).
G4.6	The business logic does not rely on the contract's balance (e.g., *balance* == *0*).
G4.7	Sensitive operations do not depend on block data (e.g., *block hash*, *timestamp*).
G4.8	The contract uses mechanisms that mitigate transaction-ordering (front-running) attacks (e.g. pre-commit schemes).
G4.9	The contract does not send funds automatically, but lets users withdraw funds in separate transactions instead.

Access Control	**Test Name**
G5.2	The principle of the least privilege is upheld. Other contracts should only be able to access functions and data for which they possess specific authorization.
G5.3	New contracts with access to the audited contract adhere to the principle of minimum rights by default. Contracts should have a minimal or no permissions until access to the new features is explicitly granted.
G5.4	The creator of the contract complies with the principle of the least privilege and their rights strictly follow those outlined in the documentation.
G5.5	The contract enforces the access control rules specified in a trusted contract, especially if the dApp client-side access control is present and could be bypassed.
G5.6	Calls to external contracts are only allowed if necessary.
G5.7	Modifier code is clear and simple. The logic should not contain external calls to untrusted contracts.
G5.8	All user and data attributes used by access controls are kept in trusted contracts and cannot be manipulated by other contracts unless specifically authorized.
G5.9	the access controls fail securely, including when a revert occurs.
G5.10	If the input (function parameters) is validated, the positive validation approach (whitelisting) is used where possible.

Communication	**Test Name**

G6.2	Libraries that are not part of the application (but the smart contract relies on to operate) are identified.
G6.3	Delegate call is not used with untrusted contracts.
G6.4	Third party contracts do not shadow special functions (e.g. revert).
G6.5	The contract does not check whether the address is a contract using *extcodesize* opcode.
G6.6	Re-entrancy attacks are mitigated by blocking recursive calls from other contracts and following the Check-Effects-Interactions pattern. Do not use the *send* function unless it is a must.
G6.7	The result of low-level function calls (e.g. *send*, *delegatecall*, *call*) from other contracts is checked.
G6.8	Contract relies on the data provided by the right sender and does not rely on tx.origin value.

Arithmetic	**Test Name**
G7.2	The values and math operations are resistant to integer overflows. Use SafeMath library for arithmetic operations before solidity 0.8.*.
G7.3	the unchecked code snippets from Solidity ≥ 0.8.* do not introduce integer under/overflows.
G7.4	Extreme values (e.g. maximum and minimum values of the variable type) are considered and do not change the logic flow of the contract.
G7.5	Non-strict inequality is used for balance equality.
G7.6	Correct orders of magnitude are used in the calculations.
G7.7	In calculations, multiplication is performed before division for accuracy.
G7.8	The contract does not assume fixed-point precision and uses a multiplier or store both the numerator and denominator.

Denial of Service	**Test Name**
G8.2	The contract does not iterate over unbound loops.
G8.3	Self-destruct functionality is used only if necessary. If it is included in the contract, it should be clearly described in the documentation.
G8.4	The business logic isn't blocked if an actor (e.g. contract, account, oracle) is absent.
G8.5	The business logic does not disincentivize users to use contracts (e.g. the cost of transaction is higher than the profit).
G8.6	Expressions of functions assert or require have a passing variant.
G8.7	If the fallback function is not callable by anyone, it is not blocking contract functionalities.
G8.8	There are no costly operations in a loop.

G8.9	There are no calls to untrusted contracts in a loop.
G8.10	If there is a possibility of suspending the operation of the contract, it is also possible to resume it.
G8.11	If whitelists and blacklists are used, they do not interfere with normal operation of the system.
G8.12	There is no DoS caused by overflows and underflows.

Blockchain Data	**Test Name**
G9.2	Any saved data in contracts is not considered secure or private (even private variables).
G9.3	No confidential data is stored in the blockchain (passwords, personal data, token etc.).
G9.4	Contracts do not use string literals as keys for mappings. Global constants are used instead to prevent Homoglyph attack.
G9.5	Contract does not trivially generate pseudorandom numbers based on the information from blockchain (e.g. seeding with the block number).

Gas Usage and Limitations	**Test Name**
G10.2	Gas usage is anticipated, defined and has clear limitations that cannot be exceeded. Both code structure and malicious input should not cause gas exhaustion.
G10.3	Function execution and functionality does not depend on hard-coded gas fees (they are bound to vary).

Clarity and Readability	**Test Name**
G11.2	The logic is clear and modularized in multiple simple contracts and functions.
G11.3	Each contract has a short 1-2 sentence comment that explains its purpose and functionality.
G11.4	Off-the-shelf implementations are used, this is made clear in comment. If these implementations have been modified, the modifications are noted throughout the contract.
G11.5	The inheritance order is taken into account in contracts that use multiple inheritance and shadow functions.
G11.6	Where possible, contracts use existing tested code (e.g. token contracts or mechanisms like *ownable*) instead of implementing their own.
G11.7	Consistent naming patterns are followed throughout the project.
G11.8	Variables have distinctive names.

G11.9	All storage variables are initialized.
G11.10	Functions with specified return type return a value of that type.
G11.11	All functions and variables are used.
G11.12	*require* is used instead of *revert* in *if* statements.
G11.13	The *assert* function is used to test for internal errors and the *require* function is used to ensure a valid condition in input from users and external contracts.
G11.14	Assembly code is only used if necessary.

Test Coverage	**Test Name**
G12.2	Abuse narratives detailed in the threat model are covered by unit tests.
G12.3	Sensitive functions in verified contracts are covered with tests in the development phase.
G12.4	Implementation of verified contracts has been checked for security vulnerabilities using both static and dynamic analysis.
G12.5	Contract specification has been formally verified.
G12.6	The specification and results of the formal verification is included in the documentation.

Decentralized Finance	**Test Name**
G14.1	The lender's contract does not assume its balance (used to confirm loan repayment) to be changed only with its own functions.
G14.2	Functions that change lenders' balance and/or lend cryptocurrency are non-re-entrant if the smart contract allows borrowing the main platform's cryptocurrency (e.g. Ethereum). It blocks the attacks that update the borrower's balance during the flash loan execution.
G14.3	Flash loan functions can only call predefined functions on the receiving contract. If it is possible, define a trusted subset of contracts to be called. Usually, the sending (borrowing) contract is the one to be called back.
G14.4	If it includes potentially dangerous operations (e.g. sending back more ETH/tokens than borrowed), the receiver's function that handles borrowed ETH or tokens can be called only by the pool and within a process initiated by the receiving contract's owner or another trusted source (e.g. multisig).
G14.5	Calculations of liquidity pool share are performed with the highest possible precision (e.g. if the contribution is calculated for ETH it should be done with 18 digit precision - for Wei, not Ether). The dividend must be multiplied by the 10 to the power of the number of decimal digits (e.g. dividend * 10^18 / divisor).
G14.6	Rewards cannot be calculated and distributed within the same function call that deposits tokens (it should also be defined as non-re-entrant). This protects from

	momentary fluctuations in shares.
G14.7	Governance contracts are protected from flash loan attacks. One possible mitigation technique is to require the process of depositing governance tokens and proposing a change to be executed in different transactions included in different blocks.
G14.8	When using on-chain oracles, contracts are able to pause operations based on the oracles' result (in case of a compromised oracle).
G14.9	External contracts (even trusted ones) that are allowed to change the attributes of a project contract (e.g. token price) have the following limitations implemented: thresholds for the change (e.g. no more/less than 5%) and a limit of updates (e.g. one update per day).
G14.10	Contract attributes that can be updated by the external contracts (even trusted ones) are monitored (e.g. using events) and an incident response procedure is implemented (e.g. during an ongoing attack).
G14.11	Complex math operations that consist of both multiplication and division operations first perform multiplications and then division.
G14.12	When calculating exchange prices (e.g. ETH to token or vice versa), the numerator and denominator are multiplied by the reserves (see the *getInputPrice* function in the *UniswapExchange* contract).

Audit Findings

Hardcoded values to msg.sender

<table>
<tr><td>Status</td><td>Fixed</td></tr>
<tr><td>Risk</td><td>Critical</td></tr>
<tr><td>Location</td><td>initialize function</td></tr>
<tr><td>Tools</td><td>Manual testing</td></tr>
<tr><td>Description</td><td>

Multiple variables are hardcoded to msg.sender, which is wrong as the real addresses are set in a commented code.

While this is probably by local or testnet debugging, having it right before the deployment can cause developers to deploy it as it and forget to change it.

```
       // TODO Vulnerability
       // address walletPetCoinSafe =
0xe251b3D01966C84E6833056077B2faF411839B86;
       // address walletLiquidity =
0x9cDc5e4E32B3F6d58b7ED62971b185a67a31DA4c;
       // address walletPublicSale =
0x5cc6D2D19912191D589324012b8aCc7337D10380;
       // address walletReserve =
0x9d13BD96722A2834638849E8f362785A1d1aD3E1;
       // address walletTreasury =
0xbbEbE0F1c36AA937d1474d0C1370fa91F70b820D;
       // address walletCharity =
0xbc6C5697f205D339Db8F3eA0762125E02f621daB;
       // address walletFounders =
0xDDb914BB14406B505638eFa5273552c356B7B85c;

       address walletPetCoinSafe = msg.sender;
       address walletLiquidity = msg.sender;
       address walletPublicSale = msg.sender;
       address walletReserve = msg.sender;
       address walletTreasury = msg.sender;
```

</td></tr>
<tr><td>Mitigation</td><td>Replace the initializations to msg.sender with the previous commented lines.</td></tr>
</table>

Deleting Array Element While Iterating over it

Status	Fixed
Risk	High
Location	taxRateDelete function
Tools	Manual testing

Description	iterating over an array and then deleting an element in it can cause unexpected behavior. This can cause wrong length vulnerabilities or 0x0 address filling up the array causing significant gas consumption after multiple deletion
	<pre> function taxRateDelete(address recipientAddress)
	onlyRole(DEFAULT_ADMIN_ROLE) external returns (bool){
	        if(isInTaxMap[recipientAddress]) {
	            // loops all taxKeys to find array key for recipientAddress
	            for(uint i; i < taxKeys.length; ++i){
	                if(taxKeys[i] == recipientAddress){
	                    delete taxKeys[i];
	                }
	            }
	            delete taxRecipientName[recipientAddress];
	            delete taxRecipientRate[recipientAddress];
	            delete isInTaxMap[recipientAddress];
	            return true;
	        }
	        return false;
	    }</pre>

Mitigation	The team proposed creating another temporary array. Sayfer propsued a long-term solution - using a mapping for address => RecipientStruct which eliminates the need for multiple variables and for loops

Missing events

Status	Fixed
Risk	Low
Location	liquidityPoolCreate, liquidityPoolUpdate functions
Tools	Manual testing
Description	Two critical functions liquidityPoolCreate and liquidityPoolUpdate, do not emit events. An audit trail for security and user actions performed on the contract can be generated using events. In addition, these events can be used to create a custom monitoring system that alerts owners or security tools of a potential upcoming attack
Mitigation	Add events for liquidityPoolCreate and liquidityPoolUpdate

Unused variables/events/libs

Status	Fixed
Risk	Low
Location	Multiple places
Tools	Manual testing
Description	We found multiple unused variables: 1. Line 13: Library Counters.sol 2. Line 50: Event CreateLiquidityPool 3. Line 55: Event MaxTransferAmountRateUpdated Having unused variables in the code can: ● Cause an increase in computations (and unnecessary gas consumption) ● Indicate bugs or malformed data structures and they are generally a sign of poor code quality ● Cause code noise and decrease readability of the code
Mitigation	Remove everything that is not used.

Wrong error message

Status	Fixed
Risk	Low
Location	_transfer function
Tools	Manual testing

Description	On line 383 the error message is wrong. We think the if statement condition is correct and it is just the error message, but please verify us.
	
	`if(!allowSelling && !hasRole(DEFAULT_ADMIN_ROLE, sender) && sender != address(this) && !excludedFromLimitSwap[sender]){`
	`    require(recipient != liquidityPoolAddress, "PETCOIN: Selling disabled");`
	`}`
	
	This could indicate something bigger that was implemented the wrong way, we can not know for sure

Mitigation	Fix the error message or, if the code should have a different condition, implement it correctly

startBlock Checking Redundancy

Status	Fixed
Risk	Low
Location	_transfer function and antiWhale modifier
Tools	Manual testing
Description	startBlock is being checked in both the antiWhale modifier as well as inside the _transfer function which is redundant. From a logical/architecture the anti Whale modifier isn't supposed to check for this. Having such logic can cause confusion in future versions of the contract and create gas waste `require(startBlock <= block.number, "PETS::swap: Cannot Swap at the moment");`
Mitigation	Remove the startBlock check from the antiWhale modifer